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**DEVELOPMENT AND EVALUATION OF A LOW-FIDELITY MEDICATION ADMINISTRATION
SIMULATION THAT GENERATES ERROR AS A SALIENT LEARNING EXPERIENCE FOR FIRST-YEAR
NURSING STUDENTS OVER THE LONG-TERM**

by

Sinead Marie Helyar

Thesis for the degree of Doctor of Philosophy

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ABSTRACT HEADING

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ABSTRACT

Nurses are taught protocolised checking procedures as the foundation method for safe medication administration practice. However, medication administration occurs in the complex clinical environment and medication administration error is endemic in clinical practice. As a consequence, nurses need further support to administer medications safely. Simulation education is widely used in nurse education and making an error in simulation is one potential method to make salient the importance of protocolised checking procedures in clinical practice. The purpose of this study was to determine if a low-fidelity medication administration simulation which generated error underlined the importance of checking procedures and provided a salient, effective and sufficiently realistic learning experience for nursing students over the long-term.

The study was conducted over a three-year period between April 2007 and April 2010. A low-fidelity online medication administration simulation was developed which replicated a hospital-based medication round using paper charts. A preliminary titration study was completed to titrate variables from clinical practice to generate a 'right drug, wrong patient' error was generated if the 'five rights' were not applied. In the comparative study, 124 first-year nursing students were randomly allocated to one of three teaching sessions: the simulation session or one of two identical classroom-based sessions in which students made an error external to the simulation but was actively linked to medication administration error. In one of these sessions, participants were informed about the simulation, its underlying theory and rates of error generated. All participants completed a post session questionnaire investigating the impact of their learning experience. In the long-term qualitative interview study, 12 simulation session participants completed qualitative interviews two-years later about their experience of using the simulation.

35% of participants made an error in the simulation. The results of the questionnaire indicated that a combination of the simulation and the classroom-based session comprised the most effective learning format. The majority of qualitative interview study participants considered the simulation and the active experience of error to be a valuable and realistic learning experience. It reinforced the importance of the five rights and the potential risk of error if they are not applied.

The active experience of error in the simulation underlined the importance of the five rights and generated affect to provide an effective learning experience which was salient over the long-term. The active experience of error made the simulation sufficiently realistic. Error can make lower-fidelity simulations more realistic and salient over the long-term. Error should be transformed from a useful but passive by-product into an active component of the simulation learning approach.

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List of Accompanying Materials

CD - Medication Administration Simulation

DECLARATION OF AUTHORSHIP

I, Sinead M Helyar

declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

Development and Evaluation of a Low-fidelity Medication Administration Simulation that Generates Error as a Salient Learning Experience for First Year Nursing Students Over the Long-term

I confirm that:

1. This work was done wholly or mainly while in candidature for a research degree at this University;
2. Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
3. Where I have consulted the published work of others, this is always clearly attributed;
4. Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
5. I have acknowledged all main sources of help;
6. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
7. Parts of this work have been published as:

Helyar, S., Griffiths, P., Norman, I. J. (2014). The damage I could do..." Qualitative evaluation of a low-fidelity medication administration simulation that generates error as a learning experience for pre-registration nursing students. *Journal of Nursing Education and Practice*. 4,(2)

Signed:

Date:

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Making mistakes simply means you are learning faster. Weston H. Agor

Chapter 1: Background

1.1 Summary

Medication administration error is a persistent and multifaceted and global patient safety issue (World Health Organisation 2016). Historically, the focus of medication administration error centred on the individual who made the error (for example, Wolf 1989). The literature cites numerous causes of medication administration error that relate to individual, for example, inadequate calculation skills (Oldridge et al 2004), lack of knowledge (Hicks et al 2004) and fatigue (Ulanimo et al 2007, Gordon et al 2006, Keers et al 2013 and Feleke et al 2015). More recently, focus has centred on a systemic approach to error. This approach recognises that many causes of error, including those attributed to the individual, are frequently systemic in origin (Reason 2000). Nurses administer medications in a system led, error prone, busy, distracting and changeable clinical environment (Santell et al 2006 and Croskerry et al 2004, Westbrook et al 2010, Feleke et al 2015 and Armstrong et al 2016) which generates conditions for error to occur. The systemic approach analyses the organisation, its systems, structures, training and processes to identify underlying systemic causes of human error to generate solutions to minimise and mitigate future error.

1.2 Research Problem and Significance

In the United Kingdom, pre-registration student nurses are taught to administer medications using a variety of theory based protocolised checking procedures, for example, the five rights (Jones and Treiber 2010) in university to be applied in clinical placement. A cornerstone of the United Kingdom's nursing code, 'Professional Standards of Practice and Behaviours for Nurses and Midwives' (Nursing and Midwifery Council (NMC) 2015a) is to provide safe and effective care, including in medication administration. The extent of medication administration error (National Patient Safety Agency (NPSA) 2015), demonstrates that medication administration error remains a real and ubiquitous patient safety concern in clinical practice. The rate of medication administration error highlights a disconnect between the professional obligations of nurses to provide safe medication management and the standard of care received by patients. The systemic approach to minimise error advocates a multifaceted approach which includes designing work processes to facilitate safe and effective medication administration. Integral to this approach is to support nurses to administer medications safely. Nursing is a practice-based profession and nurse education must develop educational tools to support nurses to provide safe and effective clinical practice over a nursing career. One concern is that universities often do not cater or support

student nurses to understand the complexities of clinical practice where theory, such as the five rights, should be applied (Rafferty et al 1996). As a consequence, student nurses can find it difficult to link theory to practice. University education must actively support student nurses to construct links between theory and practice to support the application of checking procedures, such as the five rights within the complex clinical environment (Tang et al 2007).

Simulation is an education tool which can potentially create and support links between theory and practice and provide insights into the complexities of clinical practice (Hope et al 2011) within the university setting. Simulation can represent various aspects of the clinical environment to encompass both intellectual and practical learning (Rauen 2004 and Long 2005). The literature suggests that one central benefit of simulation education is that it provides an active learning experience (Shin et al 2015) and the opportunity to make and learn from error safely (Ziv et al 2000 and 2005). Simulations which are salient, incorporate the richness of clinical practice and enable students to learn from error are considered to be an effective education tool (Kneebone et al 2007 and Kneebone 2010). Making an error in a simulation that accurately replicates the complex clinical environment has the potential to underline to nursing students the importance of protocolised checking procedures to clinical practice.

1.3 Rationale for the Study

Medication error is most prevalent during the medication administration stage and minimising error is essential to providing a safe healthcare system. In order to develop effective solutions to reduce medication administration error, medication administration should be viewed within the wider, systemic context of health care, rather than as an isolated process undertaken by an individual (Wright 2013). In recognition of this, numerous strategies have sought to redesign the clinical environment to support safer medication administration practice. Examples include the optimisation of staff/patient ratios (National Institute for Health and Care Excellence 2014), adoption of barcode technologies (Poon et al 2010), management observing nurse medication administrations (Drach-Zahavy et al 2014), and dedicated medication cabinets / administration rooms (Davis 1994 and Connard et al 2010). However, no matter how many initiatives are implemented to improve conditions and procedures in which nurses administer medications, the literature, for example Stultz and Nahata (2015) suggests that the inherent complexity of the clinical environment means systemic causes of medication administration error are unlikely to be fully eradicated.

Simulation and the experience of error can potentially support student nurses to understand the importance of, and transfer the theory of checking procedures to clinical practice. Currently, the literature advocates the use of high-fidelity simulation as the most effective learning experience because it is deemed to be most realistic (Yuan et al 2012 and Butler et al 2009). However, developing, integrating and maintaining high-fidelity simulation into the student nurse curriculum is expensive (Gaba 2004 and Zigmont et al 2011), and can pose a significant challenge for nurse educators (Parker and Myrick 2009). In addition, evidence is still required to justify the investment required (Lapkin and Levett-Jones 2011) over lower-fidelity alternatives. Incorporating error into a low-fidelity simulation is one method that could make a low-fidelity simulation realistic and transform it into a cost-effective, salient learning experience over the long-term.

The aim of this study was to develop a low-fidelity online simulation that generated error, as a salient learning experience for first-year nursing students over the long-term. The simulation incorporated real life causes of error to generate error a 'right drug, wrong patient' error. Firstly, the experience of error would generate affect and makes salient and available the importance of applying checking procedures, in the form of the five rights of medication administration in clinical practice over the long-term. Secondly, error would transform the low-fidelity medication administration simulation into a realistic, authentic and effective learning experience.

Chapter 2: Medication Error Overview

2.1 Introduction

Chapter 2 outlines medication administration error as a significant patient safety issue and examines the role of nurse education and simulation to further support nurse medication administration practice. Section 2.2 examines what is a medication administration error and details the prevalence of medication administration error in clinical practice. Section 2.3 details the potential consequences of error for both patients and clinical personnel as well as the financial implications for healthcare systems to underline the need to improve medication administration practice. Section 2.4 discusses the unique role of nurses within medication administration and how this affects medication administration error. Section 2.5 examines the individual and contextual causes of medication administration error and section 2.6 establishes the historical and current strategies used to reduce medication administration error. Section 2.7 will introduce the potential role of simulation as an educational tool to support safer nurse medication administration practice.

2.2 Definition and Prevalence of Medication Administration Error

Medication error is endemic in healthcare and is a major patient safety issue. The seminal document 'To Err is Human' published by the Institute of Medicine (1999) describes error as 'a failure to complete a planned action as intended, or the use of an incorrect plan of action to achieve a given aim' p21), or when the failure cannot be attributed to chance (Reason 1990). Medication error is one classification of a patient-related safety incident that result in "any unintended or unexpected incident which could have or did lead to harm for one or more patients" (Medicines and Healthcare Regulations Agency (MHRA) 2014) p2. Within this classification, medication error is an error that occurs during the prescription, transcription, dispensing or administration stage of medication management. Within this, medication error is a failure in the treatment process that leads to, or has the potential to lead to, harm to the patient (Aronson 2009a). Potential or actual harm occurs through the patient not receiving required

treatment or receiving unnecessary treatment. A medication error differs from other forms of medication-related patient safety incident because it is preventable and can be predicted beforehand (NPSA 2009). One key example is patient allergy status. A medication-related incident occurs when a patient experiences an allergic reaction to a medication taken for the first time and the allergic response could not have been predicted. The same scenario becomes a medication error if the patient is known to be allergic to the medication and the medication is still prescribed and administered, even if harm does not subsequently occur. Aronson's use of the concept of failure within the definition of medication error is important. It signifies that the medication management process has fallen below the acceptable standard of care which patients should receive. Medication error also comprises a multiplicity of sub-classifications and it is important to have precise definitions of medication error, so that patients, prescribers, manufacturers and regulators can all understand each other (Aronson 2009a). This can involve numerous error scenarios across the whole medication process, for example, inappropriate prescription, errors within the written prescription which leads to the wrong dose, dispensing the wrong formulation of medicine, or administering the incorrect medication or dose (Aronson 2009a).

Medication error remains a prominent patient safety issue. It is one of the most common causes of unintended harm to patients and constitutes large financial burden to healthcare systems (Cloete 2015). Medication-related incidents, which forms all medication incidents including error, constitute a consistent and prominent cause of harm to patients. Between April 2015-March 2016, there were 205,255 reported medication incidents in England and Wales (National Reporting and Learning System (NRLS) 2016). This was the third most common form of reported patient-related incident after patient accident and inappropriate implementation / monitoring of care, and the vast majority were reported within the acute hospital setting. Medication error constitutes a similarly prevalent issue in comparable international healthcare systems. For example, approximately 1.3 million people in the United States experience medical error annually and within this, medication error forms a substantial component (Allen 2013). The extent of medication error highlights that expected standards of medication management are frequently not achieved and as a consequence, patients receive suboptimal care.

Medication error is also an increasingly reported problem, with approximately 50,000 additional reports submitted between 2005 and 2007 (NPSA 2007, 2009). In addition, between April 2013 and March 2014, 159,000 medicine-related incidents were reported to the NRLS for England

(National Institute for Health Care Excellence (NICE) 2015). More recently, between April 2015 and September 2015, there were 74,464 medication incidents reported to the NRLS from acute specialist and acute non-specialist departments across 143 hospitals within the United Kingdom (NRLS 2015). However, despite increased rates of reporting, the United Kingdom's National Health Service (NHS) 'Review of Candour' estimated that only 7-15% of incidents were reported and that the levels of reporting fail to provide an accurate picture of the extent, level of harm and cost of error in healthcare (Dalton and Williams 2014).

In the context of medication administration error, definitions of medication administration error vary across the literature and include deviation from any medication administration procedure, policy or best practice (Drach-Zahavy et al 2014), and the discrepancy between the medication received and the intentions of the prescriber (Department of Health 2004). Aronson (2009a) states medication administration error can include the wrong dose, wrong route, wrong frequency and wrong duration.

The majority of studies highlight that medication administration is both the most prolific form of medication error and the most likely form to be reported (NPSA 2009 and Choi et al 2016). Whilst research methods employed vary, and as a consequence identify different rates of error, all highlight medication administration error as consistent and important problem. For example, in an analysis of incident reports, Picone et al (2008), Hicks et al (2004) and Beyea et al (2003) highlight that medication administration error accounts for 54.2%-62.0% of all medication errors. Keers et al (2013) completed a systematic review to determine the prevalence and nature of hospital inpatient medication administration errors published between 1985 and May 2013. Studies were included if they were published in English and identified causes in relation to specific errors or near misses that staff members either made themselves or were directly involved with. This was a comprehensive study which included 91 studies across Europe, the United Kingdom and the United States. It also captured various research methods, including direct observation, interview, log book, chart review and questionnaire, and encompassed a wide range of locations, research methods and clinical areas. A median error rate across studies of 19.6%, or one in five doses was identified.

There are a number of mixed method studies, including observational analysis that underline the prevalence of medication administration error, particularly in comparison to other forms of medication error. For example, Dabaghzadeh et al (2013) assessed the incidence and characterised the type of medication error within a 24-bed emergency department in a large teaching hospital in Tehran between February and March 2010. Two hospital pharmacists and two clinical pharmacy residents observed care provision and collected data on 203 medication errors observed over 180 hours. The incidence of medication error was 50.5% at various times within the emergency department, 63.6% of which occurred during medication administration. In addition, Härkänen et al (2015) completed a cross-sectional study to specifically determine the frequency, type, and severity of medication administration error in four medical and surgical wards at a university hospital in Finland between April and May 2012. A combination of direct observations and medication record reviews was conducted to identify the accuracy of 1058 medications administered to 122 inpatients by 32 registered nurses. Observations were recorded using a structured observation form and a review of the patients' medication record. A multiprofessional team analysed and classified all of the detected errors and assessed their severity. At least one error was found in 22.2% (235/1058) of administered medications, 63.4% of which were medication administration errors.

There are a minority of studies that suggest other forms of medication error are more common. For example, Shehata et al (2016) suggests prescribing errors are more frequent. Fifty hospital pharmacists reviewed and analysed 12,000 medication error reports logged with the Egyptian national database between June and December 2014. 66% of reports originated from inpatient settings, including 23% from intensive care units. Prescribing errors constituted 54% of errors administration errors accounted for 16%. This difference may be due to reporting emphasis or methodological variations across hospitals and still demonstrates medication administration to be a prevalent source of error.

Despite these estimates, it is difficult to quantify the extent of medication error (Dean and Barber 2001). This is due to methodological variations within the literature (McLeod et al 2013 and Wright 2013), variable medication error reporting mechanisms, and because the majority of medication errors go unreported (Aboshaiqah 2013 and Moumtzoglou 2010). For example, Westbrook et al (2015) completed an audit of 3291 patient records to identify prescribing errors and detection rates at two Australian hospitals. A total of 12567 prescribing errors were identified

and an incident report was logged in 1.2 in 1000 of errors. The authors categorised clinically important errors which ranged from an incident likely to lead to a reduction in health which results in, for example, an increase length of stay or surgical intervention, to an incident which lead to a major or permanent loss of function or death. 539 clinically important prescribing errors were detected by staff at a much higher rate of 218.9 out of 1000 but only 13.0 out 1000 had a submitted incident report. In addition, medication administration errors were identified from a direct observational study of 180 nurses administering at total of 7451 medications, however, no timeframe was documented in the literature. 2043 observed medication administrations (27.4%) contained at least one error, and there were no corresponding incident reports logged. Many errors remain unreported and undetected. Therefore, reported incidents do not reflect the profile or rates of actual medication error. This demonstrates the inaccuracy of using incident frequency to compare patient risk or quality performance within or across hospitals. Only the most serious cases of error are most likely to be reported (Lomas 2010, Westbrook et al (2015) whilst others are covered up (Leape 1995).

Despite the lack of methodological uniformity and disclosure of error, the literature does consistently identify medication error and medication administration error as a major patient safety issue. Patients trust they will receive the correct medications. As the literature demonstrates, accuracy and safety cannot be guaranteed.

2.3 Consequences of Medication Error

There are numerous consequences of medication error for the patient, the healthcare system and the individual who made the error. Medication error is both a direct and contributory cause of patient mortality and morbidity. To put this in context, Makary and Daniel (2016) estimated medical error causes approximately 250,000 deaths annually within the United States. A significant proportion of those deaths were attributed to medication error and constituted the third most common cause of death after heart disease and cancer. Cousins et al (2012) completed a review of medication error related incidents reported to the United Kingdom's NRLS between 2005 and 2010. A total of 525,186 incidents were reported, of which 86,821 (16%) resulted in patient harm and 822 (0.9%) resulted in severe harm or death.

Medication administration error is the form of medication error most likely to result in severe harm or patient death. Unclear / wrong dose or frequency, wrong medicine and omitted / delayed medicines account for 71% of medication-related incidents resulting in patient death or severe harm (NPSA 2009). Kale et al (2012) completed a retrospective chart review of clinical events following 1271 observed medication administration errors. 133 (10.4%) of errors were judged to be potentially serious and life-threatening and 10 (7.5%) resulted in significant, serious or life-threatening injury. 41 out of 100 medication incidents that resulted in patient death or severe harm reported to the NPSA between January and December 2007 were due to medication administration error (NPSA 2009). The prevalence and potential for harm in specific clinical areas is illustrated by Nanji et al (2016) who completed a prospective observational study to assess the rates of perioperative medication error. Anaesthesia-trained staff observed randomly selected operations at a 1,046-bed tertiary care academic medical centre over an eight-month period. Retrospective chart abstraction was also performed to ensure events missed by observation were included. A total of 3,671 medication administrations were documented, of which 193 (5.3%) involved some form of error or adverse incident. Of these, 153 (79.3%) were preventable. Of the preventable errors, 99 (64.7%) were considered to have the potential to cause symptoms associated with a serious level of harm, but not life-threatening, and 3 (2.0%) were considered to be life-threatening. In addition, Cloete (2015) estimate one third of the errors that harm patients occur during the medication administration phase and therefore this ubiquitous task is a high-risk activity for patients.

There are also financial consequences to medication error. NICE (2015) estimated that 72% of adverse drug reactions which include medication errors, are potentially avoidable. They estimated the total number of bed days for potentially avoidable adverse drug reaction-related admissions during 2012-2013 was 1,997,814, at an average cost per bed per day of £265. This is a potential avoidable annual cost of £529,420,710. With regards to litigation, the NHS Litigation Authority data indicates that since 2008, 551 successful claims were made against NHS trusts in which medication error is petitioned (NICE 2015). A total of £16,572,028 was awarded in damages and £1,643,142 and £9,637,309 was paid to cover defence and claimant costs respectively. In a report prepared for the United Kingdom's Department of Health which explored the costs of unsafe care, 5-8% of unplanned hospital admissions are due to medication issues and medication errors cost £770 million in 2007 due to admissions due to adverse drug reactions and other forms of harm due to medicines in in-patient stays (Fronteir Economics 2014).

The financial burden of medication error is also demonstrated in individual studies. For example, Jolivot et al (2016) completed an observational study to determine the extent, preventability, severity and cost of admissions to a medical intensive care unit due to medication-related incidents between February 2013 to February 2014. 743 admissions were included in the study and 173 (23.3 %) of admissions were due to medication-related incidents. 102 (13.7 %) of these were deemed preventable and accounted for a total of 528 days of hospitalization. This equated to a mean of 1.4 beds required per day with an associated total cost amounting to 747,651€. Similarly, Choi et al (2016) completed a retrospective case-control study to estimate the incidence, types and causes of medication error and attributable costs reported within two hospitals in New Jersey in the United States during 2005-2006. 57,554 patients were admitted to hospital and a rate of 0.8 medication errors per 100 hospital admissions was identified. The majority of errors occurred during medication administration. Treatment costs attributable to medication error ranged from \$8,439 and \$8,898 per patient, depending on the statistical analysis used. The authors concluded that medication error results in considerable financial costs, irrespective of level of patient harm caused. Pirmohamed et al (2004) conducted a study in two large hospitals in the United Kingdom to determine the burden of medication-related incidents to the NHS. The study found that of 18,820 patients aged over 16 years admitted to hospital within a six-month period, 1,225 (6.5%) of admissions involved some form of medication-related incident. In 80% of cases, the incident was judged to have led directly to the patient's admission to hospital and the majority (72%) were deemed to have been avoidable. The median bed stay was eight days and accounted for 4% of hospital bed capacity. The projected annual cost of such admissions to the NHS was £466 million. Due to the lack of full disclosure of medication error, the extent of costs of medication error remains unknown, however it constitutes a substantial financial burden on health service expenditure which could otherwise be invested in patient care.

There are also emotional and professional consequences for individuals who make a medication error. Making a medication error is a negative experience for nurses (Leite Siqueira et al 2016, Delacroix 2017 and Jones and Treiber 2012). Common reactions to making an error include guilt, anxiety, embarrassment (Wolf et al 2000), anger (Scott et al 2009, Wright 2013 and Chard 2010), upset and terror (Mayo and Duncan 2004). Many nurses feel responsible (Aleccia 2011) and doubt their own professional competence (Scott et al 2010, Jones and Treiber 2010, Gladstone 1995 and

Santos et al 2007). Wu (2000) and Jones and Treiber (2012) refer to the individual as the 'second victim' and described how they can be blamed, isolated, stigmatised and unsupported.

Making a medication error can lead to long lasting emotional trauma for the person who made the error, and in a minority of cases, can result in post-traumatic stress disorder (Rassin et al 2005). In one extreme example, a paediatric nurse who made a medication administration error which potentially contributed to a patient's death, reportedly committed suicide as a direct result of the error (Aleccia 2011). Treiber and Jones (2010) analysed the descriptive accounts of 158 nurses who made a medication error. The description of the emotional consequences of error for nurses was described emotively as 'devastating' and 'visceral' by the authors. The accounts by nurses demonstrated that their responses to error was often so profound, that it was often incongruent with error severity. O'Beirne et al (2012) investigated the emotional impact of patient safety incidents on family physicians and office staff. 82% reported experiencing an emotional response, and 62.8% needed to use active coping strategies to help them deal with the incident. Involvement in a patient safety incident was identified as an independent risk factor for subsequent burnout for medical staff (Van Gerven et al 2016). Edrees et al (2011) estimated up to half of healthcare professionals will become a 'second victim' at some point during their career. Nurses have a professional responsibility to safeguard the health and wellbeing of patients and making an error can have a detrimental impact on a nurse's emotional wellbeing and career. The reduction of medication error is therefore necessary to safeguard both the health and well-being of medical personnel as well as patients.

2.4 Role of Nurses in Medication Administration Error

One of the key roles of nurses is to administer medications safely to patients. The NMC 'Standards for Pre-registration Nursing Education' (2010) state that a newly qualified nurse must be able to correctly and safely complete medication calculations and administer medications to ensure patients derive maximum benefit and minimal harm. Nurses must demonstrate the capacity to, and work within regulatory, legal and ethical frameworks that underpin safe and effective medicine management. Two of the central United Kingdom's legislative stipulations that nurses work within include the Controlled Drugs (Supervision of Management and Use) Regulations (2006) and the Medicines Act (1968). The Medicines Act is primary legislation in which various secondary legislation relating to the manufacture, licensing, prescribing, supply and

administration of medicine stems. The 'Standards for Medicines Management' ((NMC 2015b) 2010 with minor changes in 2015) highlight that a central role of nurses in effective medication administration is checking the patient identity, patient allergy status and prescription, and have an awareness of the patient's care plan and administer or withhold medication in the context of the patient's clinical condition. Student nurses are taught to work safely and effectively within these stipulations in university and in practice placements through a combination of taught classroom based lectures, written and practical examinations, course work, and ongoing mentoring and assessment in clinical practice.

There are a series of different protocolised checks utilised within nurse education internationally to support nurses to administer medications safely, including the five rights (Hughes and Blegen 2008), the eight rights (Fothergill Bourbonnais and Caswell 2014), the nine rights (Elliot and Lui 2010) and the ten rights (Edwards and Axe 2015). Whilst all include the five rights: the right drug, the right patient, the right time, the right route and the right dose, the additional checks reflect the wider knowledge required for safe and effective medication management, including pharmacology, patient status and hospital policy including: the right frequency, the right reason, the right site (the 8 rights), the right documentation, the right action, the right form and the right response (the nine rights) and the right to refuse, the right knowledge and understanding, the right questions, the right response and the right advice (the 10 rights). The five rights are considered the gold standard of medication administration (Jones and Treiber 2010). These different series of checks are used by different nurse education establishments and jurisdictions.

The checks are performed by nurses to ensure medicines are administered to the expected standards stipulated by the professional bodies. The adherence to these standards is professionally prerequisite for each medication administration. The protocolised checking procedures appear to be an easy and practical instruction to complete this ubiquitous and routine task. However, these rights demonstrate that medication administration is a multifaceted and complex task and the extent of medication administration error within clinical practice suggests that purely teaching student nurses to apply the checking procedures is insufficient for safe clinical practice (Fothergill Bourbonnais and Caswell 2014).

Whilst medication errors are made by all healthcare disciplines involved in medication management (Dhawan et al 2017, Keers et al 2014, Cina et al 2006 and Nicholson et al 2006), nurses make the majority of reported medication errors. Latif et al (2013) reviewed the United States' MEDMARX medication error database between 1999 and 2005. In that timeframe, 839,553 medication errors were reported. Administration error accounted for 46% of medication errors. Although 64% of the staff group data was missing, 26% of remaining errors were made by nurses, 6% by pharmacists, 5% by physicians and 3% by other staff groups. Although medication administration error is a multidisciplinary problem (Gordon et al 2006, Al-Shara 2011), nurses make the majority. There are three main reasons for this.

Firstly, the extent of error relates to the intrinsic nature of the nursing role. Nurses comprise the majority of the healthcare workforce and are with hospital in-patients overnight and at weekends, when other personnel are perhaps not so routinely present. Nurses spend a high proportion of their working time involved in medication management (Pirinen et al 2015). The publication 'A Spoonful of Sugar – Medicines Management in NHS Hospitals' (2001) estimate up to 40% of nurses' time is spent in medication management. This is supported by Armitage and Knapman (2003) who also suggest nurses spend up to 40% of their time dealing with medications. In addition, Hendrich et al (2008) completed a time and motion study of surgical nurses. 17.2% of nurse time was spent completing medication administrations. These statistics underline medication administration is a frequent and core task across nursing specialities. The high proportion of time nurses dedicate to medication management highlights the extent to which they are exposed to the potential of medication administration error.

Secondly, the structure of the medication administration task results in more opportunities to make an error compared to the other stages of medication management (NPSA 2009). One prescription can lead to multiple medication administrations and therefore multiple additional opportunities to make an error. This is illustrated by the multiple subcategories of medication administration error. Medication administration is not one simple single task but a series of subtasks encapsulated in the various protocolised checklists utilised in clinical practice.

The multiple opportunities for error during one medication administration task is historic and exemplified by the American Society of Hospital Pharmacists (1982), who divided medication administration error into more detailed subcategories. They defined a medication administration

error as 'a dose of medication that deviates from the physician's order as written in the patient's chart or from standard hospital policy and procedures' p139. However, this is divided into specific subcategories which include: omission error, wrong time error, unauthorized drug error, improper dose, wrong dosage form error, wrong preparation of a dose, incorrect administration technique and monitoring error. Each one of these subcategories provides a unique opportunity to make a medication administration error. Therefore, medication administration error does not derive from one finite error type, but from a variety of error generating opportunities. This is illustrated by Renata et al (2014) who completed a cross-sectional, descriptive and exploratory study to analyse the frequency, type of error and risk factors in the preparation and administration of medications to medical patients in a public hospital in Brasilia. Eight nurse technicians observed 484 doses. 69.5% errors occurred during the administration stage, of which, 48.6% were timing errors, 1.7% were dose-related errors and 9.5% were errors of omission. In addition, Kiekkas et al (2011) completed a systematic review of articles published between 1985 and 2008 that examined medication errors identified through direct observation in adult intensive care units. Six studies were incorporated into the study. Although error rates varied across studies, wrong dose, wrong time, wrong rate, and dose omission were the most common form of error. In addition, the authors identified that error rates were compounded by the fact that one medication administration can lead to more than one error.

The variety of medication administration error subcategories is epitomised by the inability of nurses to reliably identify what constitutes as a medication administration error (You et al 2015). Mayo and Duncan (2004) completed a questionnaire study and identified that although 92.6% of 983 nurses believed they knew what constituted a medication error, there was clear disagreement when asked to decide if a medication error had occurred in a given scenario. Dias et al (2014) completed a thematic analysis of a discussion by 20 nurses about medication administration and error. Similarly, nurses were unable to reach agreement about what constituted a medication error. If nurses cannot recognise a medication error, then it is impossible to guarantee clear and consistent reporting of medication error in all circumstances.

Finally, medication administration is the last stage of the medication management process. This renders nurses particularly vulnerable to error because they complete the majority of medication

administrations and therefore are predominantly responsible for the last safety checks before the patient receives the medication (Reid-Searle et al 2013). Nurses remain at the front line when it comes to medication accountability. Medication administration is a part of the nurses' responsibility (Johari et al 2013 NMC 2015b). With patient proximity in mind, nurses perceive themselves to be the bastions of patient advocacy and well-being, and key guardians of patient safety (Van de Castle et al 2004). All nurses, irrespective of diligence, can make medication errors (Anderson and Webster 2001). When taken collectively, the extent, consequences and potential for medication administration error underlines why it is the most prevalent form of error and illustrates that nurses need further support to administer medications safely. Assuming the integrity of the nursing profession and that most nurses hold the safety and wellbeing of their patients as paramount, the question of how to reduce error and support nurses to administer medications safely remains.

2.5 Causes of Medication Administration Error

2.5.1 Overview of Causes of Medication Administration Error

To determine how to reduce error and support nurses to administer medications safely, it is important to understand the causes of medication administration error and how they relate to the professional standards that nurses adhere to. There are two broad categories of causes of medication administration error: individual and contextual. Individual causes of error relate to the individual who makes the error. Contextual causes of error relate to environmental or systemic factors. There are a variety of methods used to identify causes of error including diaries, incident report review, questionnaires, interviews and observational analysis.

2.5.2 Individual Causes of Medication Administration Error

There are numerous individual causes of medication administration error. The literature highlights that the primary individual cause is personnel neglect. The literature provides no single definition of personnel neglect; however, studies suggest it involves two interchangeable elements; the failure to administer medications safely despite possessing the appropriate skills, and the failure to follow required checks and procedures (Cloete 2015, Dias et al 2014 and Thomas and Panchagnula 2008). It relates to the failure to meet an expected standard of care (Sohn 2013). This is epitomised by the medication error definition provided by Aronson (2009a) who states that

error relates to the failure to adhere to accepted standards. The notion that medication administration is due to personnel neglect is acknowledged by staff involved in error (Shahrokhi et al 2013). For example, Hicks et al (2004) analysed 645 incident reports of medication errors and near misses made by personnel across healthcare disciplines in 189 post-anaesthesia care units over a four-year period. Of these, 59.5% were medication administration errors. Performance deficit, defined as possessing the correct skills and knowledge for the task but failing to complete it, accounted for 45.6% of all errors, and the failure to follow procedure accounted for 23.8%. Nurses made the majority of errors and doctors made 22% of errors.

There are a number of studies that directly observed nurses failing to adhere to accepted medication administration standards. For example, Kim and Bates (2013) completed an observational analysis and evaluated the adherence of nurses to a protocolised medication administration checklist during 293 medication administrations. The checklist was based on medication guidelines including the five rights, infection control recommendations and medication recording rules. Despite being observed, a variety of checks and procedures were consistently not adhered to. For example, only 45.6% of nurses verified the amount of medication indicated on the vial at least once for at least one second. In addition, only 6.5% of nurses read the name of the patient from the wristband. The correct time guideline was observed 41.0% of the time. Adherence to guidelines was low which suggests they are not strictly followed.

Nurses report that they often developed a 'laissez faire', complacent approach to medication administration and as a consequence, fail to routinely apply checking procedures (Tsang et al 2014 and McBride-Henry and Foureur 2007). The repetitive nature of medication administration can lead to complacency until an error occurs. Kopp et al (2006) analysed 645 medication administrations completed over 16.5 days on a medical/surgical intensive care unit. 172 errors were identified and independently assessed by two evaluators. 132 errors were deemed to be clinically important of which, 48 (36%) were medication administration errors. Of these 11 (26%) were caused by 'rule violation', which included failing to implement appropriate checking procedures. Personnel neglect is also viewed as a prominent cause of error by clinical personnel, (Gladstone 1995, Ulanimo et al 2007 and Gordon et al 2006). Tang et al (2007) employed a mixed method qualitative approach to identify the perceptions of 81 registered nurses on causes of

medication error. 86.1% of nurses believed personnel neglect contributed to medication error and the authors specifically linked it with failing to adhere to the five rights of medication administration.

Although calculation skills and knowledge are interlaced with training, the literature cites calculation error and lack of knowledge as individual causes of medication administration error, for example, Coben and Weeks (2014) and Blignaut et al (2017) because they relate to the competence and knowledge of the individual nurse. The literature highlights that deficits in both these areas are prominent causes of medication administration error. Beyea et al (2003) completed an analysis of medication incident reports from 731 operating rooms submitted to the United States' MEDMARX database between August 1998 and March 2002. 62% of reported errors were administration errors. 2.1% were caused by calculation error and 9% of were caused by 'knowledge deficit'. Unfortunately, the reports do not specify if the knowledge deficit related to knowledge of the patient's condition or the intrinsic lack of knowledge of personnel making the error. In an observation study, Wirtz et al (2003) identified 12% of intravenous medications were miscalculated. Fleming et al (2014) evaluated the calculation skills of 124 registered nurses in five major academic teaching hospitals in the Republic of Ireland. Participants completed a 20-item drug calculation test which included scenario-based tablet and fluid dosages, infusion rates and metric conversions. Participants were allowed to use calculators. The mean scores achieved for metric conversion, tablet doses, fluid doses and infusion rates were 64.75%, 81.25%, 68.67% and 36.67% respectively. Only 60% of all questions were answered correctly and only 5 (4.03%) of participants answered all 20 questions correctly.

The lack of calculation skills is a multidisciplinary problem. Oldridge et al (2004) asked 111 registrars, pharmacists, house surgeons, medical students and nurses to complete five medication calculations. Each of the calculations tested a slightly different type of calculation skills. Less than 14% of participants answered all calculations correctly and nurses answered only 24% of questions correctly. This lack of competency is a concern because robust calculation skills are important throughout the medication process and other medical personnel also complete medication administrations. In line with professional standards, all medication administrations should be safe and to achieve this, it is vital that all calculations are accurate.

Multiple studies highlight that nurses consider lack of pharmacology knowledge to be a leading cause of error. Cheragi et al (2013) completed a cross-sectional study to evaluate the type and cause of nurse medication error. Nurses who were at least six-months post qualified and held a bachelor's degree in nursing working in a hospital in Tehran, Iran were invited to participate. 237 nurses consented to participate in the study. They completed a seven-item questionnaire about their experience of medication errors. The content validity of the questionnaire had been established by literature review and opinions of experts. The reliability of the questionnaire had been approved by test–retest method ($r = 0.9$). They identified that the most important cause of medication errors was lack of pharmacological knowledge. In addition, Ulamimo et al (2007) completed a questionnaire study of nurse perceptions of causes of medication administration error. 29.2% of 61 nurse respondents considered lack of knowledge to be a leading cause error. This is supported by Tissot et al (2003) who completed an observational study of medication administration in two hospital departments across 20 days. Nurses displayed clear deficits in knowledge when describing how to administer medications. Nurses also state that they had insufficient knowledge of pharmacology and required further support to provide safe standards of practice (Lan et al 2014).

Lack of pharmacology knowledge is supported by the literature which highlights it is pervasive in nursing (King 2004 and Ndosu and Newell 2008). This means that nurses have intrinsic difficulty to achieve the protocolised rights for example, the 10 rights (Edwards and Axe 2015) which stipulate nurses are to monitor for therapeutic effective. For example, Lan et al (2014) asked 262 nurses to complete a bespoke questionnaire on pharmacology knowledge. The questionnaire contained 20 yes/no questions relating to high alert and commonly encountered medications in clinical practice. The questionnaire was checked for content validity by pharmacists, doctors and nurse specialists. Face validity was checked by nurses. Nurses achieved 72.9% and 73.2% for high alert medications and common use medications respectively, which is markedly below the expected standard of 100% required. In addition, the dichotomous framing of the question means nurses should achieve a 50% pass rate by chance alone, which further compounds the lack of knowledge highlighted in this study. This is reflected by Fleming et al (2014) who demonstrated the lack of pharmacology provision provided by university education. They analysed the number of hours of pharmacology skills tuition nursing students received at seven nursing schools in the Republic of

Ireland. The number of hours devoted to pharmacology over a four-year course (including lectures, practicals and tutorials) was 27.3 hours (SD 21.8; minimum 3 and maximum 72). Nurses need comprehensive support with and further teaching of pharmacology and calculations skills to provide safe and effective clinical practice.

Fatigue is another individual cause of medication administration error. Gordon et al (2006) analysed questionnaires about medication error submitted by 133 anaesthetists in South Africa. Fatigue was identified as a contributory factor in 14% of errors. Gordon et al argue that medication administrations should be minimised at times of peak fatigue, specifically during the night. Fatigue is also highlighted as a leading cause of error in numerous nurse questionnaire studies, for example, Mrayyan et al (2007), Gladstone (1995) and Ulanimo et al (2007). Ferris (2015) completed a literature review of medication errors in oncology between 2005 and 2015. Seven articles were included in the study. Although the authors were unable to complete a meta-analysis due to methodological variation, they concluded there was a correlation between fatigue and hours worked with medication errors and needlestick injuries. The authors identify working night shifts as a particular contributing factor.

2.5.3 Contextual Causes of Medication Administration Error

There are also numerous contextual causes of medication administration error. One prominent cause is high workload (Ebru 2012 and Fathi et al 2017). Tabatabaee et al (2013) randomly selected nurses working in a private Iranian hospital to rank the causes of medication error. 97 nurses participated in the study. The content validity was confirmed by nurse experts and the reliability was examined using test-retest method. High patient-low nurse ratios, high workload and improper work assignments were identified as the most important contributors to medication error. Keers et al (2015) completed 20 semi-structured interviews with nurses working in a variety of inpatient environments at two teaching hospitals in England to discuss perceived causes of intravenous medication administration errors they had been directly involved with. Nurses reported that the quality of intravenous administration checks were compromised due to high workload and working relationships, particularly during ward rounds, shift changes or emergencies.

Workload can be divided up into two components: patient acuity and staff-patient ratios. Tabatabaee et al (2013) identified that intensive care nurses, who nurse patients with the highest

acuity and likely to complete a greater number of patient interventions, weighted patient acuity more highly as a cause of error compared to nurses who cared for less acute patients. The perceptions of staff that patient acuity is a direct contributor to error is supported by Seynaeve et al (2011). The authors completed a cross-sectional survey and retrospective analysis of a patient data management system for a university-based intensive care unit to identify the characteristics of adverse drug events. The prevalence of adverse drug events was measured by a validated global trigger tool adapted for the critical care environment and disease severity determined by a validated algorithm. An investigator blinded to the study and a panel of experts assessed adverse drug events for each drug taken. Characteristics of patients with and without adverse drug events were compared using univariate and stepwise multivariate logistic regression. 175 of 1009 intensive care unit days were screened in which 230 adverse drug events occurred in 79 patients. The mean severity of disease was significantly higher on days when one or more adverse drug events occurred. Adverse drug events were common in intensive care unit patients and were directly associated with illness severity.

The effect of workload defined by staff-patient ratio on medication administration error is highlighted by a number of studies using a variety of research methods (for example, Donaldson et al 2014). Tissot et al (2003) completed an undisguised observational analysis of medication administration in two units at one hospital in France over a 20-day period. Workload was defined as the number of patients per nurse. High patient - low nurse ratio was identified as a statistically significant risk factor for error across both units. In the Cardiovascular Thoracic Surgery Unit, the average patient number per nurse was 2.5 (+/- 0.7) and the odds ratio for error was 2.44; 95% CI = 1.30 - 4.60; $p = 0.006$, $p = <0.05$. In the Geriatric Unit, the average patient number per nurses was 5.2 (+/- 1) and the odds ratio for error was 2.52; 95% CI = 1.01 - 6.30; $p = 0.048$. A ratio of more than 5.2 patients per nurse was a significant risk factor for error. Picone et al (2008) completed a retrospective study of 861 medication error incident reports experienced by elderly patients admitted to one hospital in the United States over a three-and-a-half-year period. Staff-patient ratio was an important determinant of medication administration error rates. Error rates increased by 18% for every 20% reduction in staffing levels below the lowest average time a nurse spent with a patient. In addition, patients were 5% more likely to experience a medication error, (including prescribing and dispensing errors) for each additional medication received.

The role of high workload as a cause of error is supported by nurse's experiences of error, for example, Fahimi et al (2008), McBride-Henry and Foureur (2007) and Gladstone (1995). Balas et al (2004) analysed 392 logbooks completed by nurses over a 28-day period and identified 33% of medication errors were due to delays in administrations. Heavy workloads hindered nurses' ability to administer timely medications. Tang et al (2007) completed a questionnaire study in which 72 nurses detailed their perceptions of the most important causes of medication administration error. Workload was identified as the joint second most important causal factor of error. Tang et al argued that high workload results in a rushed work environment and this directly leads to personnel neglect during medication administration.

The literature suggests distraction is another prominent contextual cause of medication administration error (Renata et al 2014 and Donaldson 2014). Nurses view distraction as a prominent cause of medication error (Westbrook et al 2010, Ulanimo et al 2007, Kreckler et al 2008 and Elganzouri et al 2009). This is supported by observation studies which confirm distraction to be commonplace within clinical practice. For example, Berg et al (2013) observed 18 clinicians, licensed practical nurses, registered nurses and medical doctors at two Swedish emergency departments for two hours per participant. All staff were routinely distracted at a mean rate of 5.1 interruptions per hour. With respect to the impact of distraction on medication administration, Buchini and Quattrin (2012) recorded the source and frequency of interruptions during medication-related activities in one Italian intensive care facility over a six-month period. 18 nurses were observed over a cumulative period of 3000 hours. 1170 interruptions were observed from a variety of sources, including requests for information by patients or relatives, hand washing performed away from the patient's bedside, dealing with requests from physicians or other health-care professionals, and problems with the readability and completeness of prescriptions. Similarly, Johnson et al (2017) completed an observational study of nurse medication rounds which identified the impact of interruptions on workflow. 56 medication-related activities were observed and 99% involved some form of interruption. Interruptions forced nurses to stop medication preparation or administration for a mean of 2.5 minutes. 34% percent of medication-related activities involved at least one procedural failure and while 3.6% resulted in a clinical error.

Distraction is deemed to constitute such a prominent cause of error that multiple studies focus solely on the role of distraction in medication administration error. For example, Palese et al

(2009) observed 56 medication rounds and a total of 298 interruptions or distractions at a ratio of 1:3.2 interruptions to medications administered. Interruptions included obtaining medications and dealing with patients. There was a corresponding increase in interruptions with the number of medications administered. The authors suggest interruptions are a highly frequent cause of error because they force nurses to lose concentration on task to be completed.

The literature highlights medication administration error is also potentially more prevalent at times of change and transfer (Santell et al 2006). Hicks et al (2004) conducted a retrospective analysis of errors reported to the MEDMARX database from peri-operative departments of 189 healthcare facilities in the United States between 1999 and 2002. 675 medication errors were identified and 8.7% of errors were linked to shift change. The study closely linked change with distraction as a cause of medication administration error. Studies that focus on departments with rapid patient turnover also suggest a link. For example, Croskerry et al (2004) detailed 15 emergency department case studies based in which rapid patient turnover and high patient load contribute to error. The literature demonstrates that the complex working conditions within the clinical environment contribute to medication administration error and actively hampers nurses to safely administer medications. This reflects the fast paced, dynamic and changing clinical environments which nurses work within because they give rise to error prone conditions. In addition, much of the literature highlights that they contribute to personal neglect.

2.6 Approaches to the Management and Reduction of Medication Administration Error

There are two main approaches to the management and reduction of medication administration error: the person approach and the systems or 'human factors approach' (Reason 2000). The person approach is the historical approach to error management and predominantly focuses on the individual who makes the error. The systems approach in contrast focuses on systemic causes of error. This approach acknowledges that error occurs within a complex organisational context which enables errors to occur and flourish. The next section will describe these approaches, methods to classify error and discuss their role to identify causes of error and error prevention strategies.

2.6.1 Person Approach to Medication Administration Error

The person approach views error as the fault of the individual who makes the error (Wright 2013). Nurses are regarded as professionals and therefore should be able to administer medications correctly on every occasion. This approach to error focuses on the person who made the error to the almost exclusion of the circumstances that enable error to flourish. Error is viewed as failure of the individual due to, for example, forgetfulness, inattention, poor motivation, carelessness, negligence, and recklessness (Reason 2000). The premise is that medication administration error will not occur if nurses administered medications in the manner in which they were prepared. Reason (2000) argues that the person approach treats error as a moral issue; that only irresponsible or incompetent nurses make errors and it is solely the nurse's responsibility to ensure safe medication administration practice. This is epitomised by Wolf (1989) who states that 'nurses who administer medication in effect commit themselves to providing for their patient's best interests...and when nurses make medication errors they violate the value to first do no harm and fail to uphold the trust of patients' p8. In addition, Wolf continues to state that 'medication errors are not merely social offenses breaching acceptable rules of behavioural conduct. Medication errors, as mistakes made by nurses at work, constitute acts against patients...'p9. This retributory approach focuses on the individual and is reflected in how the literature emphasises nurse incompetence in areas such as drug calculations and numeracy skills, for example, Ofusu and Jarrett (2015) and Ramjan (2011).

The person approach traditionally attempted to identify individual nurse characteristics which contribute to error making practices, for example, level of education, (Chang and Mark 2011). However, studies have consistently failed to demonstrate any correlation between individual nurse characteristics, for example, age, experience (Cheragi et al 2013) and level of education with the number of medication errors made (Anderson and Webster 2001). All nurses, irrespective of their competency, diligence and commitment are highly likely to make a medication error at some point during their career.

The culture of blame on the individual is widespread within healthcare. For example, historically the misadministration of medications was a common cause of removal from the United Kingdom's NMC professional register (Carlisle 1996). In addition, individuals who make an error are judged negatively by colleagues. For example, Kroll et al (2008) completed a qualitative study on the

views of medical error amongst 38 junior doctors. They reported experiencing feelings of anger at other professionals who made an error with their patients.

The view that making an error is a moral issue is exemplified by the unsystematic, punitive and ineffective manner in which nurses who make errors were traditionally subject (Anderson and Webster 2001). The person approach is castigatory in nature and this approach actively discourages individuals from reporting error. Wolf et al (2000) surveyed the responses of nurses, pharmacists and physicians to medication error. Respondents reported that they feared they would be subject to disciplinary action and punishment if they disclosed that they had made an error. Shame, guilt and fear of punishment make nurses reluctant to report mistakes (Osborne et al 1999). In a cross-sectional survey conducted by Aboshaiqah (2013), 307 nurses in one hospital in Saudi Arabia identified fear of blame and the focus on the individual as two prominent reasons why medication administration errors were not reported. Hartnell et al (2012) conducted focus groups with nurses, doctors and pharmacists about their experiences of medication error. Participants reported loss of professional identity, organisational factors and fear as key factors which prevented them from reporting error.

Similarly, Yung et al (2016) completed a questionnaire study to explore nurse attitudes and perceived barriers to reporting medication administration error. 306 Taiwanese nurses completed the questionnaire. The major perceived barrier was fear of the consequences of reporting error. Nurse self-recrimination was common after making an error. This is supported by Horns and Loper (2002) who state that the underreporting of errors is due to a systematic emphasis on blame and reprisal. Nurses and nurse managers also report that they fear for the reputation of their service or unit (Dunn 2003). Ebru (2012) completed a descriptive cross-sectional study which investigated the reporting of medication errors by 119 paediatric nurses from wards of four hospitals in Turkey. Although the majority of nurses reported that they did use the medication error notification system, many errors remain unreported. 52.95% of nurses cited blame, 50.45% cited loss of trust and 42% cited fear of disciplinary proceedings as barriers to full error disclosure. Lack of disclosure was also extended to the reporting of colleagues. Haw et al (2014) interviewed 50 nurses with vignettes to identify if and when they would report an error or near-miss made by a colleague. Less than half of nurses said they would report an error made by a colleague or a

near-miss which also involved themselves. Reasons for not reporting included; perception that there was a good reason for the error / near miss, lack of clarity as to whether the episode constituted an error/near miss, lack of clarity regarding how to report it, fear of the consequences, or because reporting it was too much work.

Fear of being blamed results in many nurses only reporting errors that actually cause harm (Lomas 2010). However, it is important that all near misses and errors, not just those that result in patient harm, are reported (Kavanagh 2017). They provide insight into the extent and causes of error (Novek 2000) and can inform new protective measures to combat future medication error. The lack of error disclosure directly hinders patient safety and prevents root-cause analysis of error (Reason 2000 and Kalra et al 2013). Blaming the individual who made the error does not prevent human error but instead hinders disclosure, which hampers effective improvements in safety. It prevents an open and honest investigation of the causes and contributors to the error and limits the opportunity to reduce error (Horns and Loper 2002 and Reason 1990). In addition, although medication errors involve different health professionals and present across all stages of the medication process, nurses have a particular insight into medication errors which the healthcare system can learn from.

2.6.2 The Systems Approach to Medication Administration Error

More recently, the literature has emphasised a systems approach to medication administration error (Reason 1990, 2000 and Zyoud and Abdullah 2016). This is a human factors approach to error which incorporates the scientific study of work or the job to the worker (Pheasant 1991). It recognises that humans are fallible, error is a natural part of the human condition and the system in which an individual works within should be designed to minimise error (Reason 2000). Error is viewed as systemic in origin and a consequence of the human, environmental, organisational and technological system in which the individual works. Effectively, it purports that error is an interplay of workplace factors which impact on the individual and hinders them to utilise their skills and experiences to work to the best of their ability.

Within the systems approach, classifying and understanding error causation is pivotal to any process of change and will influence the approach taken by healthcare systems to reduce the frequency and consequence of error. Error can be deconstructed and defined as an act of commission, (doing something wrong) or omission, (failing to do the right thing) which results in,

or has the potential to result in, an unintended outcome (Reason 1990). Reason separates this further into active failures and latent conditions. Active failures are the immediate unsafe act made by personnel which directly results in error. These are categorised as, “slips,” “lapses,” and “mistakes.” Slips and lapses are actions where the original intention was correct, but the action did not result as intended. A slip is observable, for example, giving the right medicine to the wrong patient. A lapse is not observable, for example, incorrect memory recall. In contrast, a mistake occurs when an action proceeds as planned but the intended action was incorrect, for example, the wrong drug is given because of an incorrect diagnosis. Latent errors are seen as consequences of ‘upstream’ systemic factors which give rise to active failures. Latent conditions are systemic ‘resident pathogens’ which can occur at all levels within an organisation. In the context of medication administration error, this is illustrated in the multiplicity of contextual factors that contribute to medication administration errors, for example, workload and distraction.

Within this context, one method to understand how medication error occurs is to use a classification system that is contextual (specific time, place, medication, people), modal (way errors occur, omission, substitution), and more importantly psychological (explains events) and relate to the circumstances in which error occurs (Aronson 2009b). Aronson uses a similar classification to Reason and states mistakes are divided into knowledge-based errors, which can be related to any type of general, specific or expert knowledge, for example, knowing penicillin can cause an allergic reaction and rule-based errors, which relate to the misapplication or failure to apply a good rule, or the application of a bad rule. Failures of skill are divided into action-based errors (slips) which relates to performing an action that was unintended, for example, selecting a similarly named medication, and memory-based errors (lapses), which relates to forgetting to complete an action. Technical errors form a subset of action-based errors. This occurs when the desired result fails to occur or because there was an error in the implementation of an action.

The systems approach to error recognises that organisational and contextual factors contribute to error and is a result of the the complex interaction between the individual nurse and the working conditions in the clinical environment which gives rise to error (Armstrong et al 2016 and Yoder 2015). Aside from genuine negligence, it is now more commonly accepted that the majority of

medication administration errors are caused by an interplay of many factors which are often unrelated to the individual who made the error (Merry and Webster 1996 and Karavasiliadou and Athanasakis 2014). Many of the individual and contextual causes of medication administration error identified in the literature, for example, fatigue, lack of calculation skills, high workload and distraction can be defined as systemic and latent in origin. In addition, the causes of medication administration error can be deconstructed within this classification system to determine antecedents and methods to counter commonly occurring error scenarios. Examples include clear demarking of similarly named medications, providing clear protocols and supporting nurses to have appropriate levels of knowledge and calculation skills to minimise the misapplication of good rules. Novak et al (2016) and Johnson and Young (2011) states that Reasons' and Aronson's approach to error provides the structure to assess the most common points of error origination and detection. For example, they completed a retrospective review of 1897 near miss radiology incidents from a departmental incident learning system reported between March 2012 and March 2014. All incidents were prospectively reviewed weekly by a multidisciplinary team and assigned a score 0 to 4 reflecting potential harm to the patient (no potential harm to potential critical harm). The review identified that safety barriers caught 46% of all incidents, however, most incidents that passed through a particular safety barrier were not designed to be captured at that barrier. Therefore this highlights how systems can be designed to minimise error, and an open identification of errors and near misses can highlight areas where further solutions are required. This can help tailor safety improvement efforts and target areas with the highest impact.

There are a number of examples in which the systemic and latent errors can generate working conditions that give rise to error. One prominent example is the manner in which distraction can lengthen workload (Fahami et al 2008 and Monteiro et al 2015), which is a risk factor for error. Cole et al (2016) completed an observational time study of the effect of interruptions on common nursing interventions in the emergency department of a large academic medical centre. Nurses and clinical technicians were directly observed delivering care to patients. The mean time spent on an uninterrupted intervention was 296.47 seconds while interrupted interventions took a mean of 682.02 seconds, more than double the timeframe. Interruptions can lengthen the time taken to complete nursing tasks and by extension increase workload, making nurses more vulnerable to error. Another example is Tang et al (2007) who highlighted the 'need to solve other problems while administering drugs' p447 as a prominent cause of error and voiced concerns that nurses are seldom undisturbed while administering medications

A number of studies highlight how systemic and latent conditions directly impacts upon nurse behaviour which precipitates the slips, lapses and mistakes described by Reason and Aronson. Mitchell Scott et al (2014) completed a point prevalence study using a prospective, exploratory descriptive design to establish the relationship between observed medication errors, nurse behaviour and environmental and workplace conditions in an emergency department. Environmental and workplace factors included number of patients, levels of staffing and workload. 172 patients were included in the study, of whom, 125 had a medication chart. 41.2% of medication administrations occurred without checking the patient's name band. There was a statistically significant increase in failure to apply identification bands when general cubicles were over 50% occupied ($p = 0.001$). When resuscitation room cubicles were over 50% occupied, frequency of medication administration omission errors increased by 6.3% ($p < 0.001$). There was a direct relationship between levels of staffing, nurse behaviour and rates of medication errors. In contrast to other literature, for example, (Picone et al 2008), the proportion of older patients within the study did not affect the frequency of medication errors. However, this may be due to the difference in care provided within the emergency department compared to studies of patients on the ward. Medication administration within the emergency department focus upon emergency and not routine medications which are more likely to be less discriminant across age groups.

The impact of the work environment on nurse behaviour demonstrates the importance of nurse performance to be considered within the context of the whole healthcare system. All systemic issues, for example, workforce levels, rules and regulations and drug manufacturing that might impact upon nurse performance must be considered. Mitchell Scott's analysis demonstrates that although the nurses can fail to complete checking procedures, and as a consequence fail to deliver expected standards of care, as defined by Abelson's (2009a), it does underline how systemic and contextual factors directly contribute to this failure and incumbers the nurse to administer medication to expected standards. This goes to the heart of what constitutes as negligence and is consistently supported by the literature which indicates that conscientious nurses make medication administration errors (Jones and Treiber 2012) and that workplace factors and a breakdown of the healthcare system significantly impacts upon error rates and performance.

This assertion is supported by Parry et al (2015) who completed a thematic analysis and narrative synthesis of 26 papers published between January 1999 and 2012 to explore staff perceptions of factors contributing to nurse medication management. The review is wide ranging incorporating studies conducted in four continents across 11 countries predominantly in North America and Europe, with one multi-national study incorporating 27 countries. Data was extracted by one reviewer and checked by a second. The authors used Bandura's (1986) Theory of Reciprocal Determinism as an organising framework. This theory supports Reason (1990 and 2000) and proposes that there is a reciprocal interplay between the environment, the person and their behaviour. The theory stipulates a person's behaviour both influences and is influenced by personal factors and the social environment and that behaviour can be conditioned through consequences. Within the environment domain, two key themes of clinical workload and work setting emerged. The person domain includes nurse characteristics and their lived experience of work. The interplay between factors that influence behaviour were poorly accounted for within the selected studies. It is proposed that a shift away from error as an event to a focus on the relationships between the person, the environment and medication administration management behaviour is needed to better understand medication administration error.

Despite the greater understanding of the influence of systemic causes of medication administration error, some recent literature often still holds nurses responsible for medication administration errors (for example, McMullan et al 2010 and Wright 2013). Nurses are responsible and accountable for their practice (NMC 2015a) and need to take responsibility for the errors they make. However, an in-depth understanding the causes and mechanisms and categories of error are required to learn and minimise future error. If focus is placed solely on the nurse who made the error, error will continue to be underreported. This will hinder the design of optimal solutions to prevent future error. Medication administration error should be viewed within the wider systemic context of healthcare and the complex clinical environment in order to develop solutions to reduce medication-related error. The systemic approach to error suggests effective management of conditions that give rise to error involves two components: improving working conditions to reduce the opportunity for error and creating systems that are better able to mitigate the consequence of error (Reason 2000). To be able to redesign the workplace to improve safety, it is necessary to firstly to identify how and why error occur. The systems approach actively encourages error reporting to complete a root cause analysis and identify

methods to minimise future error. A systemic and multifaceted strategy is needed to reduce error and support nurses to administer medications safely and effectively.

2.7 Strategies to Reduce Medication Administration Error

The systems approach underlines the importance of the healthcare system to be designed in a manner to support nurses to be safe practitioners. Medication errors need to be managed within their real-life contexts by designing the healthcare system to integrate barriers to minimise potential errors (Renata et al 2014). This requires a multidisciplinary systemic approach and should encompass the structures, processes and the environment of the healthcare setting. The literature of causes of medication administration error provide insights into areas in which opportunities that lead to error could be reduced. Numerous interventions have been proposed to reduce medication administration error which reflect both the systemic approach to error and the individual and contextual causes of error. For example, maximum staff-patient ratios (NHS England 2016 and NICE 2014), reduced workloads (Picone et al 2008), limiting medication administration during times of peak fatigue (Gordon et al 2006) and the adoption of new technologies (Joseph and Guttman 2011).

System wide strategies to reduce medication error are possible and can be effective in reducing error rates (Yoder et al 2015). For example, Keiffer et al (2015) reported that a mixture of unit based multidisciplinary interventions can reduce medication errors in a paediatric intensive care unit. They initiated numerous quality improvement interventions, for example, a multidisciplinary quality improvement committee, additional nursing education, shift change medication double check procedures, medication error huddles, safety systems checklist, a distraction-free zone to enter orders and medication bar coding. These implementations reduced identified medication errors from 33 in 2010 to four in 2013. However, the unit was small with a well-integrated team which increases the likelihood that new interventions will be accepted and incorporated into everyday practice. Rodriguez-Gonzalez et al (2015) completed a systems wide, failure mode, effects and critical analysis to evaluate the causes of preventable adverse drug events during the nurse medication administration process in inpatient units with a computerized prescription order

entry system. A multidisciplinary consensus committee composed of pharmacists, nurses and doctors analysed all stages of the medication process to identify failure modes that can arise, including antecedents which only materialise during the administration phase. Error criticality was determined by rating severity, frequency and likelihood of failure detection on a scale of one to 10. The committee identified eight processes and 40 failure modes, of which 20 were classified as high risk. This resulted in 24 recommendations which included maximum dose limits, linking medications with laboratory results, automatic notification of nursing staff of a change in a patient's treatment and more distinct labelling of similar looking and sounding medications. Thirteen recommendations were prioritized and developed over a 24-month period and reduced the subsequent error criticality by 32.0%.

Another significant area which incorporates a systems approach to reduce medication administration error uses information technology (Drach-Zahavy et al 2014 and Poon et al 2010). Stultz and Nahata (2015) completed a retrospective analysis of voluntarily reported or trigger tool-identified errors and adverse incidents reported between July 2011 to June 2012 at one paediatric tertiary care institution. The aim was to identify medication errors prevented by technology, determine why technology preventable errors still occurred and identify risk factors for errors not preventable by technology. A technology preventable error was defined as having the system in place to prevent the error at the phase and location of its origin. 936 medication errors were analysed and of these, 470 (50.2 %) errors were considered to be preventable by technology. 155 of errors were due to system bypasses, 103 were due to the intrinsic insensitivity of the alerting systems and 47 were due to alert overrides. This occurred across the medication process and departments. Dispensing, administration, and documentation errors were significantly more likely than prescribing errors ($p < 0.001$). The authors concluded that despite extensive implementation of technology, approximately 50% of the medication errors identified were not preventable by the utilized systems. Therefore, adoption of technology does not necessarily result in the irradiation of the majority of error.

Many studies focus on reducing distraction to improve nurse concentration when preparing and administering medications (Davis 1994, Buchini and Quattrin 2012, Tang et al 2007 and Cottney and Innes 2015) including using dedicated medication administration rooms or cabinets (Connard et al 2010). Identifying conditions that cause nurse interruptions may contribute to the

development of strategies to avoid this occurrence and minimise the impact on care delivery (Montiero et al 2015).

There are a number of practical distraction initiatives that have been implemented. One specific example is where nurses wear a tabard that directs patients, family members and staff to not disturb them during the medication round (Verweij et al 2014, Pape et al 2005 and Craig et al 2014). In a more widely scoped study, Williams et al (2014) implemented a number of interventions designed to decrease distractions and interruptions during medication preparation as part of a pilot quality improvement project in a 32-bed surgical care unit in an academic medical centre. The five interventions were: nursing staff education, medication safety vest, delineation of a no-interruption zone, signage, and a card instructing nurses how to respond to interruptions. Four types of distractions and interruptions decreased significantly between the two months pre and post-implementation and interruptions by staff of differing causes decreased significantly. The total number of reported adverse drug events also decreased by 60%, however as the literature implies, this is dependent on staff reporting the error.

In addition, Raban and Westbrook (2014) completed a systematic review which examined the effectiveness of interventions to reduce interruptions during medication administration on error rates. The authors do not provide a date range for the search. Ten studies were included in the analysis. All studies implemented more than one type of intervention including, designated quiet zones, signage requesting nurses administering medications to not be interrupted and medication administration checklists. Seven studies showed a reduction in interruption rate post-intervention and of these, only three were statistically significant ($p < 0.05$). Three studies measured the long-term impact of interventions and showed an expected reduction in medication administration error and two of these were statistically significant ($p < 0.05$). In addition, four studies failed to evaluate the statistical significance of the observed change. The authors concluded that there is weak evidence of the effectiveness of interventions to significantly reduce interruption rates and limited evidence of their effectiveness to reduce medication administration error. Further research is also required to better understand the complex relationship between interruptions and error to support intervention design.

Although these strategies are seen as potential solutions to reduced medication error, their introduction can introduce unintended additional problems (Novek 2002, Stetina et al 2005 and Ulanimo et al 2007) and can potentially generate new antecedents for error. Technology, for example, can often insert itself between patients and nurses (O'Keefe-McCarthy 2009) and place barriers in between this key relationship. Many technologies are intrinsically high technological which can interfere with the personal touch required (Musk 2004 and Weeks 1994). Even though technologies can prevent error, they also become inefficient substitutes for knowledge and discretion (Reason, 1995). The result is that technology can be used as an excuse for poor nursing care (Barnard and Sandelowski, 2001). It is therefore important to study impact of technology on patient care.

The importance of identifying the unintended consequences of integrating technology on subsequent nurse skills and autonomy is corroborated by Orbæk et al (2015) who explored nursing students' experiences and competences with the technology-driven medication administration process. They completed two focus groups of 16 pre-graduate nursing students using the systematic horizontal phenomenological-hermeneutic template methodology. Whilst students were positive and confident using the technology, they experienced difficulty in identifying and adopting best practice. Therefore, when systems are implemented, additional consideration is required to determine the impact of the system on work practices.

There are inherent consequences in implementing strategies to reduce distractions that can also affect patient-nurse or family-nurse interactions. For example, placing stipulations to stop the nurse being disturbed negates the ethos of the caring nursing role, which requires the nurse to be fully available to patients and next of kin and responsive to their needs. It also places a communication barrier between nurse and patients. In addition, interventions to reduce error can be impractical to implement, for example, there may be limited space in which to redesign the clinical environment and key signage can be ignored (Gosbee 2004). Interruptions, however, may still occur depending on patient need and therefore, it is necessary for nurses to be able to manage not just interruptions, but competing demands (Monteiro et al 2015).

Much of the medication literature also highlights the role of individual causes of error and the importance of nurses to improve their skills and knowledge to administer medications safely (Rogers 2017). Stolic (2014) completed a literature review of articles published between 1990 and

2012 relating to education strategies to improve nurse medication calculation skills. 20 research based articles were included which document the tuition of 5206 student nurse in calculation skills. Four types of education strategies were identified: (i) traditional pedagogy, which includes didactic and lecturer centred learning, face to face learning, remediation classes, repeated mathematical drills and problem-solving exercises, (ii) technology orientated learning, which includes computer aided technology, psychomotor skills using simulation (iii) practical learning with real medication charts and medications, and (iv) blended learning, which included a mixture of formal teaching, simulation and clinical based simulation learning. Calculation skills which can be improved with dedicated input from universities, but that more improvements could be made and more rigorous research into this area is needed.

Despite the interventions that focus on individual and systemic causes of medication administration error, studies consistently demonstrate that safe medication practice is still not guaranteed. For example, Maaskant et al (2015) completed a literature review and narrative analysis to determine the effectiveness of in-hospital interventions aimed at reducing medication error and related harm in children. Language and date limits were not applied. Two review authors independently selected studies, extracted data and assessed study quality using the Cochrane Effective Practice and Organisation of Care Group data collection checklist and Grades of Recommendation, Assessment, Development and Evaluation tool. Seven studies were included in the analysis and comprised five interventions: incorporation of a clinical pharmacist within the clinical team, introduction of a computerised physician order entry system, implementation of a barcode medication administration system, use of a structured prescribing form and implementation of a check and control checklist in combination with feedback. Lack of clinical and methodological heterogeneity between studies precluded a meta-analysis. Although some interventions described in the review demonstrated a decrease in medication error rates, this was not consistent across studies and none of the studies resulted in a significant reduction in patient harm. The overall quality and strength of the evidence was deemed to be low. The authors concluded that further comparative studies with robust study designs are needed to investigate interventions including components that focus on specific paediatric safety issues.

Part of the difficulty in implementing successful interventions to reduce medication administration error is the inherent complexity of the clinical environment. The research highlights that whilst some interventions can reduce opportunities for error, error is not yet fully eradicated. For example, Berdot et al (2016) completed a systematic review and a meta-analysis on the efficacy of strategies to reduce medication administration errors between January 1975 and August 2014. The primary outcome was the error rate, excluding wrong-time error. A random effects model was used to evaluate the effects of interventions on administration errors. Seven studies, including five randomised control trials were included in the review. Four strategies were preparation-related, and included dedicated medication nurses, interactive CD-ROM programmes, simulation-based learning and pharmacist-led tuition. Three strategies were technology-related and included computerised prescribing and automated medication dispensing systems. The authors concluded that all studies were subject to a high risk of bias and no difference between the control group and the intervention group was identified (OR = 0.72 [0.39; 1.34], p = 0.3). The authors concluded that there was a lack of evidence to suggest the interventions effectively decrease administration errors and that more evaluation studies with stronger designs are required.

These studies underline the inherent difficulty to reduce error within the complex clinical environment. There is a need for a whole system approach to medication management which encompasses a wide range of skills and knowledge to improve medication administration practice (Wright 2013). Training and education are key components of the systems approach to error reduction (Reason 2000). Therefore, nurse education has an important part to play to support nurses medication administration practice. Nurses are integral to the medication administration process and are a vital resource to help reduce error. The prevalence and consequences of medication administration error underlines the importance of supporting nurses to link the checking procedures to clinical practice as an important research topic.

The role of nurse education is to prepare student nurses to become safe and competent practitioners for future clinical practice and nurse education has a pivotal role to support and enable the use of knowledge in clinical practice (Bjork 2013 and Council of the European Union 2008). Student and qualified nurses have expressed the need to learn and understand the causes of medication errors, and need to be provided strategies to reduce or prevent medication errors (Morrell and Ridgway 2014 and House et al 2016). With the ongoing prevalence of medication

administration error in clinical practice, nurse education needs to help equip nurses with the resilience to administer medications safely and effectively within the complex clinical environment (Scholes 2008 and House et al 2016). Further investigation is required to determine how nurse education can best support nurses to administer medications safely in the complex clinical environment.

2.8 The Role of Nurse Education to Support Safe Medication Administration Practice

Nurse education uses theory-based classroom tuition and clinical practice to equip student nurses with evidence-based knowledge and skills necessary for professional practice. Traditionally, theory is synonymous with theoretical instruction, which commonly takes place in the classroom, and practice is synonymous with clinical placement (Ousey and Gallagher 2007). Unfortunately, the links between theory and practice are often not established and can lead to the theory-practice gap. This refers to the gap or dissonance between what is taught and what is practiced (Gallagher 2004, Bjørk et al 2013, Corlett, 2000). Jarvis and Gibson (1997) argue that the link between theory and practice is often so divorced that that student nurses often consider theoretical learning to be irrelevant to clinical practice.

The cause of the theory-practice gap is multifaceted (Swain et al 2003, Benner et al 2010, Romyn et al 2009 and Hope et al 2011). Baxter (2007) states there are two different cultures of theory and clinical practice. Theory is spatially located in the classroom, whilst practice is located on the ward, and students experience difficulty to mentally bridge these two locations (Jacobs and Heuther 1992). A prominent difficulty bridging the gap is the discrepancy between what is taught as theory and the realities of clinical practice (De Swardt et al 2012). With theory, students are often presented with an idealised view which is not easily adapted to the constraints, demands and realities of clinical practice (Yassin 1994 and Corlett 2000). The variability of practice is often not catered for and as a consequence, theoretical learning is not perceived as salient or relevant to clinical practice. Students also often experience competing demands and differences between university and clinical practice and find it difficult to generalise the theory taught (Sharif and Massoumi 2005 and Allan et al 2011). This is also elucidated by the fears of student nurses who

often do not feel that they are sufficiently prepared for clinical practice. In the United Kingdom, a phenomenological study about the experiences of student nurses in their final placement include not feeling prepared and not being adequately supported (Morrell and Ridgway, 2014). Similarly, new nurses in the United States felt unprepared for the transition for complex real-world practice settings (Casey et al 2004).

The discrepancy between what is taught and what is practiced is illustrated by Maben et al (2006). They completed a longitudinal study in three educational institutions in the United Kingdom between 1997 and 2000. 72 nursing students completed a questionnaire which investigated their views of ideals and values for clinical practice. In-depth interviews were also completed with a purposive subsample of 26 participants, four to six months and 11 to 15 months post qualification, to determine the extent to which these ideals and values were integrated into clinical practice. There was a clear discrepancy between evidence-based ideals and values and those encountered in clinical practice. The findings suggest that although nurses commence their qualified nursing practice with a strong set of values, professional and organisational aspects of clinical practice directly hindered them from enacting these values. Examples include obeying covert rules, lack of support, time pressures, staff shortages and work overload. This is to the detriment of both patients and the reputation of the nursing profession (Baxter 2007). This is of particular concern for nursing, because theory is supposed to be evidenced-based best practice and in the United Kingdom constitutes part 6 of the NMC code of professional conduct (2015a) whereby nurses are required to practice effectively. Inadequate theory-practice integration leads to reduced nursing standards (Gregory et al 2009 and Jones and Treiber 2010) and inadequate patient care.

Medication management is a central part of the student nurse pre-qualification education programme in the United Kingdom. The NMC's 'Standards for pre-registration nursing education' (2010) states nurses are to 'be responsible and accountable for safe, compassionate, person-centred, evidence-based nursing' p13. The collective partnership between accredited university and clinical practice partners are responsible for theory and practical learning and assessment to teach, prepare and assess nursing students to be safe, effective and evidence-based practitioners when they qualify as nurses. The 'Education framework: Standards for Education and Training consultation document (2016) details five pillars that define effective education and development, delivery and management of programmes and assessment. Primary to this is the

delivery of a learning culture in which patient safety and value of learning is prioritised and enables students to achieve their learning outcomes, required proficiencies and professional behaviours. The NMC requires nurses administer medications safely, in line with local and national policies, be proficient in calculating doses and demonstrate appropriate knowledge of pharmacology.

Safe medication management is so integral to nurse education that it comprises one of the five essential skills clusters in the 'Standards for Pre-Registration Nursing Education' document (NMC 2010). Many of the theoretical underpinnings of medicine management are taught within university and practically applied within clinical practice. Within university, student nurses are continually assessed through a variety of assessment methods including examination, coursework and objective standard clinical examination. Within clinical practice, student nurses are formatively and summatively assessed throughout their clinical placements. There are three progression points at which nurses must achieve a specified standard of competence. The progression points become more complex throughout the nurse training programme mirroring the journey of a student nurse from novice to an accountable and professional qualified nurse. The curriculum content that the progression point cover encompass the wide remit of medication management that the student nurse must become competent in including: basic and advanced medication-related calculation skills, involving tablets and capsules, unit doses, conversions and intravenous infusions, work within and have knowledge of all legal, regulatory and ethical frameworks, for example, 'The Controlled Drugs (Supervision of Management and Use) Regulations (2006)', 'Medicines Act (1968)', 'Standards for Medicines Management' (NMC 2015b), 'Professional Standards of Practice and Behaviours for Nurses and Midwives' (NMC 2015a), and have a comprehensive knowledge of medicines, pharmaco-therapeutics and the impact of the physiological state of patients. There are also stipulations on the handling of medications including, knowledge of safe ordering, receiving, storage, administration and disposal of medicines, and the effective management of adverse drug events and reactions.

Historically, student nurses were taught in university and under supervision in clinical practice to administer medications using paper charts. However, there have been technological developments in which certain clinical areas, for example, within the inpatient hospital setting, in

which computerised medication charts are now predominantly used. For example, many hospitals within the United Kingdom now use the 'Electronic Prescribing and Medication Administration' system which is specifically designed to reduce the risks associated with traditional methods of prescribing and administering medicines. The scope of the system includes electronic generation prescriptions, electronic recording of medications administered and the full record of all medicines prescribed and administered. Students are therefore assessed on their competency to administer medications using either the paper or electronic medication chart format, depending on what is used within the clinical area experienced.

Within this framework, nurse education in the United Kingdom teaches evidence-based theory of protocolised checks or 'rights' in which to administer medications (Mallett and Dougherty 2004). As detailed in section 2.4, there are a series of different protocolised checks utilised internationally to support nurses to administer medications safely, including the five rights (Hughes and Blegen 2008), the eight rights (Fothergill Bourbonnais and Caswell 2014), the nine rights (Elliot and Lui 2010) and the ten rights (Edwards and Axe 2015). Unfortunately, despite teaching student nurses the checks or rights, the extent of medication administration error and the literature underline that they are not always adhered to (Gladstone 1995). Simply teaching the theory of the checks or rights is insufficient to support nurses to apply them in clinical practice. This is illustrated by Schneidereith (2014) who completed a longitudinal study to determine how student nurses administer medications using the five rights during four simulated scenarios over one academic year. Students became less vigilant using the five rights as they progressed through the curriculum and the author argued this is a significant area for nurse educators to focus upon. It is the responsibility of academic staff to ensure students fully understand the importance of theory to clinical practice (Ousey and Gallagher 2007).

The nursing curriculum needs to increase investment in teaching medication management (Vaismoradi et al 2014). This need is supported by nurses themselves. Deans (2005) identified that nurses considered additional preparation in medication administration would positively impact their nursing practice. Nurse education needs to raise awareness of the practical constraints in applying theory to practice, and how these may contribute to medication errors (Page and McKinney 2007 and Bartley 2011). Theory should be taught to take account of the complexity and variability of clinical practice (Rafferty et al 1996). Nurses should be taught the psychological robustness to withstand the multiple causes of medication administration error, however, they do

not prescribe a mechanism in which to teach these skills (Westbrook et al 2010). Nurse education therefore needs to support nurses to acquire the non-technical cognitive skills to enable them to practice safely in the complex clinical environment (Mitchell and Flin 2008 and Tokuda et al 2011).

Nurse researchers and educators have proposed a number of solutions to close the theory-practice gap (Baxter 2007), including the use of key role models and preceptors in clinical practice (Sedgwick and Yonge 2008). Ousey (2000) argues that there is still an important role for classroom based tuition. Dadgaran et al (2012) completed 21 semi-structured and interactive interviews with 21 nursing students on their views on the theory-practice gap in clinical learning. The interviews were analysed using qualitative content analysis. Appropriate theoretical knowledge and clinical skills were deemed essential to support safe clinical practice. They propose various methods which include the prioritization of theory, applicability of cases according to theoretical materials and use of innovative curriculum to reconcile theoretical and practical educational content for students. In particular, they advocate using solutions in which students are active participants. However, there is minimal research into the underlying mechanisms of knowledge transfer (Aita et al 2007) and is an area of research that requires urgent focus (Bjørk et al 2013).

There are a number of recommended teaching strategies that could be used. Kassirer (2010) recommends teaching strategies which use clinical scenarios, near misses, errors and known biases that can lead to error as a method to help nurses to learn from and minimise future error. Gordon et al (2012) completed a systematic review which identified the efficacy of non-technical skills preparation to enhance patient safety. Studies involving an educational intervention to improve non-technical skills amongst undergraduate or postgraduate staff in an acute health care environment were considered and 22 research studies were included in the analysis. Although outcome measures and strength of conclusions were variable, and the theoretical underpinning of study interventions were not described, a content analysis revealed five key themes with reasonable consistency: error, communication, teamwork and leadership, systems, and situational awareness. Teaching was often multidisciplinary and methods used included simulation, role-play and observation.

Simulation is an education tool which is actively used to overcome the theory-practice gap (Ziv et al 2005). Simulations which are salient can potentially aid the transfer of theory to clinical practice (Kneebone et al 2004, 2007 and Ziv et al 2005) and provide a safe and controlled environment to teach a wide variety technical and non-technical skills (Jones 2015). It is used extensively in other high-technology and high-risk industries and professions, where the application of sophisticated technical and behavioural skills is vital (O'Connell et al 2014 and Ziv et al 2003). In the aviation industry, for example, simulation is extensively used and is demonstrated to help transfer theory to practice and reduce adverse outcomes (Murray et al 2008, Lateef 2010 and Jones et al 2015). The literature suggests incorporating simulation into the nursing curriculum has the potential to reduce error (Ziv et al 2000) and improve patient safety (Issenberg 2006). Simulation has the potential to improve performance in core competences such as knowledge, communication skills, team work, patient care, clinical skills and professionalism (Cooper 2015). Therefore, simulation-based medical education has the potential to equip nurses with the skills to prevent and cope with errors in medical practice (Mariani et al 2015) and support nurses to link the importance of the checks or rights of medication administration in clinical practice.

There are a number of studies that highlight simulation is a potentially valuable tool to teach medication administration. Sears et al (2010) randomly allocated 54 second-year student nurses to receive either medication administration simulation based tuition, assessment and reflection, or standard tuition. They were assessed in subsequent clinical practice. There was a significant difference between groups in medication administration error rates in subsequent clinical practice. Standard tuition participants made 24 errors compared to seven errors by participants who received simulation based tuition ($p = <0.05$). Pauly-O'Neill (2009) suggest well-designed simulations can provide structure for learning about safety measures beyond the rights of medication administration. In addition, Scudmore (2013) completed a quantitative, quasi-experimental study to determine the effectiveness of high-fidelity simulation as a learning strategy to reduce medication errors by associate degree nursing students. Using a pre and post-test design, participants made significantly fewer medication errors after completing the high-fidelity simulation ($p < .05$). This implies that simulation and learning interventions, such as the use of error are valuable and could be used.

Simulation could potentially help teach the psychological robustness, insight and knowledge-based behaviours advocated by Mitchell and Flin (2008), Tokuda et al (2011), Westbrook et al

(2010) and Kassirer (2010), to support nurses to administer medications more safely and apply checking procedures within the complex clinical environment. Simulation can actively incorporate the context of clinical practice. For example, Hayes et al (2015) developed a simulated role-play experience to enable 528 second year nursing students from one large Australian university to experience, reflect and analyse responses to interruptions during medication administration. The study highlighted that exposure to clinical experiences in a safe environment can provide a positive learning experience. In addition, awareness of interruptions and their impact upon the medication administration process and interruption management strategies can help prepare nurses for clinical practice.

2.9 Summary

Medication administration error is endemic in clinical practice and is a major patient safety issue. The systems approach suggests that the cause of error is commonly systemic in origin and organisations should be actively designed to minimise error. There are many systemic causes of medication administration error due to the complex and variable clinical environment, for example, high workload and distraction. Numerous suggestions have been made to reduce errors and indeed have a role in error reduction. Unfortunately, the complexity of clinical practice means that, irrespective of appropriateness of such initiatives, the complexity of the clinical environment means that error is unlikely to ever be fully eradicated.

Nurses are taught to use the theory protocolised checks or rights to administer medications safely. However, the extent of medication administration highlights that there is gap between theory and practice. The individual nurse is responsible for patient care and need support to develop robustness to use checking procedures to administer medications safely within the complex clinical environment. Nurse education has an essential role to provide this support and simulation is one educational tool to help achieve this.

Chapter 3: Literature Review

3.1 Introduction

Chapter two introduced simulation as a method to help prepare and support nurses to administer medications using protocolised checks or rights, for example, the five rights within the complex and error prone clinical environment. Chapter three reviews relevant literature to establish the role of simulation within nurse education to determine the composition of the medication administration simulation developed for this study. Section 3.2 introduces simulation education and the underpinning adult learning theories. It also details three established key theoretical components that are necessary for the simulation to be effective: fidelity, realism and authenticity. Section 3.3 introduces high-fidelity simulation and discusses the benefits and limitations of high-fidelity simulation in nurse education. Section 3.4 examines the benefits of low-fidelity simulation and how adopting lower-fidelity simulation can be a cost-effective alternative to high-fidelity simulation. Section 3.5 introduces the component of salience to simulation and its potential role to enhance the effectiveness of lower-fidelity simulation education. This section also introduces the concept of the psychological heuristics of availability and affect and their potential role to enhance the salience of simulation education. Section 3.6 introduces the role of error in simulation and links error to the psychological heuristics of availability and effect, and how they in conjunction can enhance the salience of lower-fidelity simulation to support nurses to apply protocolised checking procedures. Section 3.7 describes the design of the medication administration simulation selected for this study and section 3.8 provides an overview of the methods used to evaluate the transfer of learning from simulation to clinical practice and detail the evaluation methods used for this study.

A search for journal articles was performed for the literature review, using CINAHL covering publications from 1981 to March 2017, Medline covering publications covering from 1946 to March 2017 and PsycINFO covering publications from 1950 to March 2017. Details of the search strategy for each section are described in Appendix A. Simulation related records, which also included mistakes / error, adult learning theory, locus of control, high and low-fidelity simulation

(including in nursing education), salience / salient, authenticity / authentic, realism and realistic were appropriate for inclusion if they related to education. Salience and heuristic records were suitable for inclusion they related to potential behavioural changes and not to artificial constructs. As discussed in the preceding chapter, medication administration and error were also included. Related records were excluded if they were a case-study, out of hospital or related to a particular device, medication or patient condition. Following the electronic searches, additional relevant literature was identified from the reference lists of retrieved articles or through publication from professional or governmental bodies.

3.2 Simulation Education

Simulation has become a progressively more important element of nursing education to teach and assess necessary skills and knowledge to prepare nurses for professional clinical practice (NMC 2010, Aqel and Ahmed 2014, Kim et al 2016), particularly over the last 10 years (Doolen et al 2016). Simulation is an artificial representation of a specified aspect of clinical practice. Multiple authors define simulation as an activity which 'mimics' reality to enable students to learn (Jeffries 2007, Kneebone 2003 and Waxman 2010) and supports links between theory and practice (Lestander et al 2016, Kneebone et al 2007, Hope et al 2011, and Waxman 2010). Simulation comprises various methods that aim to enable a student to substitute the simulation for clinical practice to learn predefined skills (Reilly and Spratt 2007 and Nordquist and Sundberg 2015) to promote, improve or validate a student's progression from novice to expert (Meakim et al 2013). To develop and maintain patient safety, it is essential to expedite progression from novice to expert and the experience of repeated and deliberate practice using simulation with immediate feedback can accelerate students to become competent practitioners (Kalaniti and Campbell 2015). Simulation is extensively used in pre and post-registration nurse education as a teaching and assessment tool (McCallum, 2007, Harder 2010 and Stroup 2014) because it is deemed to have the potential to develop dynamic, flexible, critically thinking nurses necessary for healthcare in the 21st century, and helps to overcome difficulties securing clinical placements (Josephsen 2015).

Simulation can replicate a whole or subset of clinical practice and can include the environment, clinical task or scenario. The NMC (2010) states simulation functions as a hybrid form of learning which combines theory and practice. Simulation can illuminate and reinforce the relationship

between theory and practice in a controlled environment (Persson 2017, Hope et al 2011, Moule et al 2008 and Kneebone et al 2002), consolidate the relevance of theoretical learning (Kneebone et al 2007, McCaughey and Traynor 2010) and infuse theory into students' everyday clinical practice (Aebersold 2011). This is because simulation transfers aspects of clinical practice into the classroom and therefore merges the theory and practice of nurse training in one location. This mergence caters for Jacobs and Heuther's (1992) concerns that students find it difficult to cognitively bridge theory and practice because theory is usually located in the classroom, whilst practice is located on the ward.

Historically, simulation was used for developing psychomotor skills, such as cardiopulmonary resuscitation (House et al 2016). Indeed, one of the most iconic and widely known forms of simulation is the Resusci-Annie which is a static part-trainer mannequin developed in the early 1960s for healthcare professionals and layperson resuscitation training. Various simulation methods can be adapted according to specific learning outcomes and educational levels (Kim et al 2016). Simulation is used to develop a wide range of both technical and clinical skills (Li and George 2017 and Lestander et al 2016), including cognitive and critical-thinking (Lestander et al 2016, Hovancsek 2007 and Jeffries and Rizzolo 2006), problem-solving and decision-making skills (Reilly and Spratt 2007 and Kim et al 2016) provide insight through reflective practice (Garrett et al 2011), to increase confidence levels (Fabro et al 2014, House et al 2016 and Martins et al 2016), and develop team performance (Zhang et al 2015) satisfaction (Dearmon et al 2013) and communication skills (Rashid and Gianduzzo 2015). Simulation can also engender the professionalism and attitudes required for clinical practice in a context that does not harm patients (Andersen et al 2016, Wilford and Doyle 2006, Li and George 2017 and Issenburg 2006). The literature suggests that simulation helps to reduce error and enables students to practise skills in a safe environment which are transferable to clinical practice (Rashid and Gianduzzo 2016).

Healthcare is progressively more technologically dependent and nurse education needs to respond accordingly to reflect this reality as a basis to prepare nurses for the reality of clinical practice. The integration of technology used in clinical practice into simulation education has the potential to not only facilitate nurse education but facilitate the transition of student nurses from

classroom to clinical practice. It reduces the shock of entering clinical practice (Berragan 2011 and Du Boulay and Medway 1999), and provides a less threatening environment in which to practice clinical skills (Sanford 2010). Simulation education can provide a safe, controlled environment in which key competencies can be practised in real time. This provides an opportunity for the learner to experience multiple events simultaneously and to learn skills and experiences particularly difficult to teach or assess using conventional educational methods (Cooper 2015), for example rare, emergency or life-threatening situations. It is an established education method which has the potential to support nurses to administer medications more safely in clinical practice.

3.2.1 Forms of Simulation

Simulation encompasses a wide range of interventions, methods, levels of technology, and costs (Kim et al 2016, Baptista et al 2016, Nehring and Lashley 2009 and Kalaniti and Campbell 2015). Simulations can be designed to be generic or targeted at a specific clinical speciality (Jones 2015), specific skill, for example, suture simulation (Rashid and Gianduzzo 2016) or clinical scenario, for example, emergency life support (Resuscitation Council (UK) 2015). Cooper (2015), Kneebone (2007), Lasater (2007) and Rashid and Gianduzzo (2016) describe the different types of simulation into the following categories:

- a) Low-technological models, box trainers and statistic mannequins, which include partial or whole body reproductions to gain competency in simple techniques, procedures, knowledge and skills. It also includes peer-to-peer learning and basic role play.
- b) Screen-based computer simulators, often used to train and assess clinical knowledge, inform decision-making and problem-based learning.
- c) Standardised patients in which actors are trained to portray patients in a realistic and consistent manner and enact simulated scenarios to support training and assessment of, for example, history taking, physical examination and communication skills.
- d) Virtual-reality simulations which combine a computer-generated environment with tactile, auditory and visual sensory stimuli which are often used to train clinical staff in more complex procedures, for example, endoscopy. These vary in technology but can provide some visual, motion, vibration, structural or other haptic feedback.
- e) Complex task trainers which include computer-based simulators used for high-fidelity training of procedures and clinical scenarios, for example, partial or whole body realistic

patient simulators, which include life-like computer-based able to replicate human functions, including pulse, respiration and blinking and is responsive to predefined clinical scenarios and various medical and pharmacological interventions.

- f) Whole scale environments, for example, full scale theatres.

There are also a variety of environments in which simulation education can occur which directly reflect the increasing technology used in healthcare. Many universities within the United Kingdom and internationally with comparable education and healthcare systems have dedicated simulation education centres, for example, Southampton, Salford and Surrey, which are used for training and assessment. These centres portray realistic clinical environments with responsive part or whole body patient mannequins and cater for a range of clinical training and scenarios. They comprise a variety of clinical ward areas, for example, integrated theatres, adult and children's wards with treatment rooms and bathrooms in which students learn and practice clinical skills. Bed spaces can be equipped with oxygen delivery ports, suction points, nurse call buttons, emergency buzzers and bed lights to mimic a real hospital environment. Other simulation training can take place within dedicated classrooms, in which simulation equipment is permanently stored, or in a generic classroom where portable simulation equipment is brought directly to students. In addition, some basic simulation, for example, role-play can be completed within a classroom environment without equipment. There is also in situ simulation which occurs within the actual clinical environment using simulation or real healthcare equipment.

There are also commercial simulations that are integrated into the nursing curriculum (Li and George 2017) that are used to both teach and assess student competencies. This reflects the broader integration of technology within healthcare, medication management, simulation and nursing education. There are a number of specific examples that support safe medication administration practice. SafeMedicate® programs (Authentic World Ltd) is a medication dosage calculation learning and diagnostic assessment environment which supports both students and qualified nurses. It is incorporated into approximately 70% of university nursing education programmes in the United Kingdom and has registered users across 10 countries (Weeks 2017). Another example which focuses on dispensing medications is the medDISPENSE® system (Ferguson et al 2014) which is an automated medication-dispensing unit, which consists of a

workstation with a computer touch screen and 24 medication drawers. The system has a handheld scanner to scan medication barcodes. Both these commercial simulations focus on separate aspects of the medication administration process and demonstrates the variability of simulation and technology now available.

3.2.2 Learning Theories in Simulation Education

With the increased implementation of simulation into the nursing curriculum, and the variety of types and environments in which simulation can occur, it has never been more important to select the most appropriate form of simulation tailored to the student group and education goals to achieve optimal education outcomes. Combinations of simulation methods are possible depending on the target population and educational aims (Aqel and Ahmed 2014). Irrespective of the simulation method selected, it is essential that simulation is based upon adult learning theory (Tutticci et al 2016, Zigmont et al 2011 and Pasquale 2015).

Within adult learning theory, it is important to distinguish between pedagogy, which is the method and practice of teaching, and andragogy, which is the method and practice of teaching adult learners (Knowles 1984). Knowles states there are five distinct premises that differentiate adult from child learning: self-concept, in which adults are self-directed and regulated to learning, possession of previous knowledge and experience that can be used to facilitate their own learning and fellow learners, readiness to learn, in which the learner becomes orientated to the developmental tasks of his social roles, orientation to learning, in which learning shifts from subject centred to problem centred, and the intrinsic internal motivation to learn. Within this, adults need to be involved in the planning and evaluation of their instruction. Adults are most interested in learning when it has immediate relevance to their job or personal life and is problem-centered rather than content-oriented (Kearsley, 2010). Appropriately planned simulation will have immediate relevance to student's learning, allow the opportunity to learn from experience and learn from error. As a consequence, Doolen et al (2016) emphasises the importance to engage the student in the simulation experience and to enable this, it is vital adult learning theory is considered when designing nursing curriculum. This demonstrates the specific requirements of an adult learner distinct from the learning needs of children within the concept of pedagogy and underlines the motivation of using simulation within nurse education. Nurse educators have a responsibility to understand learning theory when they select a particular form of simulation teaching and learning strategy to ensure optimal learning outcomes. There are a

number of learning theories that underpin simulation education. The most common are experiential learning, constructivism, vicarious learning theory and student locus of control.

Experiential Learning Theory

Experiential learning is classed as an 'active' learning method more in keeping with the educational requirements of modern students (Detweiler 2005, Jeffries and Rizzolo 2006 and Shin et al 2015). Experiential learning theory (Kolb 1984) is based on the work of Dewey, Lewin, and Piaget (Koob and Funk 2002). Experiential theory is "an integrative perspective on learning that combines experience, perception, cognition, and behaviour" (Kolb, 1984, p 21). It is described as learning by doing, in which the meaning of what is taught is captured through the experience of the action and consequence (Poore et al 2014 and Hope et al 2011). Learners need to be engaged in activities to help them apply the knowledge learned in different situations (Pasquale 2015). The theory stresses the significance of learning through experience, rather than passively through textbooks and teachers. For an experience to be educational, Dewey stated that the experience must possess continuity and interaction. Continuity relates to a chain of experience, where one experience leads to another, which in turn prompts an individual to learn more. Interaction refers to the degree to which an experience is linked to the goals of an individual. Lewin focused on integrating theory into practice. In addition, Piaget's work focused on how cognitive development is influenced by experience (Kolb, 1984). As such, learning is grounded in experience. For nursing education, competence in clinical care is the goal. Experience is central to this and helps negate the practice-theory gap.

Kolb (1984) proposed an iterative cycle of experiential learning in which the learner progresses through four phases: (a) concrete experience where the learner participates in an experience (b) reflective observation where the learner reflects on the experience, (c) abstract conceptualization where the learner considers thoughts and reflections to identify the significance of the learning experience and considers alterations to improve outcomes and (d) active experimentation which involves using what was learned to direct future practice. Within the theory, the learner's prior experience is integral to future learning and will affect how the individual processes and employs the knowledge gained through the new learned experience (Kolb and Kolb and 2005 and Shapira-

Lishchinsky 2015). It builds upon previous experience and purposeful active engagement from the learner, and therefore links well within the andragogy framework detailed by Knowles. Kolb (1984) also identified four individual learning styles which are “the consistent way in which a learner responds to or interacts with stimuli in the learning context” (Loo, 2002, p 252). The four learning styles are tailored to the leaning needs and preferences of the individual (Kolb 1984):

- assimilators, who learn better when presented with sound logical theories
- convergers, who learn better when provided with practical applications of concepts and theories
- accommodators, who learn better when provided with “hands-on” experiences
- divergers, who learn better when allowed to observe and collect a wide range of information.

The four learning styles are depicted along two continuums: perception which is the extent to which an individual emphasises abstractness over concreteness, and processing, which is the extent to which an individual emphasizes action over reflection. Therefore, irrespective of the individuals learning style, experiential learning theory offers a process to facilitate learning through application of the preferred style.

In essence, experiential learning theory is based on six propositions (Manolis et al 2013). Learning is best conceived as a process, not in outcomes, it is a continuous process grounded in experience, learning requires the resolution of conflicts in which to adapt to the world, it is a holistic process of adaption, learning results from synergistic transaction between the person and the environment and most significantly, it is the process of creating knowledge. Kolb’s theory therefore offers both a foundation and process for knowledge acquisition based on the needs of each individual learner suited for adult simulation education.

One of the benefits of experiential learning theory is that it caters for the change in the nature of education (Manolis et al 2013) offered by simulation education, more in keeping with the demands of modern students. Education has been transformed from being teacher-centred in which information is traditionally imparted passively and didactically to students to one in which students learn through their own experience (Manolis et al 2013 and Kinney and Henderson 2008). Experiential learning theory supports this more student-focused experience in which the

teacher is transformed to a learning facilitator and organiser of meaningful experiences that should be oriented around the individual needs of students (Pai 2016 and Jeffries 2005). Experiential learning is particularly suited to simulation because it is based on the application of knowledge and the learner's ability to apply the knowledge in various clinical practice scenarios. Simulation is a hands-on experiential learning method (Pasquale 2015) and offers the learner the opportunity to build knowledge and skills that are vital to clinical practice. Experiential learning through a simulated clinical setting can help students to better understand the challenges of an actual clinical setting (Dhital et al 2015). When used effectively, simulation can provide an environment for to support critical-thinking, problem-solving, and decision-making skills through experiential learning (Pai et al 2016). The theory also incorporates the role of post simulation debrief in which students have the opportunity to interact with one another and the environment to examine their learning, beliefs and ideas (Poore et al 2014).

Multiple authors support the application of experiential learning theory to underline simulation education. Neill and Wotton (2011) state experiential learning helps teach skills and evidence-based practice, develops higher order cognitive skills and links theory with contemporary practice (Childs and Sepples 2006 and Waxman 2010). Stevenson and Gordon (2014) argues student performance improves when they are actively engaged and when instructors create opportunities for them to actively participate in their own learning. In a small-scale study, de Oliveira et al (2015) interviewed three undergraduate nursing students to assess the implementation of an experiential learning nurse consultation exercise using clinical simulation with actors. Data was collected over a three-month period and analysed using Kolb's (1984) four stages of learning. They concluded that the experiential form of learning was useful to students, facilitates training through experience, encourages critical-thinking, improves training quality and has the potential to improve patient safety. This student-centered approach is particularly important in nursing education because it is critical for student nurses to achieve their core clinical competencies. Active learning strategies using simulation have been used to help students to gain competency, but their effectiveness has not been systematically examined.

Although active learning is more established in science, engineering and mathematics education (Freeman et al 2014), a comprehensive and systematic evaluation of the role and effectiveness of

active learning in undergraduate nursing programs is more limited (Shin et al 2014). Therefore, Shin et al (2014) completed a descriptive, cross-sectional comparative design to evaluate the effect of an active learning program on the clinical competency of 147 final-year nursing students. Students were randomly allocated to experience either an active learning program or a traditional learning program. The active learning program incorporated high-fidelity simulation, situation-based case studies, standardised patients, audio-video playback, reflective activities and technology including a SmartPad-based program. The traditional learning program included lecture-based classes and practical clinical training. Participants were asked to complete a post session questionnaire comprised of three outcome measures (self-evaluated learning achievement by students, satisfaction on clinical practicals and general self-confidence at graduation) and an objective assessment of nursing core competency using the Korean Nurses' Core Competency Scale (KNCCS). This 70-item assessment was developed by Lee et al (2010) to measure new graduate nurses' nursing core competencies in Korea and achieved a pre-study Cronbach's Alpha of 0.97. There was no pre-test to determine pre-intervention baseline, however participants pre-nursing academic scores were examined and there was no significant difference between groups. The active learning group achieved significantly higher competency scores than the traditional learning group ($P < 0.001$). Students' self-evaluation of learning achievement and satisfaction with the nursing programme was also significantly higher in the active learning group ($p = < 0.001$ and $p = 0.002$ respectively). Although these scores are based on questionnaire data and not on actual clinical performance, they do imply that improved learning can occur through experiential and active learning.

Constructionist Learning Theory

Constructivism is a second learning theory that has been used to underpin simulation education (for example, Juhary 2006, Shapira-Lishchinsky 2014, Dreifuerst 2009 and Kuiper et al 2008). Constructionist Theory is proposed by Bruner (1986) and is based on the work of Piaget (1977). It refers to the ability of students to mentally construct new information in a symbolic manner so that it can be stored and processed through active engagement in the learning context and content (Pasquale 2015). It is also an active learning paradigm in which the learner is guided by the educator to establish meaningful connections between prior knowledge and the learning experience to construct new knowledge. The constructivist approach holds that exposing the learner to new experiences creates perturbations, or forms of mental disquiet, that challenge the

learner to understand and make sense of new information generated by the new experience (Powell and Kalina 2009). Individual learners use the new experience to actively build, expand or reshape their prior knowledge and skills (Neill and Wotton 2011). If the new experience diverges from previously held knowledge and skills, it can create a conflict which in turn stimulates the learner to process and understand the new information (Powell and Kalina 2009). The role of the teacher is to facilitate and support the construction of new knowledge (Neill and Wotton 2011). Juhary (2006) states simulation learning occurs when students 'interact' with their learning, and do not take the role of observers. In this respect, is comparable to experiential learning theory. Therefore, the constructivist approach forces the learner to critically assess and re-evaluate new information which leads to deeper understanding (Baturay and Bay 2010).

There are divisions within constructionism. In cognitive constructivism, the learner develops ideas based on their own experiences. This cognitive development occurs when the learner is compelled to use prior experiences and knowledge to comprehend and digest new information which helps them to acquire new knowledge (von Glaserfeld 1989). Thus, the constructivist approach forces the learner to think through the new information, leading to a deeper understanding of that information (Baturay and Bay 2010). Whereas cognitive constructivism recognizes that individual learners construct ideas based on their personal experiences, social constructivism expands the construction process to include interaction with others as another means of making sense of new information (Phillips 1997). In social constructivism, the learner develops ideas through interacting with others (Shapira-Lishchinsky 2014). In an educational setting, the combination of social and cognitive constructivism contributes to the constructivist learning environment (Powell and Kalina, 2009). Students are encouraged to apply existing knowledge to engage in dialogue with peers to help them interpret information. As a result, learning satisfaction increases because there is a link between their learning and real-life activities (Baturay and Bay, 2010). Role-play, simulation, reflective essays and cooperative learning are all among the activities that can promote knowledge construction and individual learning (Willey and Burke 2011).

There are similarities between experiential and constructionist theory which makes them both suitable underpinnings for simulation education in that students bring their individual pre

simulation experience to their learning and actively create new knowledge to promote learning through interaction with their environment. To achieve this, students must incorporate active learning, reflections and debriefing, challenge current thinking and be student focused, which requires self-directed learning and motivation (Cooper 2015). Experiential and constructionist learning within simulation education can help students recognise the importance of what they are learning and bridge the theory practice gap.

Vicarious Learning Theory

Vicarious learning theory is a third learning theory linked to simulation education. Vicarious learning theory is based on Bandura's Social Learning Theory (1971) in which learning occurs through direct observation of others and where, in contrast to experiential and constructionist learning theory, new behaviours can be built without trial and error. Bandura described this as a process of attention, retention, reproduction and motivation. This requires active listening, reflective thinking and situational engagement in which a teacher helps to find meaning for the individual observer Nehls (1995) facilitated by reflection and discussion. In effect, the observer becomes an 'active observer', which fits with the common simulation scenario whereby fellow learners often participate as observers or actors within the scenario. For this to occur, it is fundamental that the learner recognises that there is something to learn from other peoples' experiences. This is in direct contrast to experiential and constructionist learning theory which stress the primacy of personal experience and the literature suggests that direct clinical experience is required in order for learning to take place. However, there is a link with social constructionism and first-hand experience may not be the only mechanisms by which students engage in experiential learning (Roberts 2010).

There is a growing body of literature within nurse education which suggests that students are able to use another's experience to learn. There are a number of methods in which vicarious learning can occur (O'Regan et al 2016), for example, modelling, peer and near-peer assisted learning and alternative instructional design methods whereby learners are actively directed to observe without hands-on participation. O'Regan et al (2016) completed a literature review of studies published between 1980 and 2015 to evaluate the effectiveness of directed observation as an educational method and features that lead to positive educational outcomes. The study population included any healthcare professional or student who participated in mannequin,

simulated patient or role-play based simulations that included a specific observer role. Exclusions included computer or virtual reality-based simulations, video-based learning and expert role-modelling due to lack of comparison between the hands-on and observer role. Nine studies were included in the analysis. The authors defined an observer role as an external role whereby the learner watches, but does not participate in the simulation, or participates in an in-scenario observer role, where their role mirrors usual practice. In addition, the role of observer was deconstructed further into a role with or without a specific instructional briefing or observer tool. Two reviewers rated the quality of the studies and achieved an inter-rater agreement of 0.94 across 99 data points. The studies included involved a variety of research methods including mixed-methods, observational, qualitative, ethnographic methods and interviews. Three studies used self-assessment tools, three objectively tested knowledge and six incorporated a pre and post-test design. The studies also encompassed a wide variety of education outcomes including knowledge, non-technical skills, technical skills, attitude and behaviour.

Four studies found no difference in educational outcomes between the hands-on learners and the observers, two studies reported improved outcomes in the hands-on group and one study reported improved outcomes in the observer group. Two studies reported the participant preference for a hands-on role and three found no difference in preference. Importantly, studies with improved outcomes in the observer group and three of the four studies that found no difference in outcomes between the hands-on and observer groups actively incorporated an observer tool to guide the observer group. Therefore, an integrated structure to observer learning is important, which may increase the engagement and therefore the active learning of observers so the learning experience is equivalent or superior to direct experience.

Theory of Locus of Control

Another component of simulation learning theory is the concept of locus of control. Locus of control is integral to simulation due to its emphasis on student engagement and student-centred learning. Locus of control is derived from Social Learning Theory (Rotter 1954, 1966) which proports personality is an interaction between the individual and their environment. To understand behaviour, one must consider both the individual and their history of learning and

experiences, and the environment to which the individual responds. Rotter described personality as a relatively stable set of potential behaviours or responses to a particular situation. Locus of control refers to people's general cross-situational beliefs and defined as internal and external. Individuals with high internal locus of control attribute outcomes due to their own efforts whereas those with high external locus of control tend to attribute outcomes to external forces, for example, luck. Therefore, individuals see little impact of their own efforts on the amount of reinforcement they receive. This represents a continuum which predict people's behaviour across situations. However, there may be some specific situations in which people who, for example, predominantly have high external locus of control behave like someone with high internal locus of control. That is because they have been conditioned to perceive that they have control over certain limited situations.

Locus of control has been explored in healthcare-related disciplines as well as in relation to learning characteristics, education and academic performance (Ponto et al 2014). Although there is a considerable research into learning styles of nursing students, there is minimal research linking learning styles to locus of control. Locus of control of control is fundamental to adult learning theory andragogy and simulation education in experiential, constructionist and vicarious education theory because they emphasise the importance of student engagement and motivation. Students need to be actively engaged in the simulation experience to enable learning and new constructs to be derived. A student with an internal locus of control will identify the importance of their own efforts and engagement in their simulation experience and that improved education outcomes are dependent upon their own efforts (Cirakoglu and Tezer 2010). This is important in the medication administration simulation as it may support student nurses to recognise the importance of their own actions using protocolised checking procedures for safe medication administration practice.

The importance of locus of control and its role in learning is demonstrated in Arcan et al (2016) who completed a descriptive questionnaire study to examine the relationship between nursing students' locus of control and self-directed learning, 171 first to fourth-year students on a health-related degree programme participated in the study. The authors used the Locus of Control Scale developed by Dag (2002) which comprised a number of subscales: Auto-control, belief in luck, meaninglessness of striving, fatalism and unfair world belief. In this study, Cronbach alpha value of the locus of control scale was calculated as 0.85 and the Self-Directed Learning Skill Scale

developed by Fisher et al (2001) which comprised three subscales: self-management, willingness to learn and auto-control was 0.92. There was a positive correlation between self-directed learning and locus of control ($r=.249$, $p=0.001$) and a negative correlation between auto-control ($r=-.307$) and self-directed learning. Students with high levels of internal locus of control were more orientated to self-directed learning, which is important in simulation education. This is supported by Yilmaz and Kaya (2010) who completed a study to determine the relationship between nursing students' epistemological beliefs and locus of control. 350 nursing students completed the Turkish version of the Epistemological beliefs questionnaire and Rotter's Internal-External Locus of Control Scale. Students demonstrated greater belief that learning depends on effort compared to the belief that learning depends on ability. There was a significant correlation between nursing students' locus of control and perceptions of the importance of effort and ability to improve educational outcomes.

Whether the experience of simulation education in itself can imbue a realisation of control for students with an external locus of control and on novice students is an important area of study. Rockstraw (2006) for example, examined the impact of self-efficacy and locus of control in learning basic nursing skills using two simulated educational methods. First-year nursing students were randomly assigned to receive high-fidelity human patient simulation, or an actor-based simulation. Self-efficacy and locus of control questionnaire data was collected pre and post-simulation from students who received 80% or higher on clinical skills, for example, blood pressure and pulse monitoring. There was a significant increase in pre to post self-efficacy ($p < 0.001$) and a non-significant change towards an internal locus of control. Therefore, the experience of simulation itself might be an educational method to engage novice students and increase external locus of control. This is supported by Rose (2011) who identified that motivation is positively related to learning outcomes, and positive learning outcomes have been correlated with increased retention in higher education. Improving internal locus of control can be completed through a number of education strategies, including mentorship training (Bulut et al 2010).

Importance of Reflective Practice

The learning theories that underpin simulation education require the learner to engage in reflective practice. Reflective practice is both central to simulation learning and nursing practice in general which has been exemplified recently in the United Kingdom where it is a statutory requirement to revalidate and retain their registration (NMC 2015a). Within simulation, reflection is integrated into experiential, constructionist and vicarious learning theory as a mechanism in which to assess and reorganise learning and experiences to improve practice and reinforce continuous learning (Gustafsson and Fagerberg 2004). To reflect in a meaningful way, it is important to understand what is meant by reflection, the skills required, and how reflection can be undertaken successfully (Nicol and Dosser 2016). Reflection is a purposeful activity that enables practitioners to think, feel and imagine while learning from an event (Rolfe et al 2010).

Traditionally, reflection occurs after an event however, Nicol and Dosser (2016) argue that reflection requires the ability to critique in a focused way and can be completed before, during and after an event or action. Before action refers to reflecting before about what you aim to achieve and how this will be accomplished by drawing on previous experience. In action relates to conduct during the task and altering behaviour where appropriate to achieve identified goals. On action refers to retrospective evaluation of the event in terms of knowledge, new learning and professional development. In addition, reflection includes considering what might have happened if things were done differently and how things could be done in the future. Although the role of the teacher is fundamental to ensure a safe simulation environment, the teacher's role is to also ensure students reflect and learn from their experience (Lendahls and Oscarsson 2017). However, what must be emphasised within simulation education is that successful reflection must be combined with active critical-thinking in which the knowledge and understanding gained informs future practice (Price 2004).

Although there are numerous models of reflection, Rolfe et al (2010) discussed two commonly used models of reflection that have been advocated by educationalists for example, Borton (1970) (further developed by Driscoll (2007)) and Gibbs (1988). Jasper (2013) states to maximise learning through reflection, the model of reflection chosen helps the individual to specifically reflect upon their own experiences. Within simulation education, reflection commonly occurs after the experience within a debrief in which the group discusses the process, outcome, and application of

the scenario to clinical practice and reviews the relevant teaching points (Jeffries 2005). There are many debriefing models that can be applied however, they commonly reinforce the positive aspects of the simulation experience and encourage participants to think critically and link theory to practice and research.

One example specifically related to simulation is Kneebone et al's (2007) simulation-error learning framework. This framework exploits the opportunity in simulation education to learn through error and can be incorporated into the reflection stage of the adult learning theories. It incorporates four stages: the identification and acknowledgement of mistakes performed by individuals or teams, analysis of errors in an attempt to discover the root causes and course of events that led to their occurrence (at individual, team and system levels), determination of changes and corrections to be implemented and internalisation, and implementation of the lessons learned. This demonstrates the flexibility of reflection models, and the importance of choosing a reflective model targeted at the specific educational requirements.

3.2.3 Integration of Adult Learning Theory in Simulation Education

Simulation education is comprehensively incorporated into nationally and internationally recognised and accredited training and qualifications, for example, Advanced Trauma Life Support (Royal College of Surgeons 2017). This highlights the degree to which simulation forms a central teaching and assessment tool across healthcare education. Despite the importance of learning theories to underpin simulation education, much of the literature discusses the application of simulation education and evaluates the effectiveness of learning outcomes of individual simulation and educational programmes without reference to adult learning theory. As a consequence, there is further need to integrate educational theoretical frameworks in future research on simulation in healthcare (Schaefer et al 2011) and in particular, nursing education.

The literature suggests nurse educators often integrate simulation into their education strategy without full consideration of the underlying mechanism that promote effective learning (Bland et al 2011). Miller and Bull (2013) completed seven qualitative interviews with nursing lecturers at one Australian university to identify factors that influenced academics opinions, experiences and

attitudes to simulation education. The authors concluded there was little evidence of how nurse educators perceive simulation as an education strategy. This is supported by McGarry et al (2014a) who reported an online survey conducted in 2012 which looked at the use of high-fidelity simulation in 14 schools of nursing in Australia. Only one school made reference to the underlying theory which supported use of high-fidelity simulation within their institution. The results confirm previous studies, for example, Arthur et al (2011) which highlight how simulation is often adopted without consideration of underlying learning theory.

The lack of adult learning theory in simulation education is highlighted by the difference between the perceptions of nursing students and nurse educators relating to learning outcomes. Feingold et al (2004) identified that although the majority of 65 baccalaureate nursing students who experienced high-fidelity mannequin simulation considered the experience to be realistic and valuable, only 46.9% of students reported an increase in confidence and perceived clinical competency. In addition, only 54.7% believed the simulation helped prepare them for clinical practice. In contrast, the majority of educators considered the learning outcomes would transfer to clinical practice. Bland et al (2011) support the majority view, stating nurse educators see simulation as a powerful learning strategy, but that research is again limited (Prion 2008). It is therefore imperative to understand the separate components of simulation education that collaboratively provide an effective learning experience. Educators must understand the background to teaching via simulation, and dedicate the time and skill base required to maximise the learning experience (Rashid and Gianduzzo 2016).

Despite this, students do however view simulation to be an important education method. For example, Lasater (2007) examined 15 student nurse responses to the implementation of simulation as part of their nursing curriculum. Simulation was perceived to be a useful method to develop clinical judgment skills. Student enthusiasm for simulation is underlined by Akhtar-Danesh et al (2009) who report both nursing students and lecturers consider simulation to be an important educational tool. In addition, many participants in studies of simulation education describe simulation as an enjoyable learning experience, (McCaughey and Traynor 2010, Childs and Sepples 2006, Au et al 2016 and Reilly and Spratt 2007). Lendahls and Oscarsson (2017) interviewed 61 advanced midwifery students in 13 semi-structured group interviews to determine their experiences of simulation and skills training. Data was analysed using content analysis and four main categories were identified: simulation develops clinical and communication skills, the

importance of collaborative learning, simulation provides a highly valued learning environment which facilitates clinical practice. Gore et al (2012) states that with the rapid adoption of simulation, further research is required on simulation as an education strategy to generate the most effective educational outcomes. Nordquist and Sundberg (2015) argue that successful simulation which improves education outcomes requires interaction between technology, faculty, learners and clinical context and investment in time and money. Understanding and integrating adult learning theory is central to this.

Another perspective which underlines the lack of integration of adult learning theory into simulation design is Persson (2017) who completed a literature review of the extent to which human-centred design processes were incorporated into simulation design. The central focus of human-centred design is to ensure the designed product achieves the goals and requirements of the target end user. It involves an International Standard Organisation (ISO) (ISO 9241-210, 2010) which aims to make 'systems usable and useful by focusing on the users, their needs and requirements' p 8, by applying human factors/ergonomics methods and techniques throughout the design process to ensure technology is suitable for the end user. The approach is based on six key components: the users, tasks and environments, to involve users throughout the design process, the design is refined by user evaluation, the design process is iterative, it involves the whole user experience and incorporates multidisciplinary skills and perspectives. 27 articles from between 2000 and 2016 were included in the analysis which captures the more recent uptake of high-fidelity simulation within the nursing curriculum (Doolen et al 2016) and the more recent focus on high-fidelity, low-cost simulation in which human-centred design is particularly relevant for example, Sadideen et al (2016). Interestingly, many studies that incorporated the human-centred design focused on virtual reality and computer-based simulation methods to the almost exclusion of other methods and forms of high-fidelity simulation. Of the studies that did incorporate human-centred design, the technical solution for the simulation was almost always decided upon before any of the steps of the human-centered design process were initiated and therefore before the needs of the student were established. This supports previous studies, for example, McGarry et al (2014a) and Arthur et al (2011) who highlight that choice of simulation is determined before consideration of the learning requirements of the student.

3.2.4 Simulation Theoretical Concepts: Fidelity, Realism and Authenticity

In addition to the variety of methods, learning goals, adult learning theory and technologies that need to be considered before simulation is incorporated into nursing education, nursing education also needs to understand the theoretical components internal to the design of the simulation. The simulation literature discusses four key theoretical components which are integral to effective simulation education; fidelity, realism, authenticity and, to a limited degree, salience. There is a lack of uniformity within the literature in how these components are discussed. Understanding the role these components play within simulation education is fundamental to understanding how a medication administration simulation can be developed and used to help support nursing students to apply the rights or checking procedures within the complex and error prone clinical environment. This section will introduce the components of fidelity, realism and authenticity. The remaining component of salience will be discussed in section 3.5.

Fidelity

A search of the CINAHL and Medline databases highlight fidelity is the most widely used of the components within the literature (Appendix A). Fidelity is a ubiquitous term and refers to the extent to which a simulation replicates clinical practice (Rashid and Gianduzzo 2016 and Norman et al 2012). An overview of how the term fidelity is used in the literature in some illustrative studies is found in Table 1. The term fidelity is used both to name and describe simulation. Fidelity is commonly categorised as 'high', 'medium' or 'low' and relates to the type of design, level of expense, technology and complexity of the simulation (Jones 2015). High-fidelity is traditionally viewed to be more technologically complex and expensive compared to low-fidelity methods.. Low-fidelity focuses on single skill acquisition which can be learnt in isolation, medium-fidelity provides more realism without full immersion, whilst high-fidelity simulation provides full immersion and active responses (Andersen et al 2016).

Table 1. Overview of Fidelity in the Literature

Author and Date	Use of Fidelity in the Literature	Study Design and Sample Size
<p>McCaughey and Traynor (2010) United Kingdom</p>	<ul style="list-style-type: none"> • Discussed high-fidelity simulation • Name given to the simulation • Description of the level of technology and complexity of simulation design • Description of level of realism achieved by the simulation 	<ul style="list-style-type: none"> • Quantitative descriptive survey • 153 third year nursing undergraduate students from one nursing school • 93 (60%) response rate
<p>Beaubien and Baker (2012) United States</p>	<ul style="list-style-type: none"> • Discussed high, medium and low-fidelity • High-fidelity used synonymously with simulation • Name given to the simulation • Description of the level of technology and complexity of simulation design • Description of level of realism achieved by the simulation • Fidelity divided into three components; environmental fidelity, equipment fidelity and psychological fidelity. 	<ul style="list-style-type: none"> • Discussion paper • Propose typology of fidelity • Discusses the application of different types of simulation fidelity.
<p>Waxman (2010) United States</p>	<ul style="list-style-type: none"> • Discusses high and low-fidelity • Name given to simulation • Description of the level of technology and complexity of simulation design 	<ul style="list-style-type: none"> • Literature Review and guidance on simulation scenario design • Bay Area Simulation Collaborative (BASC) - in San Francisco.

<p>Lee et al (2015) South Korea</p>	<ul style="list-style-type: none"> • Discusses high-fidelity • Name given to simulation • Description of the level of technology and complexity of simulation design 	<ul style="list-style-type: none"> • Mixed method qualitative and quantitative study of participating in high fidelity simulation • 33 junior nursing students from one school of nursing
<p>Venkatasalu et al (2015) United Kingdom</p>	<ul style="list-style-type: none"> • Discusses high-fidelity • Name given to simulation • Description of the level of technology and complexity of simulation design 	<ul style="list-style-type: none"> • Students randomly allocated classroom tuition or high fidelity simulation • Qualitative phenomenological interview • 12 1st year nursing students from one school of nursing
<p>Chen et al (2015) Canada</p>	<ul style="list-style-type: none"> • Discusses high and low-fidelity • Name given to simulation • Description of the level of technology and complexity of simulation design • Description of level of realism achieved by the simulation 	<ul style="list-style-type: none"> • Students randomly allocated to high or low fidelity simulation. • Compared to control teaching • Competency test and observer assessment • 60 senior level nursing students from one school of nursing

<p>Butler et al (2009) United States</p>	<ul style="list-style-type: none"> • Discusses high and low-fidelity • Name given to simulation • Description of the level of technology and complexity of simulation design • Description of level of realism achieved by the simulation 	<ul style="list-style-type: none"> • Students randomly allocated to high or low fidelity simulation. • Student reflections using three simulation survey instruments • 31 nursing students from one school of nursing
<p>Garrett et al (2011) Canada</p>	<ul style="list-style-type: none"> • Discusses high and low-fidelity • Name given to simulation • Description of the level of technology and complexity of simulation design • Description of level of realism achieved by the simulation 	<ul style="list-style-type: none"> • Discussion paper – Reflections implementing high-fidelity simulation (HFS) over three years, across Canada using the Association of Schools of Nursing (CASN) health in 2006
<p>Baxter et al (2009) Canada</p>	<ul style="list-style-type: none"> • Discusses high, medium and low-fidelity • Name given to simulation • Description of the level of technology and complexity of simulation design • Description of level of realism achieved by the simulation 	<ul style="list-style-type: none"> • Interviews of simulation experience • 17 universities and schools of nursing • 24 nursing students

<p>Datta et al (2012)</p> <p>India</p>	<ul style="list-style-type: none"> • Discusses high, medium and low-fidelity • Name given to simulation • Description of the level of technology and complexity of simulation design • Description of level of realism achieved by the simulation • Discusses simulation experience achieved at different levels of fidelity 	<ul style="list-style-type: none"> • Discussion of simulation and role in medical education
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Historically, nurse education predominantly used low-fidelity, low-cost methods. Low-fidelity methods include role-play, task trainers and static manikins (Hovancsek 2007). Over recent years and in-line with technological advances, interest has progressively focused upon the high-fidelity simulation (Edgecombe et al 2013, Garrett et al 2011 and Goodman and Lamers 2010). Methods vary and include life size anatomically correct mannequins, with sophisticated and interactive pathophysiological and pharmacological responses (Butler et al 2009, Tsai et al 2003, McGaghie et al 2009), to entire operating theatre environments (Kneebone et al 2007). The notion that fidelity comprises a continuum is exemplified by the variety and technological options of mannequin simulations available. Mannequin simulation can vary from high-fidelity computerised and interactive full-body mannequins, able to generate anatomical responses, for example, pulse, blood pressure, heart rate and rhythm (Decker et al. 2008, Grady et al. 2008 and Jones 2015) to low-fidelity, static and non-responsive part task trainer mannequins. The integration of high-fidelity simulation within the nursing curriculum is so intrinsic that many studies refer to simulation synonymously with high-fidelity simulation (for example, Alluri et al 2016).

Whilst much of the literature equates fidelity with technology, a subset makes a distinction between environmental, engineering, psychological (Rehmann et al 1995 and Berragan 2011, Dunbar-Reid et al 2015 and Kalaniti and Campbell 2015) and sociological fidelity (Nordquist and Sundberg 2015). Environmental fidelity relates to the extent to which the simulation mimics the environment, for example, through visual and motion cues (Rehmann et al 1995). Engineering fidelity relates to the degree to which simulation depicts the equipment or physical characteristics of the task and is closely related to environmental fidelity. Psychological fidelity relates to the

extent to which the skills of the task are captured in the simulation, or more simply, how realistic the student finds the simulation (Berragan 2011). Psychological fidelity includes contextual aspects, for example, stressors that are introduced into the simulation to make it as realistic as possible (Nordquist and Sundberg 2015). Komorowski et al (2017) expands this further and states psychological fidelity also involves participant emotions, beliefs and interactions, and the extent to which participants feel empowered to make mistakes in the learning environment. Sociological fidelity relates to the social context which the simulation replicates (Nordquist and Sundberg 2015). Proponents of sociological fidelity claim that the traditional simulation literature overlooks sociological aspects of clinical practice, for example, hierarchies in the clinical team, power relations and issues relating to professional identity which can affect the simulation experience.

The literature traditionally emphasised the importance of fidelity in terms of its technological components and does not distinguish between the different permutations for example, Alluri et al (2016). Therefore fidelity commonly equates to, but not exclusively with, engineering and environmental fidelity. Fidelity is a more complex interwoven variable and has to reflect and cater for the variety and complexity of healthcare settings which the simulation attempts to replicate. Although it is widely acknowledged that healthcare overall is becoming more technologically advanced (Berragan 2011), in which high engineering and environmental fidelity is integral, there are low technological equipment and healthcare environments, for example, community clinics. Therefore, high-fidelity should not automatically equate with high technology, but be based on a synergy between healthcare contexts and environments represented in simulation.

The need to expand the definition of fidelity away from technology and integrate it into the reality of the clinical experience is exemplified by Shaw and Abbott (2017) who describe an end of life high-fidelity simulation scenario. They emphasised low technology, the role of family members and descriptors to replicate a palliative care environment, which can be implemented within the low technological environment, including the family home. Another example is Komorowski et al (2017) who completed a study in which 12 midwives participated in a shoulder dystocia and postpartum haemorrhage simulation. The simulation was staged to resemble a non technologically advanced home-birth setting. Participants considered the simulation to have a

high degree of fidelity and the authors directly equated fidelity with psychological realism. Although environmental fidelity was prioritised, this did not require high technological equipment. Realism was provided by inexpensive non-technological equipment, for example, books, clothing and toys, portable equipment doppler fetoscopes and thermometer. The authors argue that the use of in-hospital simulated scenarios may negate environmental and psychological fidelity for home-birth midwives. In some circumstances, the emphasis on equating high-fidelity with high technology can actively diminish the simulation experience and take away from the training needs of healthcare professionals in a subset of clinical settings.

Realism

Realism is the second concept frequently discussed in the simulation literature. A search of CINAHL and Medline indicates that although it is an established term in the literature, it is less commonly used compared to fidelity (Appendix A). Table 2 provides an illustrative overview of how realism is used within the literature. The term realism is often used interchangeably with the term fidelity. The goal of fidelity is to generate a specified level of realism. Fidelity is frequently linked to how 'realistic' the simulation is (Berragan 2011, Hovancsek 2007 and Nehring and Lashley 2009). Therefore, when the literature discusses level of fidelity, it refers to the level of realism achieved in the simulation. More specifically, the level of fidelity relates to the number of realistic features incorporated into the simulation; the higher the fidelity, the greater the realism (Butler et al 2009 and Kneebone et al 2004).

Table 2. Overview of Realism in the Literature

Author, Date and Country	Use of Realism in the Literature	Description (Design and Sample Size – where appropriate)
McCaughey et al (2010) United Kingdom	<ul style="list-style-type: none"> • Level of realism is used to assess the effectiveness of a simulation • Terminology used with end user to discuss level of fidelity • How simulation is perceived by student 	<ul style="list-style-type: none"> • Quantitative descriptive survey • 153 third year nursing undergraduate students from one nursing school • 93 (60%) response rate
Tsai et al (2003) Canada	<ul style="list-style-type: none"> • Level of realism is used to assess the effectiveness of a simulation 	<ul style="list-style-type: none"> • Mixed methods assessment using manikin based simulation

	<ul style="list-style-type: none"> • Terminology used with end user to discuss level of fidelity • How simulation is perceived by student 	<ul style="list-style-type: none"> • Additional questionnaire of participants' perceptions of simulation experience. • 18 paediatric residents from one medical school.
Beaubien and Baker (2012) United States	<ul style="list-style-type: none"> • Level of realism is used to assess the effectiveness of a simulation • Synonymous with psychological fidelity 	<ul style="list-style-type: none"> • Discussion paper • Propose typology of fidelity • Discusses the application of different types of simulation fidelity
Dunbar-Reid et al (2015) Australia	<ul style="list-style-type: none"> • Synonymous with psychological fidelity • Refers to the perceived realism that assists evoking emotions and beliefs in the participants 	<ul style="list-style-type: none"> • Reflection of evolution of simulation in nursing education. • Discussion paper of benefits and challenges of high and low fidelity simulation

Although within simulation, high levels of realism is often created using high levels engineering and environmental fidelity (Beaubien and Baker 2004 and Dunbar-Ried et al 15) psychological fidelity is the most important component and goes to the core of realism in simulation education. Psychological fidelity is synonymous with realism because fidelity is underpinned by how realistic the simulation is perceived to be. High levels of engineering and environmental fidelity are insufficient if not paired with high levels of psychological fidelity, even in simulations which rely heavily on technology and the environment. If students do not perceive the simulation to be realistic, they will not learn from the simulation and transfer theory into practice.

This is illustrated by how the term realism is used in the literature. Whist the term fidelity is used extensively within academic discussion, the term realism is used when communicating with students. For example, students are typically asked 'how realistic' a simulation is (Feingold et al 2004 and Rhodes and Curran 2005), and not whether the simulation has achieved a specified level of fidelity. Therefore, student perception is of paramount importance. In addition, realism is frequently used as an outcome measure of simulation effectiveness (for example, Grady et al 2008, Akhtar-Danesh et al 2009 and Lasater 2007). This refers to the premise that high levels of realism correlate with improved educational outcomes (McCaughey and Traynor 2010). Wilford

and Doyle (2006) expanded this and stated that learning is retained and reproduced when it occurs in a realistic environment. Therefore, realism is an essential element of effective simulation. Many studies of simulation education in nursing focus upon intermediate or high-fidelity simulation (Baillie and Curzio 2009) and state that they successfully achieve a high level of realism. Therefore, the literature on fidelity and realism suggest that a medication administration simulation needs to be realistic for nursing students.

Authenticity

The third component integral to effective simulation is authenticity. A literature search of CINAHL and Medline highlight that it is a less commonly used term within the literature (Appendix A). Authenticity refers to how simulation replicates context (Kneebone et al 2004, McCaughey and Traynor 2010, Reilly and Spratt 2007), and provides the opportunity to learn conceptual knowledge in a manner that reflects the reality, or the context in which it is to be applied (Herrington and Herrington 2006, Bland et al 2011). King et al (2016) relates authenticity to how engaging and 'real-life' the simulation scenario is to the student. Irrespective of fidelity, learning is not truthful without the context of how the knowledge and skills will be used in real life (Gulikers et al 2005). The degree of realism or authenticity ranges along a scale from completely artificial to real-life (Munshi et al 2015).

Authenticity has progressively become a more important component of simulation education. Bland et al (2014) conducted a literature review of 25 papers on simulation-based education published between 2003 and 2013. The authors noted that although historical focus concentrated on the technological components of simulation, authenticity is increasingly recognised as a fundamental component to effective simulation. This suggests that a medication administration simulation needs to be authentic and actively incorporate the complexities of clinical practice to support students to link theory to practice. It also caters for the concerns of Rafferty et al (1996) that theoretical teaching must take incorporate the realities of the clinical environment. A challenge for nurse educators is how to instil authenticity into simulation and further research is required. Simulation design characteristics should be used as a fundamental guiding principle in development implementation and evaluation of simulation scenarios (Groom et al 2014) and therefore an analysis of the education effectiveness of high and low-fidelity simulation needs to be examined.

3.3 Benefits and Limitation of High-fidelity Simulation in Nurse Education

The literature highlights an increasing trend to integrate high-fidelity simulation into healthcare education (Jeffries et al 2008, Baillie and Curzio 2009, Tan et al 2012, Kim et al 2016, Childs and Sepples 2006, Schoening et al 2006 and Doolen et al 2016). High-fidelity simulation is used to teach a variety of skills and competencies, including team and inter-disciplinary working (Kneebone et al 2007), critical-thinking, reflexive practice and communication skills (Berragan 2011). However, many studies use specific definitions of high-fidelity simulation. Doolen et al (2016), for example, defined high-fidelity simulation as full-scale computerized human patient simulators which have been increasingly used in nursing education over the previous two decades. Similarly, Garrett et al (2011) examined the results of a 2006 web-based survey which examined the extent to which high-fidelity simulation was integrated into 65 schools of nursing, medicine or allied health professionals in Canada. The authors defined high-fidelity simulation to be sophisticated responsive computerised full-scale mannequins. The majority of studies that discuss high-fidelity simulation relate it to the traditional technological and environmental components, for example, high-fidelity patient mannequins, often utilised within simulation laboratories, unless specified.

The support for the integration of high-fidelity simulation in the nursing curriculum is exemplified internationally. In the United Kingdom, high-fidelity simulation is fully embedded within pre-registration nurse training. 300 high-fidelity simulation practice hours directly contribute toward clinical practice hours (NMC 2010) required to qualify and register as a nurse. Within individual states in the United States, simulation can be substituted for up to 50% nursing students' clinical instruction (Hayden et al 2014 and Doolen et al 2016). The United States' National Council Licensure Examination compared the examination pass rates, nursing knowledge assessments and perceived readiness for practice between student nurses who spent all of their clinical practice hours in clinical placement or between 25% to 50% of clinical practice hours in high-fidelity simulation. There was no significant difference in attainment between groups. This indicates high-

fidelity simulation is a valid alternative education method compared to clinical practice, based on traditional assessment methods.

3.3.1 Benefits of High-fidelity Simulation

Much of the literature supports the use of high-fidelity simulation in nursing education for a number of pragmatic reasons and because it is considered to more effectively improve education outcomes. It affords hands-on and risk-free learning (Dunbar-Reid et al (2015)). It enables scheduled clinical experience, reproducible clinical situations and the graduated delivery of complex clinical scenarios (O'Donnell and Goode 2008). Most importantly, simulation-based education protects vulnerable patients from being 'taught on' (Nestel and Kneebone 2010) and shields inexperienced staff from the responsibilities that come with being involved with critical events in clinical practice (Sanford 2010). Many research studies indicate supplementing clinical or theory time with high-fidelity provides students with an active, safe learning environment (Bussard 2015).

Whilst these benefits can also be achieved through traditionally perceived low-fidelity methods, studies suggest that high-fidelity simulation supports more effective learning outcomes (Tan et al 2012, Scholz et al 2012, Burns et al 2010 and Konieczny 2016). A principal justification for the use of high-fidelity simulation is that they are more realistic (Baptista et al 2016) and responsive (Cooper 2015) which aids learning. Studies suggest that the increased level of realism achieved in high-fidelity simulation is pivotal to providing a more effective simulation education (Yuan 2012), motivates students to learn and, consequently, will be better able to transfer learning to real patients (Chen et al 2015). This is demonstrated by Veltri et al (2014) who completed a quasi-experimental study and compared high-fidelity laboratory-based simulation with hospital-based clinical learning to teach student paediatric nurses obstetric assessment, intervention and critical-thinking skills. The study employed a convenience sample non-equivalent comparison group design, however both groups were students on the same course. 41 students on an obstetric rotation completed the simulation and 39 students on a paediatric rotation completed hospital-based tuition. Both groups completed practical scenarios assessed by an independent observer and questionnaire. There was no significant difference between groups in assessment, intervention, or critical-thinking skills ($p = 0.41 - 0.93$). Although it must be noted that less than one third of participants from either group passed either assessment, the simulation was equally

effective as clinical practice in terms of students' performance outcomes and that well-designed simulations can substitute part of nursing students' hands-on clinical time.

The importance of realism provided in high-fidelity simulation is highlighted in a number of studies. For example, Butler et al (2009) randomly allocated 31 paediatric nursing students who volunteered to participate in the study from a larger convenience sample to complete either a high-fidelity human patient simulator or low-fidelity static mannequin tuition. Participants had completed at least 105 clinical hours in an acute hospital setting, but no previous experience of simulation. Participants in the high-fidelity group were significantly more likely to state that the simulation closely resembled real life compared to the low-fidelity group ($r = 0.57$, $p = 0.001$), and that elements of the simulation design were more important to their learning ($t = -3.86$, $p = 0.001$). In addition, high-fidelity group participants were significantly more likely to state that realism was an important aspect to their learning ($r = 0.57$, $p = 0.001$).

The importance of realism achieved in high-fidelity simulation is also highlighted in in situ simulation. Meurling et al (2014), for example, completed a case-control study to explore in situ training for paediatric teams in an emergency department using a low-fidelity model static mannequin and a high-fidelity paediatric simulator. 225 participants were divided into 34 teams and randomised to receive either the low or high-fidelity simulation training. Each team performed one video-recorded paediatric emergency scenario. The number, type and time of clinical intervention and trainer interventions were independently rated. Teams comprised a convenience sample of paediatric consultants, registrars, nurses and nursing assistants. There is no information about the composition of the groups and some participants may have completed the simulation more than once. Time to deliver oxygen was significantly longer ($p = 0.014$) in the high-fidelity group. This is unfortunate as one of the cornerstones of paediatric emergency is the immediate application of oxygen. Despite this, the frequency of trainer interventions was significantly lower in the high-fidelity group ($p < 0.001$). In addition, 20% (23 out of 113) of high-fidelity participants considered the patient simulator was the best element of the exercise and 35% (40/113) considered the degree of realism provided was the best element. In contrast, none of the low-fidelity simulation participants considered the simulator to be the best element of the training and only 12% (11 out of 95) considered that the realism provided was the best element.

Therefore, the fidelity of the simulation did impact on the perceptions of participants and affected their view of the training received.

A number of meta-analyses evaluate the effectiveness of high-fidelity simulation on a variety of educational outcomes which encompass the complexity and variability of the nursing role. Kim et al (2016) completed a meta-analysis to determine the effect size of simulation fidelity on simulation education outcomes. The authors selected studies which used human patient simulation with an experimental or quasi-experimental design and a comparison control group. Forty studies published between January 1995 and July 2013 were included in the analysis. High-fidelity simulation, medium-fidelity and low-fidelity simulation generated effect sizes of 0.86, 1.03 and 0.35 respectively. The effect size for cognitive outcomes was most pronounced in the high-fidelity simulation (0.5). The authors concluded that fidelity affected learning outcomes, especially for psychomotor skills, although there was not a corresponding increase between high and medium-fidelity. However, these findings should be interpreted with caution and other learning related factors, such as feedback and reflection were not taken into account in the analysis.

Other studies have accounted for extraneous learning related variables highlighted by Kim et al (2016). Shin et al (2015) completed a meta-analysis of studies utilising an experimental or quasi-experimental design to explore qualitative evidence about the effects of patient simulation in nursing education. They categorised simulation into low, medium and high-fidelity according to process models and level of complexity. They incorporated a variety of simulation modalities including; partial-task trainers, human patient actors, full body task trainers and high-fidelity patient mannequins. Studies that involved computer-based virtual patients and computer software were excluded. The study accounted for confounding variables, including evaluation methods and learning environment variables and employed as part of the subgroup analysis Kirkpatrick's (1994) four levels of evaluation, which consist of reaction, learning, transfer, and results to describe the type of evidence produced by different evaluation strategies. The authors specifically categorised evaluations to include the extent to which students acquired knowledge and skills. Learning was also divided into three domains: cognitive, affective, and psychomotor and how students reacted to, or were satisfied with the training program.

20 studies were included in the final analysis; 12 high-fidelity, two medium-fidelity, three low-fidelity and three standard patient simulators. Effect sizes were highest for medium-fidelity (1.92)

compared to high-fidelity (0.81) standard patient (0.54) and low-fidelity simulation (0.34). Interesting, the type of student produced different effect sizes, with advanced students, graduate students and nurse practitioners resulting in the larger effect sizes. Unfortunately, there was no specific breakdown on the effect sizes of the different type of simulation and only five studies (25%) employed random assignment which reduces the ability to ascertain a clear comparison between groups. In addition, the focus of studies on high-fidelity simulation may have affected the results, with increased reliance on a small number of studies representing medium and low-fidelity simulation.

In addition, Burns et al (2010) evaluated the effectiveness of high-fidelity simulation to teach problem-solving skills to 114 first year nursing students. Student aptitude and attitude was assessed using a pre and post simulation questionnaire. There was a significant improvement in post simulation knowledge ($z = -6.602$, $p < 0.01$). There was also a post simulation improvement in critical-thinking skills used in patient care, ($p < 0.0001$), overall nursing knowledge ($p = 0.002$) and specific skills in caring for patients ($p = 0.0003$) and self-reported confidence in nursing skills ($p < 0.0001$). The study highlights simulation can significantly improve clinical ability and levels of confidence for clinical practice.

A number of studies compare high-fidelity simulation with traditional learning formats and demonstrate high-fidelity simulation can provide an effective alternative (Kirkman et al 2013, Alinier et al 2004 and Brannan et al 2008). Lee et al (2016) examined the effects of high-fidelity patient simulation on clinical reasoning skills. 49 undergraduate nursing students completed a non-equivalent control group, quasi-experimental study which included a pre-test, post-test design. The simulation group consisted of 23 students who completed a clinical reasoning course and the control group of 26 students who did not. The clinical reasoning course was an independent standing course which aimed to integrate knowledge, skills and a professional attitude throughout the nursing process and used high-fidelity patient simulated scenarios. Eligibility criteria for the course was not provided. The control group completed a critical patient nursing course which used a traditional lecture format. Both courses were the same length and duration and therefore a similar commitment was required for both groups. Simulation scenarios were developed by a trained simulation instructor, was verified by independent faculty members

and tested with graduate students. The study used pre-test, implementation and post-test self-report data and assessed a comprehensive range of education outcomes including, nursing core competencies, problem-solving skills, academic self-efficacy and learning styles. The nursing core competencies measurement tool was developed by Lee (2011) and evaluated critical-thinking and evaluation skills, general and specialised clinical practice skills, human understanding, communication skills and professional attitude. Students also completed a questionnaire which examined their perception of competency. The internal reliability of the tool was Cronbach's alpha was 0.94. The problem-solving skills tool was developed by Lee et al (2003) which examined five subcategories of problem clarification, causal analysis, alternative development, planning/implementation, and performance assessment. In the original tool, the reliability was Cronbach's alpha was 0.94; in this study, the Cronbach's alpha was 0.90. The academic self-efficacy tool used was developed by Kim and Park (2001) and classified into task difficulty, self-regulated efficacy, and confidence. In this study, the Cronbach's alpha was 0.89. In addition, Kolb's learning style inventory were analysed quantitatively. The reliability of the tool was Cronbach's alpha was 0.88–0.89.

There was a significant improvement in nursing core competencies in the simulation group compared to the traditional learning group ($p = 0.008$). The simulation group also demonstrated a greater, but non-significant post-test increase in problem-solving scores compared with the control ($p = 0.275$). The simulation group also demonstrated a non-significant increase in academic self-efficacy ($p = 0.167$); Interestingly, the learning styles between the experimental and control groups differed which may have contributed to the differences in group selection. However, the authors argued that there is a need for the development of effective instructional methods to improve learning outcomes in nursing education. Future research is needed related to simulation education as well as management strategies so that learning outcomes can be achieved to cater for the different students' learning styles. However, the lack of randomisation and non-equivalent control groups introduced bias into the study. The authors acknowledged the students who selected the clinical reasoning course in the simulation group may have had different expectations and motivations, which is an important aspect of simulation and adult learning theory. The predominant use of self-report tools possibly threatens internal validity and more objective assessments of student competency, knowledge and skills was required.

In a second study that also compares high-fidelity simulation with a traditional teaching format, Aqel and Ahmed (2014) completed a two-arm randomised control trial to examine the effect of using high-fidelity simulators on basic life support knowledge and skills acquisition and retention. 90 nursing students who had no previous experience of basic life support received a four-hour traditional lecture on adult basic life support and randomised to receive simulation training using a high-fidelity automated external defibrillator or demonstrations on a static low-fidelity patient mannequin. Participants were tested pre and post simulation. There was no significant difference between groups at baseline. Although the knowledge and skills of both groups improved at the post-test timepoint, there was a significant difference between the high-fidelity and low-fidelity group ($p = \leq 0.001$). Importantly, there was still a significant difference in retention of knowledge between groups after three months of training. The high-fidelity simulation significantly improved education outcomes in the immediate and long-term, but with such a small sample group, further analysis with larger sample sizes is required to determinate the impact on actual clinical practice.

A number of studies directly compare the educational effectiveness of different levels of fidelity. Brady et al (2015) evaluated the effectiveness of low, medium and progressive fidelity simulation in teaching clinical examination skills to 69 midwifery students before their first clinical placement. Students were randomised to experience a low-fidelity part task trainer, a medium-fidelity part task trainer with a life-sized poster of a pregnant woman or progressive-fidelity part task trainer and a simulated standardised patient simulation. Participants' technical and non-technical skills were measured using the validated Global Rating scale (GRS) and the Integrated Procedural Performance Instrument (IPPI). In the GRS, the progressive-fidelity group achieved significantly higher scores compared to the low-fidelity group ($p = 0.010$) and medium-fidelity group ($p = 0.048$). There was also a significant difference in IPPI scores between the progressive-fidelity group and the low and medium-fidelity groups, (both $p = 0.026$ $p = <0.05$). The authors state that both progressive and medium-fidelity simulation yield better outcomes than low-fidelity simulation. The authors argue where resources are restricted, medium-fidelity simulation can produce effective learning experiences for midwifery students. In another study, Grady et al (2008) compared naso-gastric tube and urinary catheter insertion performance by 39 nursing students post exposure to high or low-fidelity patient simulation. Performance was measured by

an independent observer and through a self-report attitude questionnaire. Participants in the high-fidelity group scored more highly and reported higher levels of satisfaction, particularly with respect to responsiveness and realism.

In addition, integral to effective simulation is the transfer of simulation learning to clinical practice. A number of studies also suggest high-fidelity simulation learning does transfer to clinical practice. Morgan (2006) completed semi-structured interviews with six first-year nursing students to determine the transfer of theory using a high-fidelity clinical skills laboratory simulation. Students reported that the experience was useful and helped them to integrate theory to practice. Morgan recommends the use of clinical skills laboratories to help students develop professional skills and prepare for clinical practice. Hope et al (2011) completed a mixed-methods study designed to explore the relationship between clinical laboratory simulation, theory and practice. They completed a thematic analysis of questionnaire responses from 500 pre-registration student nurses which formed the basis of three focus groups. Participants considered simulation to facilitate learning, helped apply theory in a safe and controlled environment, helped develop psychomotor and technical skills and foster confidence.

A number of studies suggest high-fidelity simulation may significantly aid nursing students to prepare for clinical practice (for example, McCaughey and Traynor 2010). Buckley and Gordon (2011) evaluated the effectiveness of immersive and high-fidelity simulation to teach response skills to nurse clinically deteriorating patients. 38 graduate nurses at an Australian university volunteered to participate in the study. They received 14 hours of lectures focusing upon theoretical aspects of clinical emergencies and two workshops of three hours duration practising technical skills in a bespoke simulation laboratory, based on the Australian Resuscitation Council guidelines. Participants also experienced a team building exercise. Participants completed a follow-up survey three months post simulation experience. Participants reported that they experienced a total of 164 clinical patient emergencies in the intervening period, including cardiac, respiratory and neurological emergencies and cardiac arrests. Participants reported that the simulation helped improve both technical and non-technical skills. 87% of participants reported their ability to respond systematically and hand over to the emergency team had improved. 77% of participants reported an improvement in managing an unstable patient. 80% reported an improvement in respiratory assessment skills and 79% reported an improvement in respiratory management skills. Buckley and Gordon conclude that the skills taught were highly

relevant to support clinical practice. Although students considered the simulation to have assisted in subsequent performance, there is no report of actual performance and there was no comparison of perceptions or outcomes of students who experienced a lower-fidelity simulation or theory only education experience.

In a similar study, Venkatasula et al (2015) compared the effectiveness of high-fidelity simulation with a classroom-based session to teach end of life care. A phenomenographic methodological approach was adopted to explore perceived clinical outcomes of teaching methods.

Phenomenography is a form of research designed to answer questions about learning and has been used extensively in educational research (Marton, 1986). Unlike phenomenology, the research aim is not focused on understanding the phenomenon under investigation, but rather on examining how people experience a given phenomenon (Linder and Marshall 2003). A purposeful sample of 187 adult nursing students were invited to participate. Two groups of 24 participants were randomised to receive simulation-based training and six groups comprising a total of 139 participants received seminar based education. The simulation session comprised a preparation pre brief, the patient simulation experience and a post session debrief lasting one hour and 15 minutes. The classroom-based session comprised a two-hour session which included a video and discussion. 12 participants, seven from the simulation session and five from the seminar based education session, participated in subsequent semi-structured interviews which were assessed by framework analysis. Comparative analysis identified four key themes: recognising death and dying, implementing knowledge into practice, preparedness for clinical eventualities and emotional preparedness. Both teaching approaches improved students' knowledge, participants perceived the simulation enhanced practical skills, improved emotional experience during clinical placements and helped them to put theory into practice. Participants considered simulation learning to be valuable and relevant to their clinical practice.

More research is also required to establish a link between high-fidelity patient simulators and improved clinical skill acquisition for beginner and advanced nursing students. Basak et al (2016) completed a quasi-experimental randomised repeated measures study to examine the effectiveness of low and high-fidelity patient mannequin training on the educational outcomes of beginner and advanced student nurses in one large school of nursing in the United States. 34 first

semester nursing and 32 third and fourth-year students participated in the study. A 13-item instrument developed by Jeffries (2005) was used to measure student satisfaction and self-confidence in learning. The Cronbach's alpha for satisfaction achieved in a previous study was 0.94 and 0.87 for self-confidence (Jeffries 2012). Students also completed a 20-item simulation design scale tool developed to measure constructs from the Jeffries (2005) simulation model. The design features rated by the students included objectives and information, student support, problem-solving, guided reflection or feedback and fidelity. The Cronbach's alpha for the instrument in a previous study was 0.92 (Jeffries 2012).

Student satisfaction and ratings in the simulation design scale were significantly higher for the high-fidelity group compared to the low-fidelity group ($p = 0.01$). However, within the intergroup comparison, students were less satisfied with the lower-fidelity simulation on two subscales, but these were not statistically different ($p = >0.05$). In contrast, the advanced nursing students were significantly more likely to rate the lower-fidelity experience higher than the beginner students ($p = <0.05$). After adjusting for effects of advanced and beginners' groups, the high-fidelity simulation provided an overall more satisfying education experience, improved self-confidence and the high level of fidelity was more valued. This study contrasts alternative literature which states that low-fidelity simulation is more suited to beginner students (for example, Henneman and Cunningham 2005), however this was a small-scale study and previous learning experiences of students, which may impact on the results was not made explicit.

The importance of student engagement in active learning means satisfaction and motivation within the simulation learning experience is inherently important (Chen et al 2015). Baptista et al (2016) completed a randomised control trial to analyse and benchmark perceived educational gains and satisfaction post simulation. 85 nursing students were randomised to receive high or medium-fidelity patient simulation. All students received baseline pre simulation theoretical teaching of nursing the deteriorating patient across a range of clinical scenarios. Participants in the high-fidelity simulation group reported significantly higher satisfaction scores with their simulation practice and considered it to be more realistic compared to the medium-fidelity group $p < 0.001$. Students were very satisfied with the realism provided by high-fidelity simulated practice and considered it helped them with clinical recognition and decision-making skills compared with the medium-fidelity simulation. This is particularly important because the

believability of the simulation experience is inherent to acceptance of the experience and the fact that it replicates clinical practice.

3.3.2 Limitations of High-fidelity Simulation

Despite the results of these individual studies, the literature does not universally support the use of high-fidelity simulation over lower-fidelity alternatives. Persson (2017) argues that there is no linear relationship between level of fidelity and transfer of learning. A number of systematic reviews indicate a lack of robust data to support the extent of the integration of high-fidelity simulation into nursing schools. Issenburg et al (2005) completed a systematic review of randomised control trials and quasi-experimental studies conducted between 1969 and 2003, evaluating the effectiveness of high-fidelity simulation. 109 studies were independently analysed by a team of researchers who determined that the contribution of high-fidelity simulation to learning outcomes was equivocal in 80% of studies. In addition, Yuan (2012) completed a systematic review of studies between 2000 and 2011, examining the educational effectiveness of high-fidelity simulation. Two independent reviewers assessed eligibility and methodological quality and completed a meta-analysis of the outcome data. 24 studies were included in the review. There was a lack of high-quality randomised control trials and sufficiently large sample sizes. Although some positive outcomes were identified, the authors concluded there was insufficient evidence to support self-reported improvements in confidence and competencies, a lack of evaluation tools and inadequate validation of outcome measurements. In addition, further research is required to examine the transfer of high-fidelity simulation learning to clinical practice.

In a more recent systematic review, Mok et al (2016) reviewed studies published between January 1999 and September 2014 to compare the use of high-fidelity patient simulation with other teaching methods to teach clinical reasoning skills to baccalaureate nursing students. This ensured homogeneity of the student population. Studies that did not include a pre and post-test comparison were excluded. This study encompassed a range of other learning tasks and contexts and specifically contrasted high-fidelity simulation education with other methods. Therefore, a more comprehensive contrast was examined not catered for in Kim et al (2016). In addition, the timeframe examined covered the more recent integration of high-fidelity simulation in the

nursing curriculum (Doolen et al 2016) and provides a more detailed assessment of current high-fidelity patient simulation. Outcome measures included, knowledge acquisition, skill performance and critical-thinking skills. Methodological quality and determination for inclusion was judged by two independent reviewers and adjudicated by a third reviewer, using the Jadad scale, which has been specially designed to assess rigour and quality of simulation randomised control trials. They reviewed 11 randomised and quasi-randomised control trials. Seven studies investigated knowledge acquisition, four studies examined skill performance and two studies investigated critical-thinking skills. Four of the reviewed studies compared high-fidelity patient simulation with low and medium-fidelity patient simulation. The variety of assessment tools and outcome measurements precluded a meta-analysis and only a narrative of pooled results was provided.

The results highlighted that the educational impact of high-fidelity simulation is variable. Two studies demonstrate a significant increase in knowledge acquisition post high-fidelity simulation compared to standard training ($p = 0.015$ and $p = 0.002$) with one also achieving a significant difference in knowledge retention at three months ($p = 0.002$). In contrast, four studies found no significant effect on knowledge acquisition, and one demonstrated reduced knowledge acquisition in the high-fidelity group compared to traditional learning format ($p = < 0.03$). Four studies examined clinical skill performance and only two of these noted a significant difference in scores post high-fidelity training ($p = 0.00$).

The review concluded that the level of fidelity of patient simulators does not influence student's learning outcomes. Overall, the results indicate a lack of statistically significant difference in the learning outcomes from high-fidelity patient simulation versus traditional modalities and lower-fidelity simulation. However, there are other factors to consider which may impact upon the effectiveness of high-fidelity patient simulation, for example, the duration of the simulation for effective practice. The authors identified a number of methodological issues which call into question the robustness of the results obtained. Studies were predominantly small-scale in which participant numbers ranged from 13-140. In addition, despite the small number of studies included, high-fidelity simulation was compared to a variety of education methods, including lectures, online discussions as well as directly comparable static and medium-fidelity patient simulations. In addition, only one described the method of randomisation. Poor methodological quality, lack of information about randomisation process, and over reliance on small convenience samples render definitive conclusions difficult.

There are three additional key concerns related to the use of higher fidelity simulation in the nursing curriculum: Lack of uniformity in research and evaluation methods across studies, the inherent lack of realism in simulation and cost.

3.3.3 Lack of Uniformity of Research and Evaluation Methods

There are a number of methodological issues which make it difficult to determine the effectiveness of simulation education, and in particular the appropriateness of high-fidelity simulation over lower-fidelity alternatives. A central difficulty in quantifying and qualifying the effectiveness of high-fidelity simulation is the lack of uniformity between outcome measurements. The literature employs a variety of outcome measurements including: student confidence levels (for example, Jeffries and Rizzolo 2006 and Mould 2011), competence (for example, Mould 2011), critical-thinking (for example, Fero et al 2010), and knowledge acquisition (for example, Schlairet and Pollock, 2010). Whilst the diversity of outcome measurements used provides a comprehensive insight into the variety and complexity of educational requirements of nurses, it makes the definitive comparison of study outcomes complex.

Another concern is the validity of the outcome measurements. For example, confidence is frequently used as a proxy for competence (for example Basak et al 2016). However, the correlation between confidence and competence can be illusory. For example, Shinnick et al (2012) compared heart failure knowledge scores of 162 student nurses from three schools of nursing who were randomly allocated to receive either high-fidelity patient simulation or standard tuition. Multiple variables that potentially contribute to performance were analysed, including age, gender, learning style, baseline critical-thinking skills and baseline self-efficacy. Students were asked to complete three online validated questionnaires: Kolb Learning Styles, California Critical-thinking Disposition Inventory and the Health Science Reasoning Test. The knowledge pre and post-test content validity was assessed and approved by three heart failure experts. There was no difference in baseline knowledge scores which implies heterogeneity across groups. Participating in the high-fidelity simulation was the single statistically significant predictor of improved knowledge scores across both univariate and multivariate analysis, ((SD) 1.56 ± 0.50: (B) = 137 Exp (B) = -1.986 Bivariate p = 0.000, Multivariate p = 0.000 (p = < 0.01)). Self-efficacy

scores in the multivariate analysis between groups was not found to be significant. Students in the standard tuition were over confident about their abilities and calls into question the predictiveness of self-efficacy and confidence as a substitute for performance. In addition, knowledge scores of participants who received standard tuition also significantly improved after they completed high-fidelity simulation.

There are also concerns about the validity of self-report scales and inter-rater reliability in evaluating simulation performance. Eva and Regehr (2011) highlights there is inconsistency between self-assessment and self-monitoring and McGarry (2014b) states it is almost impossible to ensure inter-rater reliability. Evaluations of high-fidelity simulation use various conceptual definition of competence or lack a clear and consistent definition (Onello and Regan 2013). This could account for the inconsistent findings regarding the impact of high-fidelity simulation on competence levels and represents a considerable challenge to how simulation is applied (McGarry 2014b). Onello and Regan state a more rigorous focus on the measurability of outcomes is needed to advance the state of knowledge regarding the effectiveness of simulation in nursing education.

An additional concern is the variety of study methods identified in the literature. Cant and Cooper (2010) conducted a systematic review of studies focusing on high to medium-fidelity human simulations published between 1999 and 2009. Studies were reviewed using assessment criteria for randomised controlled trials and case control trials by the Critical Appraisal Skills Programme of the Public Health Resource Unit, England (2006). Specifically, the study evaluated the validity of simulation assessment methods for knowledge and/or skill acquisition, and whether the assessment was completed immediately after the simulation experience or at a later time point. 12 experimental quasi-experimental studies were reviewed and the authors concluded that determining the effectiveness of simulation education compared with other education methods was complicated by a lack of robust evidence and comparable studies. Comparison between studies was hindered by different experimental designs. There are a multiplicity of methods used for example, randomised control trials with post-test comparison (for example, Beddingfield et al 2011 and Aqel and Ahmed 2014), randomised control trials with post-test self-assessment (for example, Jeffries and Rizzolo 2006), surveys of use across schools of nursing (for example, Kardong-Edgren et al 2012 and McGarry et al 2014b), qualitative assessment including open ended questionnaires (for example, Dowie and Phillips 2011), focus groups (for example, Garrett et al 2011) and mixed-method longitudinal cohort studies (for example, McCaughey and Traynor

2010). In addition, the type of outcome data varies, from objective assessment of trained clinicians (for example, Haviland et al 2015 and Curran et al 2015), to self-efficacy report (Lee et al 2016), qualitative reflections on simulation experience (for example, Sadideen et al 2016) and quantitative performance in simulation or subsequent clinical practice. This means that a comprehensive meta-analysis to determine what level of fidelity is most effective, particularly in contrast or in conjunction with other education methods is difficult.

Another prominent barrier to establishing comprehensive support for the integration of high-fidelity simulation is the variable quality of simulation research. Several meta-analyses of simulation education have identified a lack of rigor and quality as key confounding factors which limit the quality of outcomes data (House et al 2016) including weak designs, lack of valid and reliable evaluation tools (Doolen et al 2016), lack of randomisation, lack of control groups and disparity or lack of representation between study groups (Cant and Cooper 2010). Overall poor methodological quality and lack of reference to adult learning theory to justify simulation selection reduces the ability to draw definitive collective conclusions from studies (Mok 2016 and Doolen et al 2016). For example, Boling and Hardin-Pierce (2016) completed an integrative review on the effect of high-fidelity simulation on knowledge and confidence levels in critical care training published in the previous 10 years. 17 papers were included in the review. 16 measured the effect of simulation experience on knowledge level and perceived competence. Six studies included a comparison control group and only three included some form of post-test analysis. There was a variety of assessment methods including seven which used self-assessment and five which incorporated some form of objective assessment. Doolen et al (2016) supports the inclusion of more experimental studies with a more rigorous design, varying student characteristics to avoid bias, mixed-methods approaches.

In addition, many studies have small sample size. Large scale, collaborative randomised controlled trials and multi-institutional studies are lacking in the simulation literature. Fragmentation between education programmes and lack of resources renders multi-institution collaborative programmes difficult (Kneebone 2009). However, Boling and Hardin-Pearce (2016) emphasised the number of comparable smaller trials which yield similar results can provide a collective weight

to study conclusions. However, a direct cause and effect relationship between simulation fidelity and education outcomes still needs to be established (Doolen et al 2016).

There is also a lack of studies focusing on the application of simulation education for specific clinical specialities and care groups. For example, Cooper (2015) completed an integrative literature review to compare traditional, teacher-centered education with high-fidelity simulation education for neonatal nurses. The review structure was based on Whittmore and Knafl (2005) methodological strategy for integrative reviews. This is a limited subject area and many of the eight articles included were not research-based. This demonstrates that further research is warranted. However, the review indicates that high-fidelity simulation has great potential to be an effective pedagogical approach, but more rigorous quantitative studies to objectively prove its effectiveness are required.

3.3.4 Lack of Innate Realism in Simulation

The literature consistently states high-fidelity is preferred over lower-fidelity simulation because it is deemed to be more realistic, (for example, Berragan 2011, Nehring and Lashley 2009, Kneebone et al 2007 and Ziv et al 2005). However, some studies suggest high-fidelity simulation does not always provide a highly realistic representation of clinical practice. This is reflected in the literature which emphasises high-fidelity to denote high engineering and environmental fidelity. However, even in high engineering and environmental fidelity focused simulations which are specifically designed have to reflect high technological clinical environments, it can be difficult to achieve realistic and complex clinical scenarios, while controlling and testing the many possible variables encountered in clinical practice [Rashid and Gianduzzo 2015]. While the benefits of high-fidelity simulation are widely reported, learners repeatedly cite limited realism (DeCarlo et al. 2008) and the need for more authenticity (Pike and O'Donnell 2010) as areas that diminish their learning experience (Dunbar-Reid et al 2015).

Whilst high-fidelity patient simulation has increased levels of authenticity, it is still outstripped by the complexity of real life human responses (Dunnington 2014). In addition, although fidelity is important when seeking to match the appearance and behaviour of the real situation, (Kinney and Henderson 2008), Bland et al (2011) state increased engineering and environmental fidelity is unlikely to result in reciprocal increases in authenticity. Inherent in the simulation scenario is that it is unreal Kneebone (2009) and requires students to suspend disbelief and engage with the

simulation as if it was a real patient or clinical scenario (Cooper 2015). The inherent unrealism means that students in a simulation scenario may not identify, interact or effectively communicate within the simulation scenario as if it was real (Weller et al. 2012). Integral is the collusion of participants to be 'willingly deceived' and accept the replica simulation scenario, which is by definition of 'sub-absolute fidelity' (Tun et al 2015).

The potential inability of students to interact with simulation as actual clinical practice is elucidated in a number of studies. DeCarlo et al (2008) surveyed 523 full and part-time nurses in a university affiliated children's hospital regarding barriers to high-fidelity simulation education. Participants reported that they knew simulation inherently unreal and this was perceived to be a significant barrier to simulation education by nurses with prior simulation experience ($\chi^2 = 5.284$, $p = 0.02$). MacCaughey and Traynor (2010) highlighted that only 54 (58.1%) of student nurses who participated in high-fidelity simulation regarded the simulation clinical scenarios to be realistic. Rhodes and Curran (2005) evaluated the use of a high-fidelity mannequin with integrated heart and breath sounds, pulses, and communication capabilities by pre-registration nursing students. Some students found it difficult to treat the mannequin as a real patient. The perceived inherent unrealism of simulation counteracts the degree to which high-fidelity simulation provides a truly realistic experience. Pike and O'Donnell (2010) argues that the lack of perceived realism diminishes the learning experience and support the need for simulation to have increased authenticity. Consequently, there is still a requirement to increase the fidelity of simulation scenarios to facilitate heightened and more realistic interpersonal interactions.

One additional aspect that reduces the realism of simulation is the context in which it is used. Simulation is commonly experienced external to the clinical environment, and usually involves some form of imposed teaching or assessment component. Indeed, the premise of simulation is to provide a replica of clinical practice and this artificial aspect lessens the context simulation represents (Kneebone 2009).

The inability for students to interact with simulation analogous to clinical practice is acknowledged by a number of studies. Lasater (2007) for example, conducted a focus group with 15 nursing students to discuss their experiences of using a high-fidelity patient simulation.

Although participants considered the simulation to be realistic, and many participants described feelings of anticipation or 'foreboding', and that 'you could really mess up' in the simulation, they acknowledged that 'you knew Sim Man wasn't going to die' p 273. This affirms the low-risk nature of simulation. Neary (1994) agrees and refers to the term 'adrenaline gap' whereby participants do not feel the same level of stress or respond within a simulation as they would do in clinical practice, irrespective of fidelity. However, other studies, for example Clarke et al (2014) highlight that simulation can induce stress. Childs and Sepples (2006) argue simulations are capable of invoking stress and fright and Gaba (2004) observes students can easily suspend belief and immerse themselves in simulations and role-play in a manner that is consistent to clinical practice.

In contrast, a section of the literature suggests students are able to immerse themselves in the simulation experience. Kneebone (2009) argues that although simulation is externally and artificially imposed teaching and assessment experience, this component renders simulation sufficient to induce stress and anxiety which can be correlated directly to perceived clinical experience. This is reflected by quantitative studies which use biological parameters to measure levels of stress and qualitative studies. Daglius Dias and Scalabrini Neto (2016) evaluated if simulated scenarios were capable of inducing stress levels comparable to stress induced during real emergency medical situations. The stress levels of 28 medical residents were measured during 16 real life and 16 simulation emergency scenarios at baseline and immediately post scenarios. The clinical parameters measuring acute stress were heart rate, systolic and diastolic blood pressure, salivary α -amylase and salivary interleukin-1 β . A self-evaluation State-Trait Anxiety Inventory score was also completed. In the real-life group, all parameters increased significantly ($p = <0.05$) between baseline and post scenario. In the simulation group, only heart rate and interleukin-1 β increased significantly post scenario. However, on these two measurements the baseline and post emergency stress response did not differ between the simulation and real life scenario. Although some of the real life stressors may be due to external issues confounding the clinical simulation, the simulation was able to generate a stress response in some measurements similar to a real clinical emergency.

Similarly, from a qualitative research perspective, Lestander et al (2016) explored written and verbal reflections of 16 nurses post simulation experience. Responses included "Even if I only was an observer, my pulse rushed and thoughts were flying round in my head" p 221. The participant specifically related their stress to the clinical environment and potential consequences to the

patient due to suboptimal care. In another example, Kai (2014) described the qualitative experience of a student who experienced an adrenalin rush whilst she cared for a clinically deteriorating high-fidelity simulation patient. Similarly Dwyer et al (2015) report the response of one participant as; 'you could believe it was real, a real patient' p434.

This illustrates that the literature does suggest students can interact with simulation similar to real clinical practice. The extent to which the student can relate to simulation as real clinical practice is heavily dependent on the authenticity of the simulation. However, in-line with recent technological advances, an emerging issue is increased authenticity can be accompanied by greater complexity, which may increase distraction from key learning goals and as a consequence hinder learning. For example, Chen et al (2015) compared the effectiveness of high and low-fidelity simulation to learn cardiac and respiratory auscultation and physical assessment skills. 60 senior-level nursing students were randomised to receive high or low-fidelity simulation, or to a control group. Primary outcome measures included auscultation tests of cardiac and respiratory sounds, as well as observer-rated performances in simulated clinical scenarios. On the auscultation test, the post training mean scores in the high-fidelity, low-fidelity and traditional teaching groups were 46.79, 57.72 and 32.50 respectively. Differences between study groups in total scores was statistically significant ($F(2,57) = 21.98, p < 0.001$). The lower-fidelity group consistently demonstrated performance comparable or superior to that of the high-fidelity group, and both were, in turn, superior to the performance of the control group. The results from this study suggest that highly contextualised learning environments may not always result in enhanced learning and may lead to ineffective learning by increasing the cognitive load on students. It might be that the increased cognitive load can distract novice users away from the task learning goals, although the extra authenticity can help apply what they learn in the task into routine clinical practice.

Cognitive load theory has been used by researchers to conceptualize instructional design for complex learning situations such as simulation. Interest in applying cognitive load theory in health care simulation is growing (Haji et al 2015 and Reedy 2015). Cognitive load theory is particularly helpful when considering how to design learning tasks and environments. Cognitive Load theory is based on the work of Sweller (1988) who developed a framework of instructional design. Within

cognitive load theory, cognitive architecture is comprised of a variety of informational processing components including working memory, long-term memory, schema, and cognitive load. It is based on the Information Processing Model by Atkins and Shiffrin (1968) which details how humans process information. This theory states there are three main aspects to information processing; sensory memory, working memory and long-term memory. Sensory memory filters the large amount of sensory information received every moment and retains an impression of what is deemed to be the most important. This is transferred to working memory where the information is either process or discarded. If the information is retained, it is then transferred into the long-term memory where it can be retrieved.

Working memory has a finite span of information that can be retained at one time and is believed to be limited to approximately 20 seconds of attention, during which time it must filter nonrelevant information and manage pertinent information for learning (Kirschner 2002).

Working memory allows the processing of about seven single elements or pieces of information that need to be stored, manipulated, or learned at one time. If a learner is to analyse the information and engage in critical-thinking, the number of elements that can be processed at one time decreases from seven to three to five elements (Josephson 2015). It is used during the initial learning process, and can be affected by various types of cognitive load including the learner's prior knowledge, the form the information is presented in (Renki and Paas 2010) and negative emotions experienced (Fraser et al 2012).

Schema is an important part of cognitive load theory and processes information from working to long term memory. A schema represents an organized pattern of relationships and chunks of information concerning an area of knowledge (Plass et al 2010). Novice learners often do not have the schema development necessary to mitigate cognitive load and as a result, may impede working memory.

Cognitive load theory is integral to simulation education because the design of the simulation must be structured to enhance learning. An essential premise of cognitive load is the relationship between the learner's cognitive architecture and instructional design (Josephsen 2015).

Inappropriate cognitive load has the potential to distract and provide an excessive burden on the student which can diminish their learning. Cognitive load theory directly impacts upon simulation design because working memory has a limited capacity and learning is impaired when aspects of

mental effort or instructional design overload this capacity (Fraser 2012). There are different types of cognitive load related to instructional design: intrinsic load, which reflects both the inherent difficulty of a given task and the learner's prior knowledge or experience of this task; extraneous load, a superfluous load that is potentially harmful to learning and is imposed on the learner by his or her interaction with the instructional material (including teachers), and germane load, which refers to the proportion of working memory dedicated to learning the new task. There is also mental load relates to instructional design which negatively impacts on overall load and decreases the overall working capacity, for example, defective materials and inadequate orientation (Fraser et al 2012). Cognitive load theory assumes that these types of load are additive, that learning is reduced when the total cognitive load exceeds the capacity of working memory.

Several researchers have used cognitive load theory to conceptualize instruction for complex and technically challenging learning situations such as nursing simulation (for example, Mayrath, et al 2011). However, Josephson (2015) completed an integrative review was to examine the extent of cognitive load theory is incorporated into simulation design and implementation. This was an expansive review which included theoretical and empirical literature and simulation to provide a broad base of information. Due to a limited amount of literature identified in a preliminary review, theoretical and empirical literature was included in the review if it was found to have some relevance to instructional design in nursing simulation. No timeframe is documented. A total of 52 articles and six books were reviewed. The author concluded that cognitive load theory is highly relevant to nursing simulation design and there are many aspects of simulation that add to extraneous, intrinsic, germane, and mental cognitive loads. Simulation experience often includes several items that require the learner's attention and ability to discern element relevance for the situation for example, performing an appropriate focused assessment concerning the patient condition, problem solving or recognizing and appropriately addressing embedded challenges to simulation design.

The degree of interactivity between elements within the simulation can carry a high intrinsic load which can potentially compromise performance (Fraser et al 2012) and the degree of fidelity and authenticity can affect this. This is exemplified by Dankbaar et al (2016) investigated the effects

of fidelity of open patient cases in adjunct to an instructional e-module on students' cognitive skills and motivation on 61 fourth-year medical students. A three-group randomized post-test-only design was completed: a control group working on an e-module; a cases group, combining the e-module with low-fidelity text-based patient cases, and a game group which combined the e-module with a high-fidelity simulation game. All conditions used the same patient cases. Participants completed questionnaires on cognitive load and motivation. Four weeks post intervention, qualified trainers in emergency care assessed and rated the students' cognitive emergency care skills in two mannequin-based scenarios. They were blinded to the student's simulation allocation. Acquired cognitive skills did not differ between groups despite time allocated to the game group was two hours longer than the control group. The game group experienced higher intrinsic and germane cognitive load than the cases group ($p = 0.03$ and 0.01), however they did feel more engaged ($p < 0.001$). The e-module appeared to be very effective, while the high-fidelity game, although engaging, probably distracted students and impeded learning.

In a study that focused on the effect of cognitive load on knowledge acquisition, Young et al (2016) studied the impact of case complexity (i.e. cases with or without a clear diagnosis) and illness script maturity and their interaction on clinical handover accuracy. 52 second and sixth year medical students four simulated handovers involving two simple cases and two complex cases. Higher illness script maturity predicted increased handover accuracy ($p = < 0.001$) and lower cognitive load ($p = 0.007$). For handover accuracy, there was no interaction between case complexity and illness script maturity. With regards to cognitive load, there was an interaction effect between illness script maturity and case complexity, indicating that more mature illness scripts reduced cognitive load less in complex cases than in simple cases. Students with more mature illness scripts performed more accurate handovers and experienced lower cognitive load. For cognitive load, these effects were more pronounced in simple than complex cases.

A major determinant of intrinsic cognitive load is the degree of interactivity between elements of in the simulation to be learned which can carry a high intrinsic load particularly for learners with limited clinical experience which can potentially compromise performance (Fraser et al 2012). There is a potential additional effect of cognitive load on novice students. Novice nurses frequently report symptoms of cognitive overload associated with error and other negative patient outcomes (Unver et al 2012). Schlairet et al (2015) for example, completed a quasi-

experimental pilot study to explore the impact of high-fidelity simulation on emotion and cognitive load among novice nursing students. Forty baccalaureate nursing students participated in a high-fidelity simulation and rated their emotional state and cognitive load. The mean rating of cognitive load following simulation was high. Statistical analysis identified a slight, but non-significant positive association between degree of emotion and cognitive load. Equally, there was a negative but statistically non-significant effect of cognitive load on assessment performance. Although non-significant, there was more pronounced relationship between lower ability students and cognitive load.

The impact of emotion on cognitive load and learning is less clear. Fraser et al (2012) indicates that heightened negative emotions, such as anxiety, can hinder learning, by generating extraneous cognitive load, but that the effect of positive emotions is less predictable. Fraser et al state the conditions under which positive emotions facilitate or suppress learning are unclear, but it has been suggested that all emotions generate an extraneous cognitive load and thus the net effect of positive emotions may depend upon their interactions with other sources of cognitive load.

There are a number of strategies Josephsen (2015) identified to mitigate cognitive load. Scaffolding relates to breaking down the task into a simple to progressively more complex format based on their expertise. This decreases the intrinsic load until no longer needed and can decrease extraneous load where relevant. In this model, the learner moves from practicing the most simple but genuine case one might encounter in the real world and progresses to the more complex examples. An example is learning resuscitation techniques on a static dummy before progressing to high-fidelity patient simulation in a bespoke simulation environment. Another strategy is using a worked-out. The learner is given the goal and an example of the solution to a problem. In this setting, extraneous load is decreased, and the learner can then focus on the problem and steps to the solution. This enables the learner to create a schema related to the problem. In nursing simulation, one example of this is the use of expert modelling before the simulation. This method has been shown to be effective with novice learners (Ayres & Paas, 2012). Another form, which can be linked to vicarious learning is collective working memory in which simulation is completed in small groups and therefore encourages the use of collective

working memory. During collaboration with multiple people playing various roles in a scenario, the learners borrow information from each other's long-term memory and then are able to organize this information from their personal working memory into their individual long-term memory. One area of caution when using collective working memory is that the amount of cognitive effort that individuals have to exert to communicate and problem solve with each other can use up working memory capacity.

3.3.5 Cost of High-fidelity Simulation

One of the key concerns with high-fidelity simulation is the relative high cost required (Mok et al 2016). High-fidelity simulation, particularly when focused on engineering and environmental fidelity is a costly and complex resource (Kneebone et al 2007, Alinier et al 2004 and Lane et al 2001) which can present a significant challenge for educators (Parker and Myrick 2009). For example, computerized high-fidelity patient simulation requires a substantial financial commitment (House et al 2016 and Li et al 2017) compared to lower-fidelity alternatives. Costs do not just refer to the initial purchase of the simulation, but includes time, physical space, training, administration (Issenberg 2006), long-term maintenance and operating technicians (Kardong-Edgren et al 2007 and Cooper 2015). Garrett et al (2011) exemplifies the resource implications of adopting high-fidelity technologies. The implementation and integration of a high-fidelity simulation laboratory at one institution cost over \$300,000, excluding ongoing maintenance costs. Garrett et al advised that the 'life cycle' of the technology should be included into the cost calculation. This is corroborated by Hallenbeck (2012) who identified high-fidelity simulator, accessories and software can cost approximately \$91,800. Similarly, Kardong-Edgren et al (2007) compared the cost of low-fidelity static mannequins with high-fidelity mannequins. The high-fidelity model was 30 times more expensive than the low-fidelity mannequin, costing \$30,000 and \$1,000 respectively.

The ongoing cost implications is recognised by nursing educators. Baghoomian (2014) surveyed the perceptions of 26 nurse educators across four training sites regarding the use of simulators in clinical practice. The greatest challenge of high-fidelity simulators reported by 61.5% nurse educators was the need for ongoing training and education and technical support. A key recommendation stated by nurse educators was initial and ongoing training on simulators and technical support, time to prepare scenarios and funds to purchase scenarios.

There are additional factors that increase the cost required to integrate high-fidelity simulation into nursing curricula (Gaba, 2004 and Zigmont et al 2011). High-fidelity simulation in particular has reduced portability compared to low-fidelity models. This can both reduce the availability of simulation and increase the organisational resources required to coordinate high-fidelity simulation centres (Dwyer 2015). In addition, learning from high-fidelity simulation is aided by repeated practice (Issenberg et al 2005) and this is often best suited for small groups (Kaplan et al 2012). However, the cost of purchasing and managing high-fidelity simulation can act as a barrier to unsupervised practise (Howard et al 2011 and McGarry et al 2014b) or training in small groups.

A number of researchers suggested mechanisms to mitigate the costs of high-fidelity simulation. Haigh (2007) and Garrett et al (2011) suggest combining resources across disciplines to mitigate costs, which could also cater for some of the methodological concerns about the robustness of studies (Kneebone 2010), but Haigh questions the ease to which this could be achieved. However, Cooper (2015) is optimistic and states as high-fidelity simulation becomes an increasingly mainstream method of education, the possibility of collaboration and cost sharing between universities and hospitals will increase and help to negate the cost of equipment and staff. Rashid and Gianuzzo (2015) also recommends changing the structure of curriculum so that modules use a mixture of technology to expand the reach of simulation into daily practice.

Another key method to mitigate the costs of high-fidelity simulation is to restructure how costs are calculated. For example, some authors argue that when determining the cost benefit of high-fidelity training, the effect on patient outcomes and corresponding cost implications should also be considered. For example, Gaba (2004) acknowledges that whilst high-fidelity simulation is expensive, it has the greatest potential to improve patient safety. Kneebone et al (2004) concurs and states that although the cost of high-fidelity simulation is likely to be substantial, it is most likely to impact on patient safety, particularly when comparing to other high reliability organizations. Kneebone argues the cost savings and improvement in care is likely to be substantial. However, this is difficult to substantiate because the initial cost outlay is frequently borne by education departments and the potential financial gains credited to healthcare systems. In addition, Alinier (2004) states most significant cost benefit can only be determined over the long-term and is this difficult to judge.

Further research is required to justify the cost and effort involved (Bradley 2006) and adult learning theory that underpin simulation education, for example, experiential and constructionist learning theory, is fundamental to the selection of fidelity implemented (Parker and Myrick 2009). As a consequence, nurse educators should question whether the motivation to adopt high-fidelity simulation is due to a comprehensive understanding of simulation learning theory or due to the appeal of rapid technological advances.

A section of the literature argues that evidence is still required to justify the cost of using high-fidelity simulation (for example, Kardong-Edgren et al 2007 and Alinier et al 2004) over lower-fidelity alternatives and learning outcomes must govern the choice of simulation method (Persson 2017). Lapkin and Levett-Jones (2011) completed a cost-utility analysis of medium to high-fidelity simulation mannequins. 268 second-year and 84 final-year nursing students were randomly allocated to receive either medium or high-fidelity training and were tested on clinical reasoning and knowledge acquisition. Mean clinical reasoning scores of the medium and high-fidelity groups was 19.22 and 42.90 respectively and the difference between the two groups was statistically significant ($p = 0.001$). Knowledge acquisition was tested pre and post simulation for 84 third-year students. The post-test mean scores were 12.8 and 13.21 for the high and medium-fidelity groups respectively. Differences in post-test mean knowledge scores, adjusted for pre-test scores, was not statistically significant ($p = >0.05$). In addition, there were no statistically significant differences in satisfaction scores between the groups ($p = > 0.05$). The cost-utility ratio of medium and high-fidelity simulation was \$1.21 and \$6.28 respectively. Medium-fidelity mannequins therefore achieved commensurate scores on knowledge acquisition and student satisfaction at one fifth of the cost. Ballangrud et al (2014) argue that high-fidelity patient simulations are costly and there is no proportional improvement in education outcomes that justified the increased investment in time, money and expertise required for high-fidelity patient simulators over lower-fidelity alternatives. In a similar study, Cheng et al (2015) completed a meta-analysis of 14 studies to compare the immediate and long-term learning outcomes of students who were randomised to use either high or low-fidelity patient simulators to teach life support skills. They highlighted only moderate improvements in life support performance for students trained using the high-fidelity manikin immediately post simulation, and no differences between groups at one year. Therefore, the question remains what level of fidelity is required to maximise education outcomes (Grady et al 2008).

There are a number of lower cost simulation alternatives that may be considered to mitigate the costs of high-fidelity simulation. Li et al (2017), for example, completed a systematic review of low cost laparoscopic simulators available between 1990 and 2014 which cost less than £1500 and examined the validity, equipment needed, cost, and ease of assembly. 73 unique simulators were identified, including 60 non-commercial and 13 commercial options. 55 % (33) of non-commercial trainers were subject to at least one type of validation compared with 92 % (12) of commercial trainers. Commercial simulators had better face validation compared with non-commercial. The cost ranged from £3 to £216 for non-commercial and £60 to £1007 for commercial simulators. Key components of simulator construction were identified as abdominal cavity and wall, port site, light source, visualisation, and camera monitor. Laptop computers were prerequisite where direct vision was not used. Non-commercial models commonly utilised retail off-the-shelf components, which reduced costs. The authors identified a number simple and affordable options models, although a significant proportion had not been subject to any validation. Although there was no analysis on the effect on face and content validity, education outcomes, ongoing costs of maintenance, curriculum integration and level of fidelity, it does demonstrate the variety of alternatives available to mitigate the high costs of simulation education.

In more recent years, to mitigate the concerns with costs of high-fidelity simulation, researchers have emphasised the use of low cost but high-fidelity simulations that maximised and prioritised high psychological fidelity, and where necessary, over engineering and environmental fidelity (Andersen et al 2016). Within this context, fidelity is closely aligned to the situation and context to be simulated. Sadideen et al (2016) argues that educational theory highlights the importance of contextualized simulation for effective learning and that this should be fully maximised and engineered to enhance the simulation experience at a lower cost. Sadideen et al describe the concept of 'The Burns Suite' as a novel tool to advance the delivery of burns education. The simulation constituted of a high psychological fidelity, realistic paediatric burn resuscitation scenario, based upon Advanced Trauma and Life Support and Emergency Management of Severe Burns principles. It incorporated all the theory and context of effective burns training, but was also low cost and portable. Therefore, it also catered for many of the concerns and limitations of high-fidelity simulation. It provided increased flexibility within the curriculum and an immersive

simulation environment. The simulation was assessed using a five-point Likert-type questionnaire which was specifically developed to incorporate face and content validity. Semi-structured interviews captured responses for qualitative thematic analysis. Participants reported that the experience felt particularly authentic because the simulation had high psychological and social fidelity, and there was a demand for such a facility to be made available to improve non-technical skills and interprofessional relations.

The importance of prioritising high psychological fidelity and equating fidelity more closely to the clinical context and not specifically to the technology used is exemplified by Pywell et al (2016). They compared the fidelity of professional and non-professional burns management moulage. Four actors were randomly assigned to a professional make-up artist or a course faculty member for moulage preparation using low cost materials. 20 participants experienced three out of four scenarios and at the end of the course completed a questionnaire evaluating the simulation experience. Internal consistency of face and content validity was 0.91 and 0.85 respectively. The professional moulage received significantly higher average ratings for face and content validity, 4.30 v 3.80; $p = 0.11$ and 4.30 v 4.00; $p = 0.06$ respectively. This demonstrates high-fidelity moulage simulations can be achieved by low cost materials and resources. In addition, the study highlights the variability of simulation methods external to patient and laboratory simulation. In a second example, Dwyer (2015) piloted an inexpensive high-fidelity humanistic role-play simulation to teach recognition and response skills to deal with the deteriorating patient. The simulation used Mask-Ed™ (KRS Simulation) which requires an expert educator to wear a realistic silicone masks and body suit to role-play a deteriorating patient with a predefined history. The simulation was portable and required relatively inexpensive props and the educator's expert skills and clinical knowledge. Participants completed the same scenario in both the high-fidelity simulation laboratory and in situ in the clinical environment. They completed a qualitative exploratory study with a convenience sample of registered nurses, medical students and medical doctors who attend Advanced Life Support training to determine their experiences of the simulation. Five subsequent focus groups were conducted with five to ten participants per group. Participants were positive about the simulation and three main subthemes were identified, including realism of the character, believability of the experience and connection with clinical reality. The simulation developed technical as well as communication skills, and the engagement achieved provided an authentic learning experience. However, participants were not randomly

assigned to the different simulation experiences and there is no comparison between the two different simulation environments.

3.4 Benefits of Lower-Fidelity Simulation in Nurse Education

With the rapid development and integration of simulation in healthcare, it is necessary to ensure that educational resources are invested where they will add most value (Persson 2017). The literature indicates lower-fidelity simulation, in engineering and environmental terms, can also provide an effective learning experience (Goodstone et al 2013 and Sullivan 2015). The literature on lower-fidelity simulation can be divided into studies that evaluate lower-fidelity simulation in isolation or compared to traditional teaching and studies that compare the effectiveness of high and lower-fidelity simulation.

3.4.1 Effectiveness of Lower-fidelity Simulation

A section of the literature focuses solely upon low-fidelity simulation and suggests that they can also provide an effective and realistic learning experience (Carrera 2013, Meska et al 2016 and Talbot 2013) and generate significant improvements in performance (Alinier et al 2006). For example, Sharpnack and Madigan (2012) evaluated an integrated pharmacology, health assessment and pathophysiology theory course using low-fidelity simulation and computer-assisted instruction. 32 nursing students experienced and assessed the course using an Educational Practice for Simulation Scale, a Student Confidence and Self Satisfaction Scale questionnaire. Participants reported a mean of 4.3 out of a maximum of 5 that the skills learned prepares them for clinical practice and 4.2 out of a maximum of 5 that the simulation was relevant to clinical practice. Participants reported the simulation experience to be realistic, effective, collaborative, individualised and supportive. They also reported improvements in thinking skills and clinical competence.

Low-fidelity simulation can be an effective education tool for other healthcare professionals. Siddiqui et al (2014) determined the efficacy and retention of low-fidelity model training on teaching sterile technique during placement of epidural catheters. 21 medical residents and trainee fellows participated in the study. Participants initially completed conventional training

before the simulation and were scored on their subsequent performance. The mean score for the residents following conventional teaching was 6.0 out of 15. Following the simulation training, which included one-to-one demonstration followed by a series of simulation sessions, the mean score significantly increased to 10.8 out of 15 ($p = < 0.001$). At eight weeks, scores ranged from 13-15 out of 15. This suggests that low-fidelity simulation can result in improved educational outcomes over the long-term when used in combination with conventional teaching. Healey et al (2010) evaluated a low-fidelity resuscitation skills simulation. 93 doctors completed a self-confidence questionnaire of in-hospital resuscitation skills and knowledge one-month pre and post simulation experience. The low-fidelity simulation course significantly improved self-reported confidence in resuscitation knowledge and skills in a number of key areas including defibrillation skills ($p = 0.02$, $p = < 0.05$), synchronised cardioversion ($p = < 0.01$) and airway support ($p = 0.001$). 45% of participants stated they used the knowledge and skills learned in the simulation in clinical practice. Healey et al argued low-fidelity simulation can provide a useful and informative educative experience. This demonstrates that that skills learnt in low-fidelity simulation can transfer to clinical practice.

A number of studies compare low-fidelity simulation to standard classroom based tuition. For example, Tiffen et al (2009) randomly allocated 32 advanced practice nursing students to low-fidelity simulation or a traditional lecture to teach cardiac and respiratory assessment skills. All students received a one-hour lecture on cardiovascular and respiratory medicine and two hours of laboratory time to practice assessments of both clinical systems. Students were subsequently randomised to receive one hour of low-fidelity patient simulation or traditional tuition. Students completed an in-house confidence assessment. Face validity was determined by ten faculty experts. Participants in the simulation group reported significantly higher levels of confidence in a number of assessment skills, including assessing murmurs ($F = 20.147$, $p < 0.001$), crackles ($F = 9.423$, $p = 0.05$) and wheezing ($F = 13.125$, $p = 0.001$) compared to the traditional lecture group.

3.4.2 Comparison of the Effectiveness of High and Low-fidelity Simulation

A number of studies that compare high and low-fidelity simulation and demonstrate that lower-fidelity simulation can lead to comparable learning outcomes (De Giovanni et al 2009, Finan et al 2012 and Tosterud et al 2013). For example, Butler et al (2009) randomly allocated 31 nursing students to complete either a high-fidelity human patient simulator or low-fidelity static mannequin tuition. Participants in the high-fidelity group were significantly more likely to state

that the simulation closely resembled real life compared to participants in the low-fidelity group ($r = 0.57, p = 0.001$), and that this element of the simulation design was more important to their learning ($t = -3.86, p = 0.001$). In addition, high-fidelity group participants were significantly more likely to state that realism was an important aspect to their learning ($r = 0.57, p = 0.001$). However, both groups perceived their experience facilitated the development of problem-solving skills and were very supportive of both types of simulation as an active learning strategy.

Haviland et al (2015) completed a randomised control trial comparing high and low-fidelity simulation training on comfort and competence in the insertion of three inter-uterine devices (IUD). 60 interns and nurse-practitioner students who had inserted fewer than five IUDs were randomised to practise the technique on either the PelvicSim high-fidelity simulator or a low-fidelity coaster like model. Insertion competence was assessed using a validated checklist and a questionnaire on perceived comfort and competence pre-training, immediately post-training and three-months later. Immediately post training, both groups reported comparable increased levels of comfort with IUD insertion across all three devices ($p = 0.23, 0.11$ and 0.47). Both simulation groups experienced similar increases in self-perceived competence across all devices immediately post training (all $p = < 0.05$) and similar decreases at the three-month time point compared to immediately post training (all $p = < 0.07$). There was also a decrease in comfort levels in inserting these devices at the three-month time-point, however there was no significant difference between groups (all $p = > 0.33$). The level of simulation fidelity did not influence self-reported comfort and competence and the effect on insertion skills remains unknown.

In another example, Curran et al (2015) examined the effect of using low versus high-fidelity patient simulators in a neonatal resuscitation programme. In a randomised post-test-only control group study, third year undergraduate medical students were assigned to receive either high or low-fidelity patient simulation. Integrated skills station performance, participant satisfaction, confidence and teamwork behaviour scores were compared. Participants in the high-fidelity group reported significantly higher total scores in overall satisfaction ($p = 0.001$) and confidence ($p = 0.001$). However, there were no significant differences in teamwork behaviour scores, as observed by two independent raters, nor differences on mandatory integrated skills station performance items at the $p < 0.05$ level. However, there was no pre-test assessment to determine

the participants baseline. In addition, Liaw et al (2014) completed a randomised control trial which compared the effectiveness of a virtual simulation with mannequin-based simulation to teach skills to assess and manage the clinically deteriorating patient. 57 third-year nursing students completed a baseline evaluation and were re-tested one day and 2.5 months after the simulation experience. Compared with baseline scores, mean scores of both groups were significantly higher at day one and at 2.5 months ($p = <0.001$). Although the virtual simulation group had significantly lower 2.5 month mean scores compared with day one ($p = <0.05$), there was no significant difference with the 2.5 month mean scores of the mannequin group ($p = 0.17$). These studies indicate that lower-fidelity simulation can provide a comparable alternative to higher fidelity simulation.

These studies suggest that lower-fidelity simulation can provide an effective learning experience because simulation offers active learning, 'regardless' of fidelity (Butler et al 2009). Indeed Patrick (1992) reports how a high a degree of cognitive task learning can be achieved using very low-fidelity simulation, including pencil and paper. Studies such as Healey et al (2010) suggest appropriately designed low-fidelity simulation can produce effective educational outcomes whilst simultaneously reducing costs. The same methodological concerns identified with high-fidelity simulation in section 3.3.3 can also be attributed to the literature on low-fidelity simulation, for example, small sample sizes (for example, Tiffen et al 2009), self-report scales, (for example Sharpnack and Madigan 2012) and lack of pre-test comparison (for example, Curran et al 2015). Despite this, the question still remains, if simulation is to be used as active learning education tool and lower-fidelity simulations can also provide a cost-effective and sufficiently realistic learning experience, what is the optimal level of fidelity for the medication administration simulation?

Suitably designed lower-fidelity simulations or simulations that prioritise high psychological-fidelity can be a cost-effective alternative to prepare nurses for clinical practice. Criteria for selecting simulation fidelity should be based on its fitness for purpose, including training needs and resources, and not on level of engineering and environmental complexity (Kneebone et al 2007 and Beaubien and Baker 2004). The mode of education selected should be based on a cost-benefit assessment and adult learning theory, in which simulation educational outcomes are maximised with the minimum of cost. Kardong-Edgren et al (2007) supports this and suggests that nurse educators adopt lower cost, lower-fidelity technologies in more austere times, if they simultaneously demonstrate knowledge improvements. There is a debate that continues in the

healthcare simulation community as to how much fidelity is necessary and the fidelity requirements vary according to the learning context (Jones 2015), however Kneebone et al (2010) argue that simulations need to be good enough and states lower-fidelity simulations are capable of providing an effective learning experience. Similarly, Dieckmann [2009] warns against placing too much emphasis on having optimal equipment and surroundings that realistically replicate the clinical setting. The required learning outcomes, not the level of technology available must govern the choice of simulation fidelity (Jones 2015).

To maximise the quality of simulation education and psychological fidelity, simulation design must take into account adult learning principles and integrate students and end users into the design process. It is not easy to determine the appropriate level of fidelity for effective teaching as high technology does not always equate to high-fidelity (Baptista et al 2016). Various levels of fidelity have different educational values and students perceive them in different ways. In suitably designed simulations, engineering and environmental fidelity become less important (Beaubien and Baker 2004). In addition, Tun et al (2015) state that a common incorrect assumption is that to achieve higher levels of fidelity, more advanced (and therefore more expensive) technology is required. They argue that fidelity should be equivalent regardless technology, as long as the representation required is reflective. More advanced technology does not necessarily imply higher fidelity from the participants' perspective.

The aim of this study was to develop and evaluate a medication administration simulation that underlines the importance of the theory of medication administration checks to support safe medication administration practice. The literature highlights that if it can be demonstrated that a lower-fidelity simulation can provide an effective 'active' learning experience, it can be a cost-effective alternative to high-fidelity simulation. With the emphasis on realism and authenticity being necessary for learning through simulation, lower-fidelity simulations need to be sufficiently realistic and authentic. One method to support the educational effectiveness of lower-fidelity simulations and increase the psychological fidelity is to enhance the salience of the simulation over the long-term.

3.5 Saliency Overview

Saliency is an underexplored but integral component to simulation education first introduced in section 3.2.2. It is infrequently mentioned in the simulation literature but it is fundamental to the composition and success of simulations to achieve its educational objectives. Saliency is a psychological concept related to attention and distinctiveness, and includes both cognition and behaviour. There are numerous operational definitions of saliency which centre on the ability of a target or feature to dominate the attention of the perceiver (Bohil et al 2005 and Ryu et al 2007). Huang and Pashler (2005) are more specific and state saliency is determined by feature difference and level of background distraction. When the difference between the background and the feature increases, saliency also increases. The focus of attention is consistently directed to the location of peak saliency (Parkhurst et al 2002) and the saliency of the feature guides attention even when it is irrelevant to an overall task (Lamy and Zoraris 2009). Saliency also relates to the past and is a key feature in the recall of past events (Hewstone 1989).

3.5.1 Saliency

Saliency is a balance between attending to a target or distracter and includes both neurological and learning components. For example, Reynolds et al (1999) report the response rate of neurons increases when exposed to salient items and captures more neurological resources. Attention is driven by the most salient, surprising and correlated items, and this occurs even if there is an explicit attempt to attend on another item. Saliency also supports higher level cognition, for example, executive processes, reasoning and language comprehension to act upon those attended items (Bowman and Wyble (2007) and can be manipulated to achieve a specific goal (Parkhurst et al 2002 and Sampson 2014). Logan (2004) describes when stimuli compete for attention, it is the most salient item that is most readily perceived. Consequently, the salient item draws attention and guides performance (Malera and Algom 2003). Mounts and Tomaselli (2005) demonstrate that participants identify a target more slowly when flanked by two highly salient items and more quickly when flanked by two non-salient items. This suggests that saliency is not static, but contextual. Therefore, the saliency of an item can be altered by the context in which it is perceived. There are numerous examples of this provided in the literature. One well known example is participants grossly overestimating the number of murders committed compared to

the number of suicides because reports of murder are proportionally more highly salient (Combs and Slovic 1979).

There are numerous manifestations of the concept of salience, which can both be internally and externally driven from the item concerned (Yantis and Egeth 1999). Internal salience relates to the intensity or contrast between the salient item and related background features, for example, loudness, orientation and brightness. External salience can be rooted in some functional attribute that can relate to goal, need or expectation (Bohil et al 2005). Although this is external to the item, it has the capacity to alter the overall level of salience.

3.5.2 Role of Salience in Simulation

Salience is important to simulation learning and the transfer of learning to clinical practice (Kneebone 2005, Young et al 1994, Kneebone et al 2010, Kneebone 2010 and Zimmerman and House 2016). The approach to salience within the literature can be divided into the internal and external derivation of salience (Figure 1). This mirrors Yantis and Egeth's (1999) notion of salience. The internal derivation of salience is explicitly referred to by a subset of the literature and relates to the importance of a simulation to replicate the salient elements of the task that it represents (Kneebone et al 2010). Simulation must mirror the essential aspect of a clinical task or scenario to be learnt. What is selected needs to relate to the key learning points or outcomes of the simulation and can include the application of theory, skills, environment, equipment and communication. Irrespective of the level of fidelity, simulation can only replicate a focused snapshot of clinical practice. Therefore, the key or salient features of the task must be identified and replicated within a simulation. The features need to be intrinsically salient to ensure the simulation is suitably realistic (Lusk-Monage and Quinn-Doherty 2014 and Alinier et al 2004).

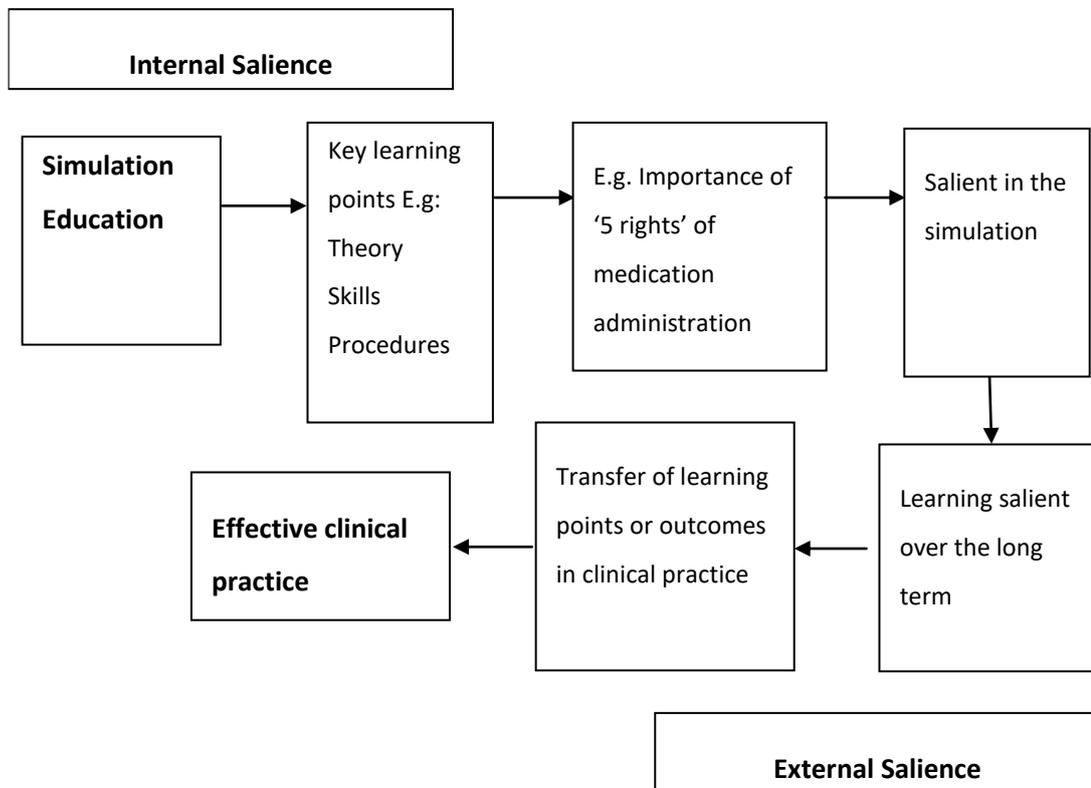


Figure 1. Internal and External Salience of Simulation Education

The external derivation of salience is not explicitly stated in the literature, but nevertheless goes to the very heart and purpose of simulation education; to provide a learning experience that is salient enough to be retained and transferred over the long-term in future clinical practice (Kneebone et al 2004, 2007, and Ziv et al 2005). This is fundamental to the essence of simulation and nurse education as a whole and epitomised in the United Kingdom, whereby 300 clinical practice hours have been substituted with 300 simulation hours as key preparation for clinical practice (NMC 2010). Ziv et al (2005) supports this and states research should focus on the long-term effects of the simulation experience. Both internal and external components of salience need to be integrated within a simulation for it to provide an effective learning experience to be translated into clinical practice over the long-term.

The literature highlights that salience can be manipulated (Parkhurst et al 2002, Mounts and Tomaselli 2005) and recommends using lower-fidelity simulation if it can be demonstrated that it can provide a cost-effective alternative to high-fidelity simulation (Beaubien and Baker 2004,

Kardong-Edgren et al 2007 and Alinier 2004). Therefore, what needs to be understood is the potential mechanism to manipulate both the internal and external salience of a low-fidelity medication administration simulation, particularly in terms of psychological fidelity, to maximise educational outcomes.

The availability and affect heuristics are two established and robust psychological mechanisms extensively reported in the psychological literature. They are intrinsically linked to salience and can be potentially manipulated to maximise the salience of simulation learning. The next section will provide a synopsis of availability and affect heuristics and will discuss in more detail how they relate to simulation education.

3.5.3 Availability and Affect Heuristics

Heuristics are systematic biases, mental shortcuts or rules of thumb which simplify decision-making processes (Peters et al 2006). Two of the most prominent are the availability and affect heuristics. The 'availability' heuristic (Tversky and Kahneman 1974) refers to the perceived likelihood of an event, for example, a medication administration error, through the ease in which the event is recalled. This is dependent on how 'available' the event is to the perceiver. One of the most seminal examples is Tversky and Kahneman (1974). They asked participants to estimate whether more words in the English language began or ended with letter K. Participants were more likely to state that a higher number of words began rather than ended with the letter K, even though the latter is true, because the former is more 'available' and therefore more readily recalled.

Closely related to this is the 'affect heuristic' or 'risks as feelings' (Loewenstein et al 2001) and relies on emotions, or 'affect'. This uses an experiential or association-based system of thinking, whereby individuals refer to images, metaphors and narratives in which to estimate the likelihood of an event (Slovic and Weber 2002). This processing often dominates over more logical rule-based processing and helps to determine the response to the risk of a particular event occurring (Slovic et al 2004). Perceptions of risk are influenced by association and affect-driven processing as much as, or even more so, than by rule and reason-based processes (Loewenstein et al 2001).

In circumstances where the output from the two processing systems conflict, the affective, association-based system usually prevails. Strong emotional responses increase the perceived risk of an event (Finucane et al 2000) and the availability heuristic is actively linked with affect (Slovic and Weber 2002). In addition, Keller et al (2006) states that although people are generally able to accurately retrieve information of past events, when they are unable to, they use the availability and affect heuristics as a mechanism in which to make a judgement.

Increased saliency can positively impact upon learning and subsequent performance (Yantis and Egeth 1999) and the literature on availability and affect highlight that manipulating this, and therefore levels of salience, can guide future behaviour. For example, Da Silva Rosa and Durard (2007) examined how the salience or availability of an organisation increased the likelihood of investors adding it to their portfolio. Salience was defined by the number of published articles about the organisation. Salience of the organisation was the principle influence on economists to include it into their portfolio. The salience of the company, through the high number of articles written about them made them more available in the minds of the economists which influenced and ultimately guided the inclusion of the company onto the portfolio.

The experience of a negative event and associated affect is a strong prediction of risk perception over and above logical argument and can guide future behaviour (Goetzmann et al 2015, Weinstein 1989 and Dixon 2015). Siegrist and Gutscher (2005) for example, researched this in terms of flood risk. Experience of a negative event, such as flood, significantly increased the perception of risk ($t = 3.92$ $p < 0.001$). Experience of a negative event translated in a statistically significant change of behaviour to mitigate any repeat of the event. 41 (52.6%) of respondents affected by flood and 16 (31.4%) of respondents unaffected by flood stated that fear of future flood damage was very important in their decision to implement precautionary measures, such as taking out insurance ($\chi^2 (2) = 10.92$ $p = 0.004$).

This is supported by Jackson (1981) who reported that exposure to earthquake increases the perceived risk that it will happen again. Individuals are in turn more likely to take out insurance to protect against the impact of future earthquakes. Zaleskiewicz et al (2002) highlighted that there is a direct relationship between perceived risk of flood and the decision to purchase insurance, to mitigate the consequences of future flood. The authors report that the negative emotional experience of a flood is a highly motivating factor. This is supported Siegrist and Gutscher (2008)

who identified that individuals who had not experienced a negative event, in this example, flooding, strongly underestimated the consequences of a flood. Gregory et al (1982) highlight that imagining an event, not just the experience of an event can increase levels of salience. Imagining an event, for example, committing a crime, winning a prize, or contracting a disease increased the individual's belief that the event was more likely to occur. Fischhoff et al (2005) focused on the terrorist events of September 11th 2001, which is a highly salient, memorable and emotive event, even for people not directly involved. Participants were able to recall these events more clearly both emotionally and intellectually. The authors were able to manipulate predictions of a similar event reoccurring in the future. Kousky and Shabman (2015) highlight that the perceived risk of a negative event can be manipulated using the availability and affect heuristics to encourage the adoption of risk reduction and management measures, for example, the purchase of flood insurance increases right after a flood event (Gallagher 2014).

Specifically with respect to the affect heuristic, the emotional evaluation of risk can lead to different behaviour compared to purely cognitive evaluation (Campo et al 2016 and Loewenstein et al 2001). For example, increased fear, through the affect heuristic, increases the saliency of an event and encourages behavioural change to minimise the likelihood or impact of a similar event in the future (Keller et al. 2006 and Villegas et al 2013). Fear has been shown to amplify perceptions of risk, whereas anger lowers risk perceptions (Slovic and Peters 2006). Sometimes emotions can completely dominate an individual's risk analysis. When considering risk reduction and management actions, particularly with respect to emotionally charged risks, individuals sometimes neglect the statistical probability of the event and focus entirely on the consequences (Sunstein 2002). Therefore, increased salience, through availability and affect can lead to behavioural change over the long-term. This demonstrates that saliency, availability and affect work in-conjunction, can promote the recall of past events, for example simulation, and have the potential to guide future behaviour.

3.5.4 The Role of Availability and Affect to Enhance Simulation Saliency

Saliency through availability and affect has the potential to enhance simulation learning to support the application of the rights or checks of medication administration in clinical practice.

Incorporating a negative event into a simulation if theory is not applied can underline and make salient the importance of theory, underline the risks involved if theory is not applied and support the transfer of theory to clinical practice. Skill acquisition usually focuses on the cognitive component to learning (Berregan 2011) and the emotional component is very often overlooked. Ziv et al (2005) views affect as delivering an emotional load which can instil an appropriate professional attitude to practice within simulations. It must be recognised that affect is a real-life component of clinical practice, for example, students must be prepared to deal with terminal patients (Mileder 2015) which can have a strong emotional impact on nurses, irrespective of their level of expertise. Affect laden learning experiences can exert a huge influence on the behaviour of individuals. Kneebone (2005) argues that the emotional component should be actively exploited to enhance learning outcomes and that incorporating affect into simulation education is a 'key challenge for future development'. In addition, it can support nurses' internal locus of control with regards to checking procedures.

The increase in simulation education can leave students socialised by fake scenarios to become real practitioners without the additional aspect of affect which is integral to clinical practice. Underman (2015) argues that simulation is one method to practice dealing with affect before clinical practice. Therefore, affect can provide an additional dimension to learning. However, the affect generated must be realistic to help transfer skills learned in simulation to clinical practice (Parr and Sweeny 2006). The previous section highlights that a negative experience is highly salient in terms of both availability and affect, and can motivate behavioural change. This is of particular relevance to teaching safe medication administration practice because of the negative emotional reactions to error. Making a medication administration error is an emotive and negative experience for nurses (Gladstone 1995 and Santos et al 2007). Making a medication administration error is a negative event that can increase the saliency of simulation learning through the heuristics of availability and affect. It can potentially underline the importance of the protocolised checking procedures to safe medication practice and guide future behaviour. Making an error is one potential method to make a lower-fidelity simulation realistic and salient over the long-term.

The literature demonstrates that affect can be generated in a simulation environment (Deegan and Terry 2013, Childs and Sepples 2006 and Gaba 2004). For example, DeMaria et al (2016) studied the impact of simulated patient death on students. Twenty-six participants received an

American Heart Association provider course and participated in high-fidelity simulation. Participants were randomised to simulated death or survival. Students in the simulated death group experienced a stress response in which heart rates increased significantly between baseline and the end of the simulation ($p < 0.0001$).

Another example is Ignacio (2015) who examined whether the use of high-fidelity patient or standardised patient simulators in a deteriorating patient scenario affects stress levels and performance. Fifty-seven student nurses who had no previous experience of deteriorating patients participated in a randomized controlled design study with pre and post-tests to evaluate stress and performance. Stress was measured by biological markers and self-assessment. Both groups experienced identical scenarios and scripts. Performance was assessed using the 'Rescuing A Patient in Deteriorating Situations' rating tool. Two trained teaching staff assessed students pre and post simulation experience. Students were blinded to assessors and group allocation. Biological stress levels were measured using salivary alpha-amylase levels which is biomarker for sympathetic nervous system activity. Fourteen participants also participated in focus group after a nine-week clinical placement to elicit their insights into the impact of the simulation experience on subsequent clinical practice. There was no significant difference ($p = 0.744$) between the performance of both groups and amylase levels were also not significantly different ($p = 0.317$) between the two groups. However, the levels were not captured at peak and therefore needs further examination. There was no significant difference in the post-test performance between groups, but there was a significant difference within groups between the pre-test and post-test performance scores ($p < 0.001$). In contrast, stress in the simulation, awareness of patient interactions, and realism were the main themes that resulted from the thematic analysis and that the level of stress helped prepare them for clinical practice.

Despite this, incorporating affect into education programmes is not unanimously supported by the literature. For example, Fraser et al (2012) trained 84 first-year medical students to identify cardiac murmurs using a chest pain scenario. At the end of the training, students were asked to rate their emotional state and cognitive load. Increased 'invigoration and reduced tranquillity' during their simulation training was associated with increased cognitive load, which in turn reduced the likelihood that students would correctly identify a cardiac murmur. The authors

acknowledge that the relationship between emotions and learning is complex and not fully understood. Indeed, Kneebone (2005a) states that affect can exert both a positive and negative effect on learning. However, emotional engagement resulting from simulation can provide the experience of stress encountered in clinical practice for student nurses with limited exposure to real patients and can increase the connection with students, the simulation and the educational goals (O'Regan et al 2016). Ziv et al (2005) argues the 'emotional load' should be balanced and channelled suitably to advance educational outcomes. Therefore, if affect is to be incorporated into a simulation, it should be done constructively and with sensitivity. If affect is to be incorporated into simulation education, it must facilitate and not hinder learning goals. One method to incorporate affect into simulation to provide an available and salient learning experience is through the use of error, which is an established and well researched component of simulation education.

3.6 The Role of Error in Simulation Education

The ability to make and learn from error is a central benefit of simulation education (Ziv et al 2005 Butler et al 2009 and Kneebone et al 2005a). The importance of learning from error is extensively documented in the simulation literature (for example, Butler et al 2009, Kneebone et al 2004, Ziv et al 2003 and Wilfred and Doyle 2006), predominantly because students can make and learn from error in simulation in a manner unethical in clinical practice (Gobbi et al 2012). Error is often viewed as a passive, but useful by-product of the simulation experience. However, some authors, for example, Ziv et al (2003 and 2005) and Kneebone (2007) argue that error should be actively incorporated into simulation education.

Making an error has the potential to provide a powerful educational experience which can enhance professional competency, foster a correct attitude and enhance patient safety (Ziv et al 2005, Maneru Zunzarren 2012 and Kelly et al 2016). Students are socialised by unintended learning which forms attitudes, beliefs and behaviours in both university and clinical practice (De Swardt et al 2012). Learning theorists highlight error can activate the learning process (Lipshitz et al 2002, Nonaka and Takeuchi 1995, Homsma et al 2009). Argris and Schön (1996) go further and state error is implicit in the learning process and learning is the "the detection and correction of error". It is a cyclical process in which past behaviour and the discovery of error provides the opportunity to change and generate new and more effective behaviours to minimise future error

and facilitate clinical skill acquisition (Jeanguiot 2000 and Nehring et al 2001). Learning through error provides additional feedback which can enhance learning and support the transfer of learning to clinical practice. Feedback on error also provides the opportunity for students to see the consequences of their mistakes and learn corrective strategies (Lorenzet et al 2005). Error is a 'hidden' part of the curriculum which should be actively capitalised upon (Kroll 2008).

The importance of error as an active learning experience is highlighted by Piaget who stated that error is the key to self-correction. Error becomes an interesting learning tool when it is the student his/herself who discovers the mistake. "An error (corrected by the subject) may be more fruitful than immediate success, because the understanding of a false hypothesis and its consequences provides new knowledge and comparison between two mistakes gives new ideas" Piaget (1978) (in Maneru Zunzarren (2012) p3212). The active experience of error can be incorporated into both experiential and constructionist learning theory (section 3.2.2). Within Kolb's (1984) iterative cycle of experiential learning, the student experiences the error, reflects upon the error, identifies the significance of the error, alterations to behaviour to improve outcomes to prevent further error and implements alterations to prevent future error in future clinical practice. Within constructionist learning (Bruner 1986), making an error has the potential to expose the student to a new experience, foster disquiet and conflict with pre-existing knowledge and challenge them to reflect upon how the error occurred, build upon previous knowledge and construct new knowledge and skills. This also incorporates locus of control theory in which the student identifies their role in making an error and the importance of their own efforts in minimising error to support effective clinical practice.

Indeed, Kneebone et al (2007) proposed a simulation-error learning framework whereby making an error and reflection of that error leads to improved learning outcomes and clinical practice. The framework involves four stages: the identification and acknowledgement of mistakes performed by individuals or teams, analysis of errors in an attempt to discover the root causes and course of events that led to their occurrence (at individual, team and system-levels), determination of changes and corrections to be implemented and internalisation, and implementation of the lessons learned.

Incorporating error into the simulation mirrors a subset of the literature which highlights the importance of ethical engagement of simulation education. For example, Gobbi et al (2012) discuss factors that influence the student experience of simulation including sensorimotor, complexity, cognitive, ethical engagement, immersion and realism components. Engagement relates to how connected the student is to the simulation and the learning experience (O'Regan et al 2016) and ethical engagement relates to a more profound understanding of the ethical and moral dimensions of clinical practice (Lewis et al 2016) and can be an important source of motivation for students (Gobbi et al 2012).

The importance of ethical engagement is highlighted by Lewis et al (2016) who completed a qualitative study to understand the experiences and emotional challenges of managing ethical dilemmas within a simulation-based learning environment. Eight senior medical students completed an interprofessional ward-based simulation-based learning activity which incorporated a series of ethically challenging scenarios. Students wore digital video glasses to capture their point of view. Qualitative interviews were completed immediately after the simulation experience and video footage was played back to them. Students recognised explicit ethical dilemmas, but were more uncertain how to manage scenarios when the moral complexity of the situation was more opaque. For example, in one morally complex scenario, a student engaged in telling an untruth and some participants felt unable to raise concerns or challenge unethical behaviour, which is a corner stone of the healthcare professional's role. Although the simulation was demanding, and students felt pushed they stated the simulation was beneficial and that they would like to experience the simulation again. The study provided a profound and realistic insight into ethical reasoning and professional boundaries which can inform clinical practice. The authors concluded that realistic simulation environments can help students develop strategies to manage ethical scenarios, corresponding consequences and appropriate responses. This form of training can strengthen and build on the foundations of ethical and professional resilience. It demonstrates learning from error is a potential mechanism to foster ethical engagement and provide a more profound educational experience underlining the importance of protocolised checking procedures in clinical practice.

The literature also highlights that implementation of risk management strategies in hospitals can reduce and prevent nursing errors. Salehi et al (2016) highlight that there is a reduction in error in nursing records and awareness about risk management ($r = -0.144$, $p = 0.48$) and nurses'

awareness of methods to reduce error ($r = -0.22$, $p = 0.01$). In other words, by raising awareness about error and risk management, errors in nursing records were reduced. Familiarity with risk management and patient safety practices reduces error in nursing records. Nursing personnel should be aware of risk management and the necessary actions should be taken to raise their awareness. It is therefore imperative that all nurses be trained in the area of error and risk management.

Some studies highlight that learning through error can negatively affect 'self-efficacy' and impact upon performance, for example, Bandura and Locke (2003) and Gist and Mitchell (1992). This is in line with Fraser et al's (2012) concern that a negative experience can have a negative impact on learning. However, studies highlight that learning through error, in which students are actively instructed to make and learn through error followed by corrective feedback is beneficial to learning (Metcalfe 2016). For example, Lorenzet et al (2005) completed a randomised control trial which taught Microsoft power-point skills to 90 undergraduate psychology students from a United States university. Participants were randomly assigned to receive either guided-error teaching or error-free teaching. In the guided-error teaching session, to make and learn from error was actively promoted. Participants were asked to recreate a number of slides and were marked on speed and accuracy. Using regression analysis, participants in the error-guided teaching session were significantly quicker and more accurate ($b = 146.67$ $p = < 0.01$ and $b = 0.35$, $p = < 0.01$ respectively) compared to participants in the error-free training session. There were no statistical differences between the guided-error and error-free group with regards self-efficacy immediately post training when age and experience levels were factored in. Lorenzet et al explain that students who experience an error-guided strategy are likely to attribute error to systemic as well as individual causes and therefore are less likely to experience a reduction in 'self-efficacy'. In addition, they assert that 'error-free' training may encourage students to overestimate their skill level or ease of a given task. This highlights that a considered guided-error teaching strategy can enhance learning and allay Fraser et al (2012)'s concerns that emotional load can diminish learning outcomes. It also supports Lewis et al (2016) which demonstrates that students see the benefits of simulation education even when they are pushed and that emotional load can be balanced and channelled suitably to advance educational outcomes (Ziv et al 2005).

Studies also demonstrate that the active experience of error can enhance retention of learning. Gardner et al (2015) completed a study to determine how an error-focused training program affected performance, retention, and transfer of central venous catheter placement skills compared with traditional training. 30 surgical interns were randomised to receive a 'correct only' or 'correct and error' instructional video and placement practice with guided instruction. Baseline knowledge and skill assessment was completed. Placement skills were video recorded and deidentified for evaluation and assessed pre-test, post-test, and 30 days later by a single blinded instructor using a validated 17-item checklist. Both the groups exhibited significant improvements ($p < 0.001$) in knowledge and skills after the training program. There was a significant decline in performance in the correct only group between the post-test and 30-day performance ($p < 0.05$), whereas there was no significant decrease during this period for the correct and error group. This indicates that incorporating error-based activities and discussions into training programs can be beneficial for skill retention and transfer.

The active experience of making an error in a simulation could therefore help to bridge the theory practice gap by making salient the importance of the medication administration rights and checking procedures to clinical practice and the risk of making a medication administration error if they are not applied. Error can also integrate Yantis and Egeth's explanation of internal and external salience. The internal component of the simulation is to make salient the importance of theory for safe clinical practice. The external component relates to the salience of the learning experience over the long-term. The experience of error (if theory is not applied) may provide a salient learning experience in terms of both availability and affect to support clinical practice over the long-term. A model of how these elements potentially could interact is detailed in the Salience and Error Model of Simulation Learning in Figure 2.

Medication administration error = negative event

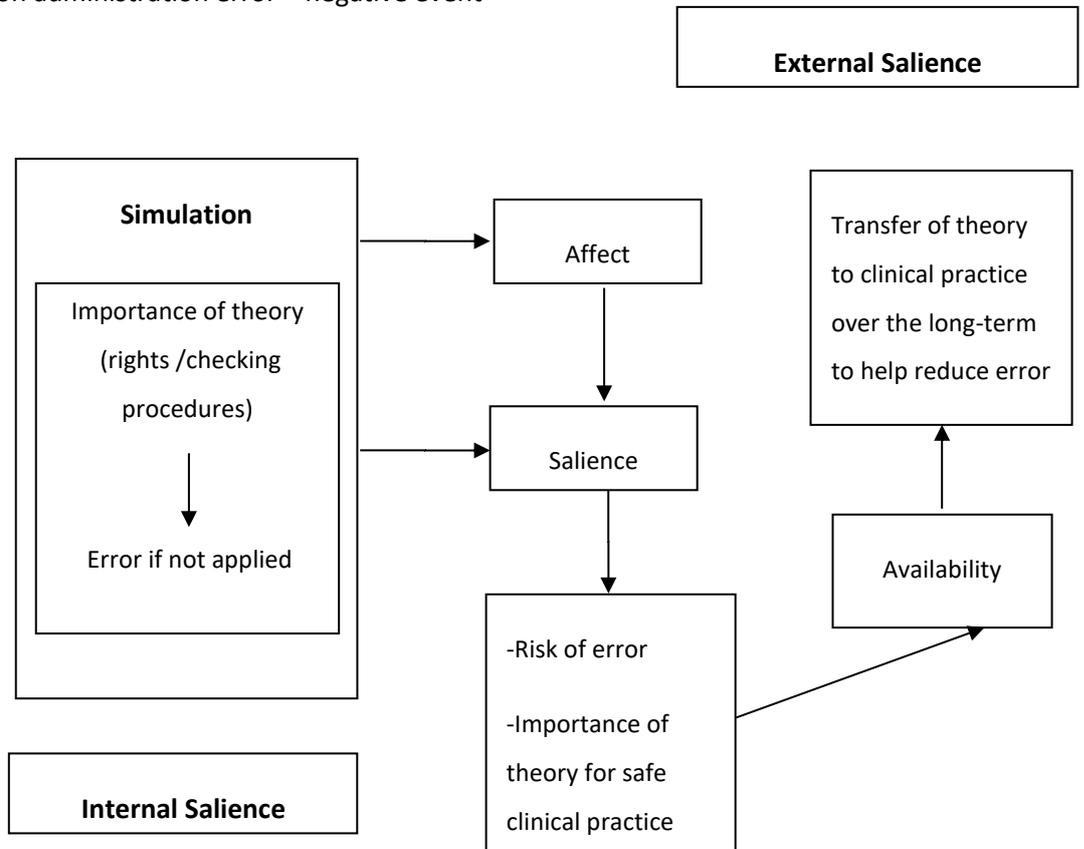


Figure 2. Saliency and Error Model of Simulation Learning

Within the model, the key cognitive and theoretical elements of medication administration, which includes checking procedures, are integrated into the simulation so that it is internally salient. Making a medication administration error forms the negative event which occurs if the checking procedures or rights are not adhered to. The experience of errors is an active experience which generates affect and makes salient the importance of the checking procedures for safe medication administration, and the risk of error if they are not applied. This in turns makes the importance of theory for safe clinical practice externally salient and ‘available’ over the long-term and supports the transfer of learning to clinical practice.

In addition, error provides the opportunity to increase the psychological fidelity of the medication administration simulation, or from the perspective of the student, make it more realistic. Section

3.2.2 discusses the fundamental role of psychological fidelity in effective simulation. Developing a simulation which uses real life contexts and causes of error can make a low-fidelity simulation more realistic and incorporate the importance of theory within an authentic context. This is supported by the literature on medication administration error which highlight nurses consider error as an everyday part of clinical practice (for example Mayo and Duncan 2004). It also can also introduce the variability and complexity of clinical practice into the simulation to help students understand the complexities of clinical practice in which theory is to be applied (Rafferty et al 1996). In addition, Tun et al (2015) argue that high-fidelity simulation is based on real-world cues and stimuli and fidelity should be based on the perceived realism of the learning and not based on the technology used. Cheng et al (2015) recommend future research should optimise fidelity to enhance both short and long-term goals and clinical outcomes. Therefore, introducing the experience of medication administration error using real life causes of error in a simulation may provide a more realistic experience for students, irrespective of fidelity.

3.7 The Design of the Medication Administration Simulation

The design of the medication administration simulation has to be appropriate for the target student group, educational aims (Jones 2015, McGovern et al 2016 and Kim et al 2016) and fidelity should be guided by overall learning objectives and pedagogy (Tosterud et al 2013). Henneman and Cunningham (2005) recommend using simulation early with novice nursing students, matching simulation content with theory and course content. Medication administration is an integral nursing task, taught in the United Kingdom at the beginning of the pre-registration nursing curriculum. Therefore, a medication administration simulation is most suitable for first year pre-registration nursing students because it is part of their taught curriculum. This is supported by Alfes (2011) who states simulation aimed at novice nursing students should focus upon one simple patient issue and gauged at the student's current level of function. Medication administration is a single task and therefore lends itself to, in technological terms, a low-fidelity design (Yaeger et al 2004). Gaba (2004) expands this and states that low-fidelity simulations are particularly fit for purpose when tailored for novice learners and specific skill acquisition (Andersen et al 2016). Maran and Galvin (2003) agrees and advise using less complex simulations for novice learners learning basic skills. Baghoomian (2014) expands upon this and states students should commence using low-fidelity simulation and move to high-fidelity simulators throughout the program to reduce their anxiety using high-fidelity simulators. Munshi et al (2015) also states

that the level of fidelity should be appropriate to the type of task and training stage. A novice can achieve similar or higher skills transfer with a simple simulator, for example, a clinical vignette, than with a complex training aid such as a simulated environment.

The cost-benefit balance also suggests it is valuable to initially ascertain if a low-fidelity simulation can provide a realistic and effective learning experience (Beaubien and Baker 2004). Kneebone et al (2010) believes simulation only needs to be sufficiently realistic and that authenticity and perceived realism can be heightened through innovative uses of technology and design. Therefore, the medication administration simulation could be low-fidelity if error can be appropriately employed to instil psychological fidelity, authenticity and realism.

There are a number of low-fidelity simulation methods that can be used. Cant and Cooper (2014) completed a literature review on the utilisation and place of web-based simulation within nursing education between 2000 and 2014. They reviewed 18 simulation programmes and identified a varied use of multi-media in web-based simulation, including, game-based programmes, video, audio and graphics to teach multiple skills, for example procedural patient care, interpersonal communication and equipment use. They conclude that web-based simulation is highly acceptable to students, provides learning benefits that align with other simulation approaches, and is an effective supplement to traditional teaching formats. They predict web-based simulation is likely to have a major role in the nursing curriculum over the next decade, however, they acknowledge further research is required to determine learning outcomes. In addition, Wheeler et al (2008) used online teaching and simulated clinical scenarios to teach final year clinical students medication administration. Poor simulation performance correlated with poor examination performance. This supports the argument that effective simulations can serve as an effective proxy for actual performance. In addition, students found the simulation engaging. Web-based simulation also enables multiple students to use the simulation simultaneously. This suggests that web-based simulation is a potentially suitable low-fidelity method which would benefit from further research. Web-based simulation allows multiple students to complete the simulation simultaneously, supporting its integration into the curriculum.

The deliberate use of error provides the opportunity to design an effective simulation that is realistic and salient over the long-term. Therefore, this study will develop a low-fidelity online medication administration simulation that generates error to provide a salient learning experience for first-year nursing students over the long-term. What needs to be determined are the methods used to evaluate the effectiveness of the simulation to help support nurses to apply checking procedures in clinical practice.

3.8 Methods to Evaluate the Transfer of Simulation Education to Clinical Practice

Nursing is a practice-based profession and nurse education is different to many other university courses where the main focus is to obtain a qualification for its intrinsic benefit. Whilst nurse education also values qualifications for their intrinsic benefit, at its foundation, nursing is a profession based qualification which certifies that student nurses have become safe and competent practitioners. Therefore, the aim for all simulation education is to support the transfer of simulation learning into clinical practice and its impact on actual patient care over the long-term.

The gold standard to evaluate the impact of simulation education on clinical practice is to assess patient outcomes (Fritz et al 2008). Only a small minority of studies link the effectiveness of simulation education to actual patient outcomes and many of these are small scale. One example is Wayne et al (2008) who completed a randomised control study that compared the impact of simulated life-support training with traditional training on patient care. 78 cardiologists were randomised to complete either simulation or usual training. The simulation group displayed significantly higher adherence to resuscitation standards at 68% compared to 44% achieved in usual training group ($t = 3.7$, $p = <0.001$), although there was no significant difference in post-event survival rates. The authors acknowledge however, that the patient group had a very low predicted baseline survival rate.

Evaluating the effectiveness of simulation education using patient outcomes requires large scale follow-up of patient cohorts (Fritz et al 2008). The logistics of tracing the long-term impact of simulation learning in clinical practice is highly problematic (McGarry et al 2014). Less resource intensive methods are therefore needed. A second method is to evaluate whether simulation

learning outcomes are transferred to clinical practice. This is only tentatively supported by the literature and robust empirical evidence supporting such transfer is again sparse (Bland et al 2011 and Stayt 2011). Cant and Cooper (2010) completed a systematic review of quantitative studies of simulation-based nurse education over a 10-year period. They concluded that measuring the impact of simulation-based learning on clinical practice is hampered by limited opportunities for longitudinal studies.

Norman (2012) completed a systematic review examining simulation outcomes in nurse education between 2000 and 2010. 18 studies were included in the review and categorised into three themes; internal outcomes, external outcomes, and clinical evaluation. They conclude that although simulation helps to create a learning environment which contributes to knowledge, skills, safety, and confidence, there is a gap in the literature as to whether these outcomes are transferred to clinical practice. Some studies evaluate the effectiveness of high-fidelity simulation training using the same simulation that was initially used to teach participants. The authors state that using the same simulation to both teach and assess learning outcomes is a potential source of bias. It also limits the applicability of research findings to the simulation and not to clinical practice, which is the ultimate goal. Indeed, Kneebone et al (2007) warns there is a potential danger that participants become experts in using simulations rather than experts in the clinical context.

Many individual and small-scale studies explicitly state that they are unable to measure the transfer of learning to clinical practice, and view this as a limitation, for example, McCaughey and Traynor (2010), Yuan et al (2012), Schoening et al (2006), Grady et al (2008) and Reilly and Spratt (2007). Prion (2008) suggests that direct information about learning is difficult to obtain because it requires a demonstrated or observed change to the participant's clinical practice. Clinical simulation is used with increasing frequency in pre-license nursing education. Nurse educators intuitively sense that the simulation experience is a powerful student learning strategy, yet much of the literature is limited to student self-report data about affective variables such as self-confidence and satisfaction.

Another concern is lack of long-term follow-up. Whilst the majority of studies evaluate the effectiveness of simulation education immediately post simulation, only a minority do so over the medium and long-term. Bruce et al (2009) compared knowledge scores and confidence levels of nurses in the management of cardiac arrest. Participant performance was evaluated pre and post simulation, and between one month to eight weeks later. Although there was a significant difference between pre and post simulation test scores ($t = -2.62$ $p = 0.010$), there was no significant difference between pre simulation and long-term follow-up scores ($t = 1.24$, $p = 0.218$). Similarly, Kinney and Henderson (2008) compared pre and post-test scores of CD-ROM tuition versus a traditional lecture on medication administration education. The post-test scores were completed immediately after the education intervention and repeated 4 months later. There was a significant improvement in both methods of education immediately post the simulation ($p = 0.00$), however, there was no significant difference between the pre-test and the long-term follow-up scores ($p = 0.399$). Levett-Jones et al (2011) compared the effectiveness of medium versus high-fidelity human patient simulation on nursing student's knowledge acquisition. Knowledge was tested before simulation training, immediately after and two weeks later. There was an improvement in scores across the time period, although the improvement was not significant ($F(2, 66) = 3.29$, $p = > 0.05$).

The studies highlight that there is a difference in the immediate and long-term impact of simulation education. It is therefore important that simulation is evaluated over the long-term and not just in the immediate term. In addition, simulation teaches skills, knowledge and competencies to be used in clinical practice and therefore some form of long-term evaluation is required. However, to evaluate using patient outcomes as recommended by Fritz et al (2008) is not financially, pragmatically or logistically feasible for many nurse education institutions. Although it is difficult for nurse educators to evaluate the effectiveness of simulation using patient outcomes, this does not undermine the importance of simulation to nurse education as may first appear. The lack of evidence to support the transfer of learning to clinical practice is an important issue for all industries that utilise simulation training. As Gaba (1992) states, 'no industry in which human lives depend on the skilled performance of responsible operators has waited for unequivocal proof of the benefits of simulation before embracing it' p 492. The need for and benefit of simulation education is embraced by both lecturers and nursing students (Lasater 2007, Akhtar-Danesh et al 2009 and Baghoomian 2014).

Although using patient outcomes to evaluate the effectiveness of simulation is not viable for the majority of studies, the long-term follow-up of nurses evaluating the impact and salience of simulation education on their own clinical practice is both feasible and worthwhile. For example, Healey et al (2010) assessed the resuscitation knowledge and skills of doctors one month before and one-month after completing a two-day low-fidelity case study based curriculum. 28% of participants felt prepared to lead a resuscitation situation before the course. 45% of participants reported using the knowledge and skills learned on the course in a resuscitation episode after the course. Participants felt they were able to transfer the learning from the simulation into clinical practice. In a study by McCaughey and Traynor (2010), 93 third-year nursing students completed a medium to high-fidelity simulation and completed a questionnaire up to eight months later. 77% of students judged over the previous eight-month period, which included clinical placement, that their simulation experience enhanced their ability to provide holistic care to patients.

These studies do not evaluate the impact of simulation education on actual patient care in clinical practice. They do however demonstrate that it is possible to evaluate the retention of simulation learning outcomes such as skills, knowledge and attitudes over the long-term. If simulation learning outcomes are salient and available over the long-term, they are then more likely to be applied in clinical practice. This could be a cost-effective and efficient method to evaluate simulation education.

3.9 Summary

Simulation is an artificial representation of clinical practice. It comprises various methods to enable a student to 'suspend belief' and substitute simulation for clinical practice to learn predefined skills and reinforce links between theory and practice. It is classed as a more 'active' learning method which integrates adult learning theories including experiential learning, constructivism, vicarious learning and aspects, for example, locus of control.

The literature highlights that fidelity, authenticity, realism and salience are integral components to simulation education. Fidelity denotes the extent to which a simulation accurately replicates what it attempts to represent. It comprises various levels from more technological advanced high-

fidelity simulation to more basic low-fidelity simulation. Fidelity is divided into environmental, engineering and psychological fidelity. Psychological fidelity refers to the extent to which the skills of the task are captured in the simulation or more simply, how realistic the student finds the simulation. Psychological fidelity is the most important component, and environmental and engineering fidelity are ineffective if not paired with psychological fidelity. Realism is closely associated to psychological fidelity and refers to how realistic the student perceives the simulation to be. The literature suggests that, lower-fidelity simulations can be made more realistic if psychological fidelity is enhanced. Authenticity refers to the extent to which simulation accurately replicates the context of clinical practice. This is an essential component to the suitability of a simulation as an effecting learning experience. If a simulation is not authentic and does not relate to the context of clinical practice, the simulation will not be connected to clinical practice.

Nursing education currently emphasises the use of high-fidelity, high cost simulation stating that they provide a more effective learning experience. However, a number of systematic reviews highlight the literature is equivocal about the effectiveness of high-fidelity simulation over more low-fidelity simulation. Studies focusing on low-fidelity simulations suggest that they too can provide an effective learning experience. The literature on simulation cost-benefit analysis suggests high cost, resource intensive high-fidelity simulations do not always result in comparatively enhanced learning outcomes. Low and medium-fidelity simulations can also provide effective learning outcomes with reduced cost and resources. This is because simulation need to be sufficiently 'good enough' and suitably designed lower-fidelity simulations are capable of providing an effective learning experience. One method to support the educational effectiveness of low-fidelity simulation is to improve its level of salience.

The salience of simulation education includes both internal and external salience. Internal salience refers to the need for the simulation to replicate the most salient and important aspects of the task represented. External salience relates to the simulation learning outcomes to be salient over the long-term so they can be integrated into clinical practice. One method to instil salience is to manipulate the psychological heuristics of availability and affect through the experience of error. Within most simulations, the experience of error is viewed as a useful by-product of the simulation learning experience. However, a subset of the literature suggests error should be actively incorporated and utilised in the simulation learning scenario.

Error and mistakes can be proactively utilised as an active learning tool within adult learning theory to improve or prepare for clinical practice. Simulation learning enables students to 'deliberately' experience and learn from failure, a strategy unethical in clinical practice. Error can be proactively used in simulation to improve or prepare for clinical practice. Error can make the simulation internally salient by underlining the importance of protocolised checking procedures for safe medication administration practice. The experience of error can also provide an affective learning experience that is salient and available over the long-term to support the transfer of learning into clinical practice. Medication administration error is common within clinical practice and incorporating error generated by real causes of error can provide a realistic and authentic learning experience.

The literature highlights that the selection of simulation fidelity needs to take into account the content and learning outcomes of simulation, the characteristics of the student population and the costs and resources available to develop and implement the simulation into the nursing curriculum. A medication administration simulation should be targeted at first-year nursing students as they learn the theory of the five rights of safe medication administration practice as part of their curriculum. Low-fidelity simulation is particularly suitable for novice learners and for teaching one task. It therefore is suitable to teach first-year nursing students medication administration. Online simulation is low-fidelity and enables multiple students to use the simulation simultaneously.

The effectiveness of simulation education and the transfer of theory into practice should be evaluated over the long-term. The literature discusses how it is logistically and financially very difficult to evaluate the long-term impact of simulation education on patient outcomes. However, identifying the salience of simulation and perceived impact of simulation on clinical practice over the long-term is a feasible alternative method.

Chapter 4: Study Design

4.1 Introduction

Section 4.2 details the aims and objectives of the study. Section 4.3 provides an overview of the four phases of this study: the simulation development phase, the titration phase, the comparative study and the long-term qualitative interview study. Section 4.4 provides an outline of phase one, the simulation development phase, which describes how the simulation was developed and the medication administration error generated. Section 4.5 provides an outline of phase two, the titration phase, in which high and low medication administration error generating conditions for the comparative study were identified. Section 4.6 provides an outline of phase three, the comparative study, in which the medication administration simulation had the high and low error generating conditions programmed in and completed by first year nursing students in the education setting for the first time. Section 4.7 provides an overview of phase four, the long-term qualitative interview study, in which comparative phase participants who completed the simulation were interviewed to determine the impact of the simulation over the long-term. Section 4.8 details the project time scales, 4.9 provides an overview of the participants. Section 4.10 provides details of the ethical considerations for the study and section 4.11 provides an overview of the strategy for data analysis.

4.2 Aims and Objectives

The aim of this study was to develop a low-fidelity online medication administration simulation (in terms of engineering and environmental fidelity), that generates error as a salient learning experience for first-year nursing students over the long-term. Firstly, using the principles of experiential and constructionist learning theory (Kolb 1984 and Bruner 1986), the active experience of error would generate affect and makes salient and available the importance of applying checking procedures in medication administration in clinical practice over the long-term. This would support students to have an internal locus of control and identify the importance of their role to promote safe medication administration practice. Secondly, error would transform the low-fidelity medication administration simulation into a realistic, authentic and effective learning experience. The specific objectives of the project were to:

1. Design a low-fidelity online medication administration simulation which captures all salient cognitive elements of the medication administration task and generates an authentic medication administration error if checking procedures were not applied. The checking procedures selected for the simulation was the 'five rights': the right patient, the right drug, the right dose, the right time and the right route (see section 5.2 for rationale).
2. Determine the educational impact of the simulation in terms of:
 - a. perceived relevance of simulation education to clinical practice,
 - b. perceived salience of the simulation in terms of affect and availability,
 - c. perceived importance of the five rights to clinical practice,
 - d. perceived educational impact of the simulation on clinical practice,
 - e. intended future use of the five rights to mitigate future error,
 - f. impact of making an error in the simulation over the long-term,
 - g. perceived level of realism achieved in the simulation.

The online simulation was designed to replicate the paper medication administration charts used in the host university, King's College London (KCL), University of London, and in clinical practice in associate hospitals between 2007 and 2010 when the four phases of the study were implemented. The five rights were selected as the key checking procedures (Jones and Treiber 2010) because they were the procedures taught as part of the syllabus at KCL and in clinical practice throughout the duration of the study (King's College Hospital 2012). In addition, they were pragmatic to integrate into the simulation design.

4.3 Phases of the Study

The study consisted of four phases:

- the simulation development phase
- the titration phase
- the comparative study
- the long-term qualitative interview study.

All four phases were completed at KCL. An overview of the study phases is displayed in Figure 3.

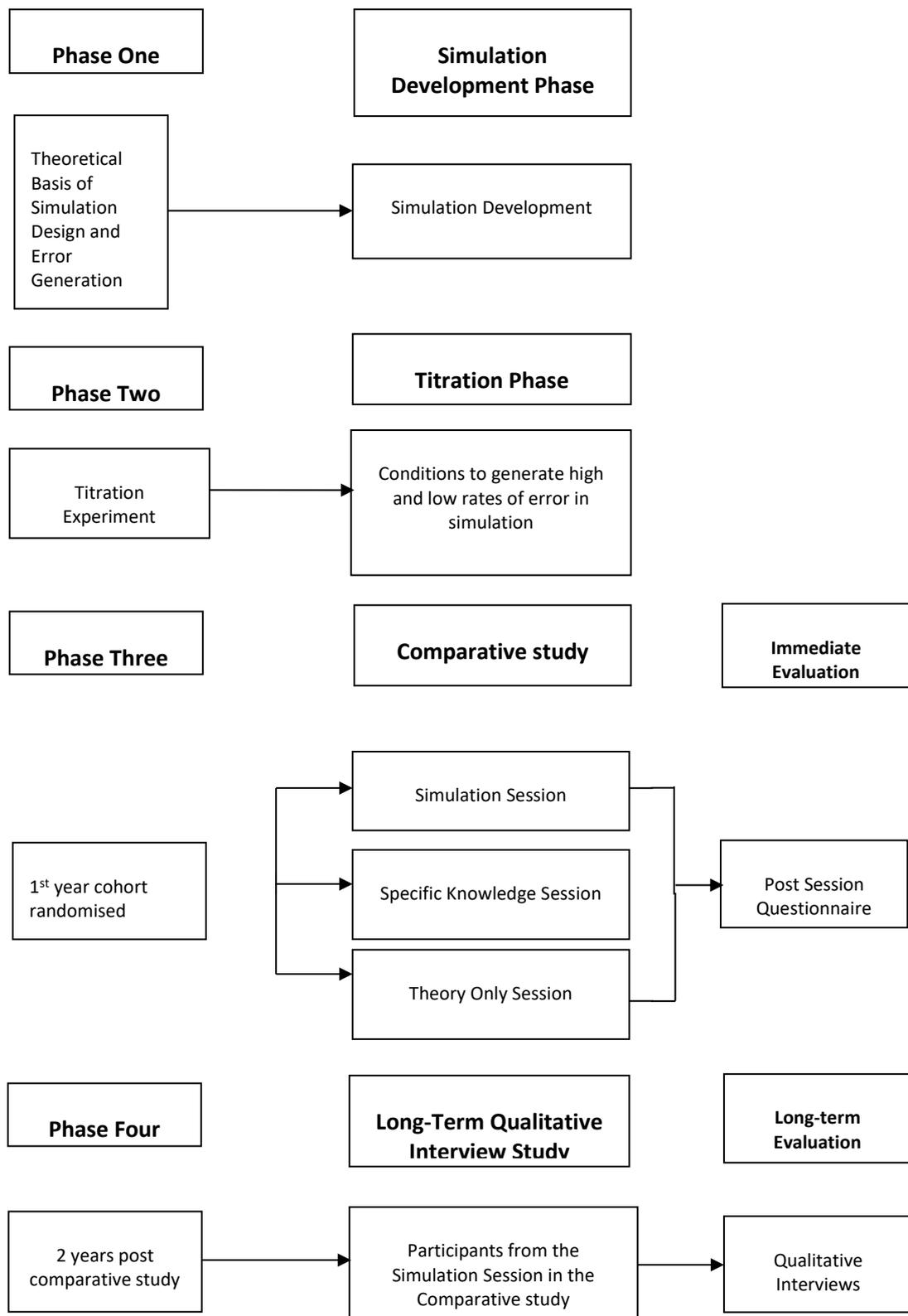


Figure 3. Overview of Study Phases

4.4 Phase One: Simulation Development Phase

The aim of the simulation development phase was to design the low-fidelity online medication administration simulation to:

1. be effective, efficient and satisfying to use,
2. incorporate all salient cognitive and theoretical elements of the medication administration task based on paper medication administration charts,
3. enable students to administer medications correctly if they apply the five rights,
4. recreate an authentic medication administration scenario,
5. generate an authentic medication administration error using real-life context and causes of medication administration error if the five rights were not applied.

The simulation was developed using 'usability engineering', a human centred approach to software design (International Standards Organisation 2010, Persson 2017). Usability engineering uses design methods and development processes to ensure computer software is effective, efficient and satisfying to use. This was to ensure the simulation was an appropriate education tool and replicated all salient cognitive and theoretical elements of the medication administration task. This involved the design methods of requirements gathering, prototyping and user-testing. It incorporated a literature search of university medication administration teaching materials, NMC medication management stipulations and contextual observations. In addition, qualified nurses, who are experts in medication administration contributed to all stages of the design process.

The authentic medication administration scenario integrated into the simulation was the 8 am hospital medication round, a scenario familiar to first-year nursing students. The authentic medication administration error selected was a 'right drug, wrong patient' error, a common error in clinical practice (Hicks et al 2004, Ito and Yamazumi 2003, da Conceição Ferreira de Abreu et al 2013 and Al-Shara 2011) if the five rights were not applied. The error was generated using the psychological phenomenon of 'change blindness' (Levin and Simmons 1997) and is the phenomenon whereby an observer fails to notice changes to non-attended items of a visual scene when they are given an additional task to attend on and complete. Change blindness relates to the psychological construct of attention, which is the cognitive process of concentrating or awareness of stimuli or information, sometimes to the exclusion of other stimuli. It incorporates the psychological theories of selective and focal attention and situational awareness. Selective attention is the process in which an individual specifically focuses or attends on a particular stimuli or item for a period of time while simultaneously not attending upon concurrent

information (McLeod 2008). This is closely associated with focal attention which relates to the the attention focused on a certain stimuli while disregarding the rest. Situational awareness relates to an individuals' awareness of the current environment, or perceptions of the perceived relevant aspects of the environment, including within a dynamic situation (Endsley 1995).

In the simulation, the participants were presented with pictures and details of three patients. They were asked to administer medications to one patient, the 'target patient'. When the participant was distracted preparing medications, the 'target' patient changed position with a 'decoy' patient. A 'right drug, wrong patient' error was generated if the participant was 'blind' and failed to notice the change whilst preparing the medications, and proceeded to administer medications to the decoy patient. Within this scenario, the selective attention and focal attention component relates to the student directly focusing on dispensing the medications to the exclusion of other concurrent information. The error occurred if the participant did not have situational awareness and failed to notice the patients changing position, and, if they did not complete the five rights, they would proceeds to administer the medication to the wrong patient.

4.5 Phase Two: Titration Phase

In the titration phase, levels of the change and cognitive load elements were incorporated into the change blindness scenario and titrated to determine conditions that generated high and low rates of the target 'right drug, wrong patient' error. Titration theory is derived from chemistry and refers to the process in which small amounts of a solution are incrementally added to determine a given or desired concentration of a solution. The change and cognitive load elements were titrated to determine what level of change or cognitive load produced significantly high or low rates of the 'right drug, wrong patient error'. The high error generating condition served to ensure participants made the error and the low error generating condition served to ensure participants noticed the patient change and noticed the opportunity for error so that they could reflect and learn from the error.

The change components were the visibility of the patients changing position and the physical similarity between the target and decoy patients. The cognitive load components were the complexity of the medication administration calculation and the number of medications to be administered. This manipulates cognitive load theory (Sweller 1988) and the impact of

inappropriate intrinsic load in simulation design on working memory to reduce educational outcomes and performance (Reedy 2015).

Within change blindness, multiple studies consistently demonstrate that whilst participants are engaged in an activity, they are less likely to notice the change when the change has a higher degree of similarity or if the change is disguised (Levin and Simons 1997). Therefore, it was hypothesised that the higher the patient similarity and the more disguised the change, the less likely participants would notice the patient change and be more likely to make an error if the five rights were not completed. Varying levels of calculation complexity and workload constituted varying levels of intrinsic cognitive load (Sweller 1988). It was hypothesised that the greater degree of cognitive load in terms of calculation complexity and workload, the more selective attention would be required to complete the task, and as a consequence, the student would be less situationally aware and not notice the patient change. This would lead to higher levels of error if the participant does not complete the five rights.

Change and cognitive load were also chosen to be incorporated into the simulation because they are both established causes of medication administration error (for example, Santell 2006, Croskerry et al 2004, Mryyan et al 2007, and Armutlu et al 2008). The change and workload components could be integrated into the change blindness process and used to mimic the complexity and variability of clinical practice.

96 participants with medical-related backgrounds completed the simulation and administered medications to 10 target patients. During each administration, participants were presented with varying levels of the change and workload elements (Table 3). Conditions that generated high and low rates of error were identified and incorporated into the simulation for the comparative study. The high error generating condition was used to maximise the likelihood that participants would make an error. The low error generating condition was used to maximise the likelihood that participants would notice the patients changing position and therefore notice that there was the potential to make an error. It was also identified whether participants were more likely to make an error during the first or second patient administration.

Table 3. Levels of Change and Workload Elements and Time Point

Name of Element	Level of Element
Change Elements	
Visibility of patient change	- Obvious - Subtle - Hidden
Physical similarity between the 'target' and 'decoy' patients	- Similar - Dissimilar
Workload Elements	
Complexity of medication administration calculation	- Easy - Hard
Number of medication on the chart	- Few - Many
Time Point	
-First -Second	

4.6 Phase Three: Comparative Study

The comparative study compared the effectiveness of the simulation as a learning experience for first-year nursing students with two other more traditional teaching formats. In this phase, the simulation was used for the first time as an education intervention. This was a randomised control trial which examined progressive levels of elements of the simulation session to identify which provided the most effective overall learning experience (Kim et al 2016).

124 first-year nursing students were randomised to one of three teaching sessions; the simulation session, a specific knowledge session and a theory only session. The three teaching sessions contained various levels of the same learning components provided in different formats and

based on a subset of the literature which recommends using randomised control trials (for example, Brady et al 2015 and Cant and Cooper 2010); the simulation, the experience of error through the change blindness phenomenon, theory of the five rights and factors that cause medication administration error. All participants were provided with feedback as to whether they made an error in their teaching session and completed a post session questionnaire.

Participants in the simulation session completed the simulation as part of their nursing curriculum and therefore informed consent was only sought to obtain the results of the simulation. In the three teaching sessions, the return of a completed questionnaire was taken as consent for analysis.

In the simulation session, the simulation was programmed with the high and low error generating conditions determined in the titration phase. Participants were required to administer medications to 10 target patients. The high error generating condition was presented before the low error generating condition to maximise the likelihood that participants would make an error and notice the potential to make an error. At the end of the simulation, participants were given feedback on their performance and of titration phase participants.

The specific knowledge session comprised a more traditional lecture format. Within the lecture, participants were taught the five rights and causes of medication administration error. Participants experienced making an error generated through the change blindness phenomenon using scenarios unrelated to medication administration. The change blindness scenarios were then actively linked to medication administration error. Participants were taught about the underlying theory of the simulation and the performance of titration phase participants in the high error generating condition. The theory only session was identical to the specific knowledge session except for their knowledge of the simulation. Participants in this condition were informed that the simulation existed, but not of its underlying theory and results.

The simulation session served as the experimental teaching session. Participants were given the opportunity to actively experience the simulation and making a medication administration error in conjunction with experiential and constructionist learning theory (Kolb 1984 and Bruner 1986). The specific knowledge session served as an intermediate teaching session which combined the theory only teaching session and knowledge about the medication administration simulation and performance of others, but they did not experience the simulation. The theory only teaching session served as a control teaching session in which the learning components were taught in a

more traditional teaching format. Immediately after the three sessions participants completed the same questionnaire, tailored appropriately to the individual teaching session to identify:

1. Participant's previous experience of medication administration error in clinical practice and attitude to the topic of medication administration.
2. Perceived educational impact of the teaching session and the simulation on clinical practice.
3. Perceptions of the causes of medication administration error.
4. Emotional response to making or witnessing error.
5. Perceived impact of the teaching session on future clinical practice.

4.7 Phase Four: Long-Term Qualitative Interview Study

Participants who completed the simulation session in the comparative study were invited to take part in a semi-structured qualitative interview on the long-term impact of their simulation experience on clinical practice, perceived contribution of the simulation to medication administration learning, emotional response from completing the simulation, and perceived realism of the simulation. The interviews were completed two years after the comparative study. Twelve participants completed this phase. One face-to-face and 11 telephone semi-structured interviews were completed (Smith 2005 and Ward-King et al 2010) and analysed using Thematic Analysis (Braun and Clarke 2006).

4.8 Project Time Scales and Location

The development of the simulation programme commenced in 2007 and its design is based upon bedside paper medication administration charts which were utilised during that time period. The simulation development and titration phase took place in February 2007 to February 2008. The comparative study took place in April 2008 and the long-term qualitative study took place between February and April 2010.

4.9 Participants

Participants of the comparative study were a convenience sample of first-year nursing students at King's College London in 2008. The student nurses were registered on the adult, child and mental

health branches of the Bachelor of Science, Diploma and Post Graduate Diploma programmes. Participants were randomly assigned to one of three teaching sessions: the simulation session, the specific knowledge session and the theory only session (full details in section 7.3). Participants in the long-term qualitative interview study were 12 self-selecting third year student nurses who participated in the simulation session during the comparative study (full details in section 8.4).

Participants received ongoing medication administration training and assessment pre and post the comparative and long-term qualitative interview studies with the aim to achieve clinical competence at the time of course completion and nurse registration in line with the Standards for Medicines Management (2015b), the 'Standards for Pre-Registration Nursing Education' (NMC 2010) and the 'Professional Standards of Practice and Behaviours for Nurses and Midwives' (NMC 2015a) (see section 2.8).

Before the comparative study, participants received training in university regarding how to administer medications using the five rights through lecturer observed peer-to-peer role-play and lectures and were formatively assessed administering medications to patients under the supervision of a mentor in clinical practice. Post the comparative study and throughout the remaining duration of their course, participants completed numerous clinical placements. Within the placements, participants were formatively and summatively assessed to administer medications by their mentor. Post the comparative study, participants were formally assessed in university using observed structured clinical examination at the end of each academic year and completed calculation assessments. Participants also received pharmacology teaching in the form of lectures in university both pre and post the comparative study and underwent a formal examination.

4.10 Ethical Considerations

This study was granted ethical approval from King's College London's ethics board and was supported by the Florence Nightingale School of Nursing and Midwifery, King's College London. Phase one, the simulation was developed with the assistance of a computer programmer and nursing lecturers at the Florence Nightingale School of Nursing at King's College London and nurses and patients from King's College Hospital. The simulation was populated with photographs obtained from friends and family of the study developers and from residents and staff of three residential homes.

4.10.1 Simulation Development Contributors

There were three sets of contributors involved in the development of the simulation; nursing lecturers, nurses and patients on one medical ward, and individuals, including those from three residential homes, whose photos were used to populate the simulation. All those who assisted with the development of the study did so voluntarily, with autonomy and were suitable to approach. They were informed why the study was necessary and how their participation would improve the design of the simulation. They were made aware that they were not participants in the study, but were helping to design an education tool for nursing students to improve medication administration practice, and it was not assessing their ability to perform.

Nursing lecturers from the Florence Nightingale School of Nursing and Midwifery at KCL, who assisted with the development of the study were self-selecting and volunteered their assistance (see section 5.4). They were provided with the background of the simulation and informed that their assistance was based on their role as expert nurse educators involved in the medication administration curriculum. They were informed their participation and feedback would be anonymous and that they could withdraw their feedback at any time.

The nurses and patients who contributed to the development of the simulation were from one medical ward at King's College Hospital where the developer worked (see section 5.4.1). The developer obtained permission from the ward manager to opportunistically approach nurses and patients to ask if they would verbally agree to being observed during their medication round. The developer was not working during the observations, and wore hospital and university identification at all times. All nurses and patients were provided with the background rationale for the simulation and that the developer wanted to observe the normal interaction between nurse and patient to inform the simulation design. The developer explained that they would like to write down the nurse / patient interaction during the medication administration activity and that all of the data obtained would be kept confidential. The developer also stated that they were interested in obtaining a realistic reflection of medication administration, and observe the normal interaction between the nurse and patient during medication administration.

There was a potential issue with power and autonomy in which both nurses and patients could have felt obliged to participate. It was therefore important that both nurses and patients were autonomous and were confident and happy to decline consent if so wished. It was emphasised

that participation was completely voluntary, feedback could be withdrawn at any moment and there would be no repercussions if they chose not to participate. It was ensured that there was no perceived coercion to participation and it was ensured that the developer had no managerial or team leader responsibility over the nurses approached. All of the nurses approached saw the benefits of the study and were happy to assist if their patients were also happy to participate. Only patients who had capacity and were being nursed by the nurses who agreed to assist with the development of the study were asked if they would mind their medication round being observed by the developer. They were informed that the developer was a nurse on the ward and that there was no compunction to participate or repercussions if they declined. All of patients approached were happy to participate.

The photographs were obtained from friends and family of the study developers and from residents and staff of three residential homes (see section 5.4.3). It was important to obtain photographs of older people to more accurately reflect the adult hospital patient population. There was also a potential issue with power and autonomy in which residents would be either not be appropriate to approach, for example, if they did not have capacity, or they could have felt obliged to participate. To ensure that the residents were appropriate to approach and had autonomy to agree or decline consent, the developer contacted the residential home manager and asked for their advice and permission to approach the residents. The developer explained the study and asked the managers if they thought their residents had the capacity and would be interested in having their photographs taken for the study. They were also provided with the background rationale for the simulation and that the photographs would be used in line with university policy. The managers provided consent to approach the residents and agreed that the residents had capacity to make an autonomous decision. The developer approached and spoke to the residents in a communal day room during planned activities and wore university and hospital photographic identification at all times. The developer introduced herself to the residents and explained the purpose of the study and why the photographs were needed. It was stressed that their names would be anonymous and it was also reiterated that their participation was completely voluntary and they could withdraw their photo at any time. All those approached agreed to have their photograph taken and signed the university photography consent form.

4.10.2 Participants

Ethical approval for phase two and three, the titration phase and the comparative study was obtained on 15th June 2007 (Appendix B). An email was sent out from KCL's ethics committee email which provided a brief overview of the study and detailed participant eligibility

requirements. The email invited eligible members of staff and students to participate in the titration phase and to contact the researcher via email. The researcher assessed volunteers for their eligibility to participate and arranged a time and location for them to participate (see section 6.3). To ensure participants were able to make an informed decision regarding whether or not to participate in the study, they were provided with an information sheet. Consent was obtained when participants logged onto the simulation and clicked on a link which asked them to consent for their results to be retained and analysed for research purposes. If they did not click on the link, the results were not retained. To maintain anonymity, participants were allocated a study identification number. Results were kept on a password protected computer. Participants were paid £10 in vouchers for their time, whether or not participants consented for their results to be retained for analysis. Participants were also asked to complete the questionnaire used for phase three, the comparative study to ensure suitability and wording. This was voluntary and return of a completed questionnaire was considered confirmation of consent.

Phase three, the comparative study was integrated into the first-year nursing curriculum and all students were required to participate as part of their studies. For the simulation session, consent for the results of the simulation was obtained when participants logged onto the simulation and clicked on a button to say their results could be retained and analysed for research purposes. If they did not click on the button, the results were not retained. Simulation results were coded so that they were anonymous and results were kept on a password protected computer. Participants for all three teaching sessions also completed a questionnaire. Return of a completed questionnaire was considered consent for the results to be retained and analysed for research purposes. The questionnaires were anonymous and coded for tracking purposes. All completed questionnaires were kept in a protected location.

Ethical approval for phase four, the long-term qualitative interview study was obtained on 6th October 2009 (Appendix B). An email was sent to simulation session participants from the comparative study asking them to contact the researcher if they were willing to participate in this phase of the study. Participants were also approached in lectures. To ensure participants were able to make an informed decision regarding whether or not to participate, they were posted an information sheet and consent form which they returned by post before the interviews were arranged. Participants were also paid £10 in vouchers for their time. Interviews were audio recorded with the permission of the participants, who were assured about the anonymity and

confidentiality of the interviews. The interview transcripts were allocated a participant number so that they were anonymous and stored on a password protected computer. Interview transcripts were destroyed at the end of the study.

There were two significant ethical issues that are specific to this project which stem from the need to conceal aspects of the simulation and the fact that the aim was to generate an error (albeit a simulated one). It was important that students were not specifically expecting the 'change' to occur and therefore they were not informed about that specific aspect of the project. However, the ethics board agreed that a full briefing (encompassing the issues covered in the consent / information sheet) on the broad aims of the project in terms of developing a simulation that would allow students to experience and practice the skills of medication administration is not misleading but rather focuses on the general aims rather than the specific mechanisms.

The premise of the study was that participants will learn through the active experience of error in the simulation. There was concern that making an error would potentially cause undue distress to participants. Students who make simulated errors may be concerned that their performance will have negative consequences for them. This is especially true during the simulation session in the comparative study where the simulation was used in a classroom setting. No personally identifiable data was retained beyond that what was necessary for the management of data collection. Participants were assured that the purpose of the exercise was a formative learning experience. It is conceivable, but unlikely, that participants became distressed by making an error. In this occurred, investigators were on hand to provide immediate advice and specifically point out that a) the errors are common and b) there is no known relationship between the simulated error and making such errors in practice although the hope is that the experience will reduce such errors. Such students would be referred to their clinical or personal tutors for further advice.

In addition, generic ethical issues arising from confidentiality and the recruitment of student volunteers within the classroom setting in the comparative study also arose. No personally identifiable data was retained. As the simulation was to be deployed as a learning aid in utilisation study students were expected to take part in the activity as they would any other participatory activity in class. However, they were given the opportunity to identify within the simulation whether or not they are happy to participate in the evaluation element and can elect to have no data about their performance recorded. The information provided made it clear that this element is entirely voluntary, there were no consequences from participating or not and that tutors would not have access to any information on their individual participation or performance.

4.11 Strategy for Data Analysis

Phase two and three were analysed using a variety of descriptive and inferential statistics using the Statistical Package for Social Sciences (SPSS). Version 15 was used in phase two, the titration phase and version 21 was used in phase three, the comparative study. Thematic analysis was used to analyse the interview data in phase four, the long-term qualitative interview phase. A summary of the data analysis strategy and corresponding aims and objectives of the study is located in Table 4.

Table 4. Data Analysis Approaches

Phase	Study Aim	Analysis Approach
Phase Two Titration Phase	Identify conditions to generate high and low rates of error	Descriptive Statistics Inferential Statistics <ul style="list-style-type: none"> • Univariate Statistics <ul style="list-style-type: none"> - Chi Square - Fisher's Exact Test • Multivariate Statistics <ul style="list-style-type: none"> - Generalised Estimating Equations
Phase Three Comparative Study	Evaluate the effectiveness of the simulation compared to two other teaching sessions	
	<ul style="list-style-type: none"> • Pre teaching experience of medication administration 	Descriptive Statistics
	<ul style="list-style-type: none"> • Perceptions of Medication Administration Error and Medication Education 	Descriptive Statistics Inferential Statistics <ul style="list-style-type: none"> - Chi Square - Fisher's Exact Test - Kruksal Wallis

	<ul style="list-style-type: none"> - Perceived Impact of Teaching Session on Future Clinical Practice 	<p>Descriptive Statistics</p> <p>Inferential Statistics</p> <ul style="list-style-type: none"> - Chi Square - Fisher's Exact Test
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	<ul style="list-style-type: none"> - Emotional Response to making or knowing about error within the simulation 	<p>Descriptive Statistics</p> <p>Inferential Statistics</p> <ul style="list-style-type: none"> - Kruksal-Wallis
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Phase Four Long-term Qualitative Interview Stage	Identify the long-term saliency of completing the medication administration simulation	
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	<ul style="list-style-type: none"> - Perceived impact on learning and clinical practice - Emotional response from completing the simulation and making an error - Perceived realism of the simulation 	Thematic Analysis
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The aim of phase two, the titration phase was to titrate levels of the change and cognitive load elements and time of presentation to identify conditions that generate high and low rates of medication administration error. Descriptive statistics were used to detail the error rates achieved. Univariate and multivariate inferential statistics were used to determine if the different levels generated statistically significant high and low rates of error and during what time point.

The change, cognitive load and time elements were initially analysed using a univariate test to determine their impact on error rates in isolation. A Pearson's Chi-Square Test is a non parametric test and was used to test analyse the visibility of patient change element because it designed to analyse differences between categorical variables for independent samples (McHugh 2013). It is also suitable when there are more than two groups within two sets of categorical data, (e.g. 3 (visibility level) x 2 (error) design). It was initially used for the visibility of patient change element.

A Fisher's Exact Test is a non parametric test, which determines the probability of obtaining the observed data or test an association between two variables for categorical data with independent samples, and is suited to be used in a 2 (level) x 2 (error) design (Ludbrook 2008). This test was used for all remaining change, cognitive load and time elements. This test was also used for the visibility of patient change element, when the subtle level within this element was discarded from the analysis and became a 2x2 table.

Not all of the change and cognitive load elements generated statistically different high and low rates of error in the univariate analysis. A multivariate analysis was therefore also completed to determine if the levels of the change, cognitive load and time elements produced statistically significant high and low rates of error in combination. Generalized Estimating Equation analysis is a semi-parametric approach was completed because it analyses correlated response data, and is particularly suitable if responses are binary (Liang and Zeger 1986).

The aim of phase three, the comparative study was to evaluate the effectiveness of the simulation as a learning experience compared to two other teaching sessions. Descriptive statistics were used to detail the error rates achieved in the simulation session. They were also used to detail a subsection of responses to the questionnaire: the previous experience of medication administration error, mean ranks of causes of medication administration error and emotional reaction to making, or knowing about making a medication administration error in the simulation.

Univariate statistics were used to identify differences between teaching sessions in learning outcomes identified in the questionnaire. A Pearson's Chi-Square Test was used to test perceptions of medication error and medication education post teaching session and perceived impact of the teaching session received on future clinical practice. This is because it tests an association between categorical variables for independent samples and can be used for more than 2 groups. However, an assumption of the test is that the value of the cell should be 5 or more in at least 80% of the cells, and no cell should have an expected of less than one (McHugh 2013). This could not be achieved for all questions and where this occurred, a Fisher's Exact Test was used instead, as it can be used for counts less than 5 and can be used in a 2x3 categorical variable design (McDonald 2014). A Kruskal-Wallis test is a non parametric test which tests whether mean ranks are the same for one variable across groups. This was employed to determine if there was a difference between teaching sessions on how they ranked causes of medication administration and their emotional response to either making or knowing about error within the simulation.

The aim of phase four, the long-term qualitative interview stage, was to identify the long-term saliency of the simulation, the perceived contribution of the simulation to participants' medication administration learning and reported impact on clinical practice. It also aimed to investigate in more detail the emotional response from completing the simulation, making an error over the long-term, and perceived realism of the simulation. Thematic analysis was used to analyse the interview data because it is a widely used qualitative analytic method embedded within many qualitative approaches, and provides a method in which to identify, organise, analyse and report themes (Bruan and Clarke 2006).

Chapter 5: Phase One: Simulation Development

Phase

5.1 Introduction

The aim of the simulation development phase was to develop a low-fidelity online medication administration simulation that generates error if the five rights were not applied. The aim was to design the simulation to achieve high levels of psychological fidelity and be realistic to participants. The desired characteristics of the simulation were to:

- replicate the most salient cognitive elements of medication administration and include all theoretical components of the task
- depict an authentic medication administration scenario
- replicate an authentic medication administration error scenario and generate error using real life causes of medication administration error
- be effective, efficient and satisfying to use.

The chapter is divided into five sections: Section 5.2 describes the medication administration scenario depicted in the simulation and discusses why the 5 rights and adult patients were selected for the simulation. Section 5.3 will detail the medication administration error scenario and introduce the psychological phenomenon of change blindness to generate a target medication administration error. Section 5.4 describes the design and development of the simulation. Section 5.5 describes the final simulation and how the medication administration error was generated.

5.2 Medication Administration Scenario

The simulation literature states simulations should replicate commonly occurring non-crisis scenarios (Kneebone et al 2007) and be grounded in a familiar context. In addition, Waxman (2010) states nurse educators should produce objective-driven scenarios to 'set the stage' which assists students to fulfil their learning outcomes. Simulation scenarios should be evidenced-based (Seropian et al 2004) to ensure the transfer of skills and learning within simulation to clinical practice.

The simulation was designed to replicate medication administration using paper medication administration charts. This is because this form of chart was used to prepare first-year nursing students, the target population of the simulation, medication administration nursing education at KCL, the host organisation, and in clinical practice in associate hospitals between 2007 - 2010 when the simulation was designed and the study conducted (King's College Hospital 2012).

The scenario replicated in the simulation was the 8 am hospital medication round. This scenario was selected because it is an inherent clinical practice scenario and is highly familiar to first-year nursing students. It was therefore an authentic scenario which reflected the clinical experiences of the target population (Kneebone 2007). It was also selected because the 8 am medication round is typically the busiest medication round and therefore provided the greatest opportunity to effectively integrate change and workload as causes of error (Holland et al 2011). Only oral medication administrations were included in the simulation because it is the most common route of medication administration completed by first-year nursing students.

5.2.1 Protocolised Checking Procedures: The Five Rights

The simulation was based upon the five rights of medication administration (Hughes and Blegen 2008). Although there are different protocolised checks utilised for medication administration internationally including the eight rights (Fothergill Bourbonnais and Caswell 2014), the nine rights (Elliot and Lui 2010) and the ten rights (Edwards and Axe 2015), it was based upon the five rights for a number of evidence-based and pragmatic simulation design reasons. Firstly, and most importantly, the five rights are considered the gold standard of medication administration (Jones and Treiber 2010) and comprise the central tenant of the other protocolised checks. Secondly, the additional checks in the other processes reflect the wider knowledge required for appropriate medication management, including pharmacology, patient status and hospital policy: the right frequency, the right reason, the right site (the eight rights), the right documentation, the right action, the right form and the right response (the nine rights) and the right to refuse, the right knowledge and understanding, the right questions, the right response and the right advice (the ten rights).

The premise and learning goals of the simulation is to underline the importance of checking procedures through the experience of error. Although pharmacology knowledge and post administration assessment that the patient derived the appropriate therapeutic effect of the medication is fundamental to effective medication administration, (NMC 2010), therefore, these aspects are external to the key focus of the simulation. They are outside the scope of a low-

fidelity simulation and introduce additional complexity into the simulation development and design that couldn't be realised. The decision to restrict the design of the simulation to the five rights reflects Josephsen (2015)'s recommendation to use scaffolding as a mechanism to design the simulation in which the key focus of the learning activity is deconstructed so it focuses on the core aspect is suitable for the novice user (see section 3.2.2). The learner commences by practicing the most simple but genuine task scenario. In addition, these skills, for example, monitoring for side effects and adverse reactions reflect the competency expectations for more experienced nursing students. For example, in the NMC Standards for Pre-Registration Nursing Education – Annex 3 (2010) they reflect the second progression point (see section 2.8 for further details). As such, the five rights were pragmatic to integrate into the simulation and reflected the core of the medication administration checking procedures (Treiber and Jones 2012). It also reflected the tuition provided at KCL, the host university and associated hospitals and therefore complied with the education expectations of the target population.

5.2.2 Using Adult Patients to Populate the Simulation

The 8 am hospital medication round and medication charts were based on adult medical patient and not mental health or child patients. Therefore, the patient profile in the simulation did not reflect the nursing specialism of all student nurses who completed the simulation. It was not practical; to design the simulation to incorporate patient profiles all three nursing disciplines. Therefore, the medication round was designed to replicate the 8 am medication round on an adult in-patient hospital ward, which is particularly suited for adult branch nursing students. There are a number of reasons for this.

Firstly, the adult branch nurses comprised the vast majority of nursing students and therefore also likely to comprise the vast majority of participants in study. Secondly, to be a realistic representation of the 8 am medication round, the simulation needed to focus on one form of patient profile and not a combination of adult, mental health and child branch patients as this combination is not commonly encountered in a ward-based in hospital environment. Therefore, the medication administration task needed to reflect this. Thirdly, mental health nursing students also completed a medical placement in their first-year of nurse training. Many adult mental health patients are likely to have medical conditions which are also found on a hospital medical ward. Therefore, these participants were likely to be conversant with adult medical presentations. Fourth, child branch nurses are taught to complete medication administration checking procedures with another nurse (Conroy et al 2015). This would be difficult to incorporate into the simulation. In addition, incorporating a second checker into the simulation would undermine the

premise of the simulation which underlines to the nursing student the importance of their role to apply checking procedures in medicine administration. In this scenario, the nurse can potentially rely on the appropriate checking procedures of another nurse for correct medication administration. Fifth, the developer did not have permission to access paediatric wards or children to complete observations of the medication administration process or take photographs to incorporate into the design of the simulation. Lastly, despite using only adult patients, the key learning outcomes of the simulation remained relevant to all students. The five rights were taught across the three branches and therefore the simulation still provided a relevant and topical education experience for child and mental health branch student nurses. In addition, the NMC 'Standards for Competence for Registered Nurses' (last updated 2016) stipulates that although there are different fields of nursing, registered nurses are expected to meet the essential healthcare needs of patients of all ages and conditions and ensure that the delivery of the care is safe. Therefore, completing an adult medication ward round was appropriate for all students.

5.3 Medication Administration Error Scenario

This simulation utilised the experience of making a medication administration error as a mechanism to generate affect and make available and salient the importance of the five rights to clinical practice. Learning from error incorporates both experiential (Kolb 1984) and constructionist (Bruner 1986) learning theory in which the active experience of error will help the student understand and construct new knowledge regarding the importance of checking procedures to clinical practice. This would also support students to have an internal locus of control and identify the importance of their role to promote safe medication administration practice. The literature, for example, Bland et al (2011) emphasises that effective simulations must be authentic to link the experience to clinical practice. To achieve this, the simulation needed to recreate both the complexity of clinical practice (Rafferty et al 1996), and incorporate real life causes of medication administration error. The mechanism selected that provided both is the 'change blindness' phenomenon (Levin and Simons 1997).

Change blindness is a psychological phenomenon within the domain of attention and occurs when an observer fails to notice changes to non-attended items of a visual scene when they are completing another task, and continues to act as if the change has not occurred (Levin and Simons 1997). Change blindness studies repeatedly highlight that the majority of participants fail to notice when actors change position and that it is highly reproducible (for example, Levin et al 2002 and Simons and Chabris 1999). In the simulation, participants were instructed to administer medications to a target patient. When the participant was distracted preparing medications for

the target patient, the target patient changed position with a decoy patient. A 'right drug, wrong error' was generated if the participant was sufficiently focused on preparing the medications and failed to notice that the patients changed position, failed to verify the target patient's identity using the five rights and proceeded to administer the medications to the decoy patient. Using Reason' (2000) taxonomy, a 'right drug, wrong patient' error is classed as an active failure in which the active behaviour of the individual leads to error. In this context, it is a slip and an act of commission, where the original intention was correct, but the action resulted in error.

A 'right drug, wrong patient error' using change blindness was selected because it was an appropriate mechanism to underline to student nurses the importance of checking procedures to their clinical practice. Due to the inherent constraints of a low-fidelity online simulation, this form of error was selected because it was more feasible to reproduce in contrast to other more common forms of error, for example, omission (McBride-Henry and Foureur 2007). The literature highlights that to be relevant to students, error should be generated using a commonly occurring clinical scenario (Kneebone et al 2007). The error is common medication administration error in clinical practice, (Hicks et al 2004) and in some studies, the most prevalent (Ito and Yamazumi 2003 Al-Shara (2011).

Nurses work in a highly complex and changeable clinical environment and are continually at risk to the change blindness phenomenon. The simulation was designed to incorporate aspects of change and cognitive load, (in terms of workload and complexity of calculations when they prepared the medications), as mechanisms to increase the rate of error. Instructional design of a simulation can affect the cognitive load and educational performance (Haji et al 2015 and Reedy 2015). The cognitive load elements incorporated into the simulation relate to the intrinsic load manipulated within the simulation (Sweller 1988). They are also established causes of medication administration error (Fahimi et al 2008 and Santell 2006). This implies that it is an authentic error that participants will relate to clinical practice. Change blindness therefore incorporates real life causes of error needed to provide a realistic low-fidelity medication administration simulation (Kneebone et al 2007), and through this can help bridge the theory-practice gap (Rafferty et al 1996).

5.3.1 Background Theory to Change Blindness

Change blindness was incorporated into the simulation as it is a fully established and robust phenomenon within the psychological literature and has been used to aid the understanding of internal representations. Change blindness occurs even when there have been marked changes to

the visual scene and is effective across multiple scenarios, for example, the failure of an individual to notice when an actor with whom they are conversing changes places with another actor (Levin et al 2002), and the failure to notice a person in a gorilla suit running around a basketball court during a game (Simons and Chabris 1999). Change blindness incorporates selective / focal attention and situational awareness.

Attention is the cognitive process of concentrating or awareness of stimuli or information and can be widely dispersed, focused on a single, narrow task, shared between two tasks or switched from one focus to another (Juola 2016). One purpose of attention is to maintain alertness for interesting or salient information, such as abrupt changes in the periphery, to which focal attention might otherwise be directed (Juola 2016). Selective attention is the capacity to attend to a particular stimulus in the context of distracting or competing information (Mcloed 2008). Similarly, focal attention is the process of attending upon certain stimuli, while disregarding the rest. Someone who is focally attentive is highly aware, consciously in control, and selective in handling sensory input. Selective and focal attention is important due to cognitive processing and requires the limited capacity of working memory (see section 3.3.4) which holds only a finite a number of stimuli or items concurrently. The amount of information that can be attended to at one time is limited, and, therefore in many cases, not all relevant information can be actively maintained in the focus of attention (McElree 2001). As a consequence, unnecessary or overloading stimuli or items are filtered out and not processed, particularly when there is high intrinsic cognitive load attached to a task.

There are a number of competing psychological theories related to selective attention, most notably Broadbent (1958)'s Filter Model, Treisman's (1964)'s Attention Model and Deutsch and Deutsch (1963)'s Late Selection Model of Attention. Whilst all the theories have distinct interpretations of selective attention, they all incorporate the concept of a bottleneck in cognitive information processing. The concept of a bottleneck within the models recognise that our cognitive information processing resources are finite and we cannot consciously attend to all of our sensory input at the same time and we have to filter out a portion of stimuli. Individuals are unable to detect, store and access all elements within the visual field and find it particularly difficult to detect changes when the visual field is disrupted (Mitroff et al 2004) or when tasked to complete another function. Change blindness occurs if an individual is selective attending upon an item and attention is not sufficiently focused to the stimulus or object at the moment of change (Simons and Ambinder 2002). Even if individuals possess sufficient representations to potentially detect a change, the change will go unnoticed if the change is not attended to. To become aware

of the change requires the conscious and deliberate refocus of attention and acknowledgement of the change for it to be both recognised and reported (Simons and Ambinder 2002).

Change blindness also relates to the theory of situational awareness, which relates to an individuals' awareness of the environment, or perceptions of the perceived relevant aspects of the environment (Endsley 1995). There are three essential elements (Endsley 1995): Perception of the current relevant elements in the environment, comprehension of the current situation and projection of future status. Accurate perception is vital for correct situational awareness and deviation results in inaccurate decision making. Comprehension of current situation builds upon accurate perception and relates to the ability to comprehend relevant information and the significance of the information in relation to what the individual is trying to achieve. Projection of future status builds upon perception of the current relevant elements and the comprehension of the current situation to predict future states of the given situation. Attention, limitations of working memory and cognitive load are all separate but related constructs that can affect situational awareness. Lack of situational awareness contributes to change blindness because the individual perceives the current situation (before the change) to reflect the future situation (after the change), without comprehension of the current situation, due to selective attention, that the change has occurred.

Endsley highlights there are a number of factors that influence situational awareness. Individuals vary in their ability to acquire situational awareness, related to innate information processing abilities, experience and training. Situational awareness is also a function of the system design in terms of degree to which the system provides the needed information and form it is provided and can include workload, stress and complexity which impacts upon cognitive load. Endsley emphasises that even the best trained decision makers will be make wrong decisions if they have inaccurate or incomplete situational awareness. Action selection and performance are directly affected by situational awareness and can lead directly to error (Reason 2000).

The appropriateness of using change blindness as the mechanism to generate error in the simulation is underlined by the extent to which novices, such as student nurses, are particularly vulnerable to the phenomenon (Curran et al 2009 and Morphew et al 2015). Novices are less able than experts to build an accurate visual representation of a situation. Within this, they are more likely to include features that are irrelevant or fail to include features that are relevant. Novices are more likely to attend to surface features of a situation and not be highly discriminating to differences, and therefore, be more likely to be affected by the change blindness phenomenon (Feil and Mestrea 2010). Experts, for example in physics or chess, are more likely to notice change

in a change blindness scenario if the change occurs within the realm of their expertise. However, the ability to negate the change blindness phenomenon is expert specific, and occurs solely in the context in which the individual is an expert (Reingold et al 2001). Also, novices who improve their training and less likely to be subject to the phenomenon (Feil and Mestrea 2010) which again supports the use of this as an education exercise. It is particularly relevant to the medication administration simulation because it is focused at student nurses who are novices in the domain of medication administration. Therefore, they are more likely to be vulnerable to the change blindness phenomenon and learn from it.

There is a subordinate phenomenon in change blindness, known as 'change blindness blindness' (Levin et al 2002, 2000). Participants believe they will not be subject to change blindness and routinely overemphasise their ability to attend and detect changes to their visual field. This suggests that participants need to experience change blindness and be given feedback that they were subject to it, for them to believe and learn from it. Therefore, this incorporates the need for some form of on action reflection in which students reflect on the making an error through change blindness (Nicol and Dosser 2016) and evaluate the experience in terms of learning new knowledge and professional development.

5.4 Simulation Development Overview

The aim of the simulation was to provide an online representation of the salient cognitive and theoretical components of medication administration and to generate a right drug, wrong patient error, as described in the previous section. The central learning outcome of the simulation was to underline the importance of the five rights of medication administration to clinical practice. Therefore, the simulation needed to be designed to simultaneously enable participants to administer medications correctly if they apply the five rights, and to make an error if they do not. In addition, it was important that the simulation was realistic, intuitive and easy to use. The structure, content, page layout and functionality needed to support the participants' immersion in the simulation and ensure minimal practise was required.

To achieve this, the simulation was designed using software usability engineering methods. Usability engineering is a human-centred approach to software development. Its purpose is to ensure that software can be used by a defined set of 'users', to achieve a specific set of goals effectively, efficiently and with satisfaction (International Standards Organisation 9241-11 1998 / ISO standard 9241-210, 2010). Persson (2017) highlights the ongoing importance of incorporating human-centered design approaches into simulation development. They discuss the current

ergonomics of human-system interaction Part 210: Human-centered design for interactive systems, where human-centered design relates to any process that “aims to make systems usable and useful by focusing on the users, their needs and requirements, and by applying human factors/ergonomics, and usability knowledge and techniques” p 8. According to this standard a human-centered approach ensures that: (a) the design is based on an explicit understanding of the users, tasks and environments, (b) users are involved throughout the design and development, (c) the design is driven and refined by user-centered evaluation, (d) the process is iterative, (e) the design addresses the whole user experience, and (f) the design team includes multidisciplinary skills and perspectives. (ISO 9241-210, 2010, p. 5).

The simulation was designed and developed using the ISO standards and methods including requirements gathering, prototyping, programming and user-testing (Usability Professionals Association 2007). This stage was completed with the assistance of a computer programmer. The full design process is displayed in Figure 4.

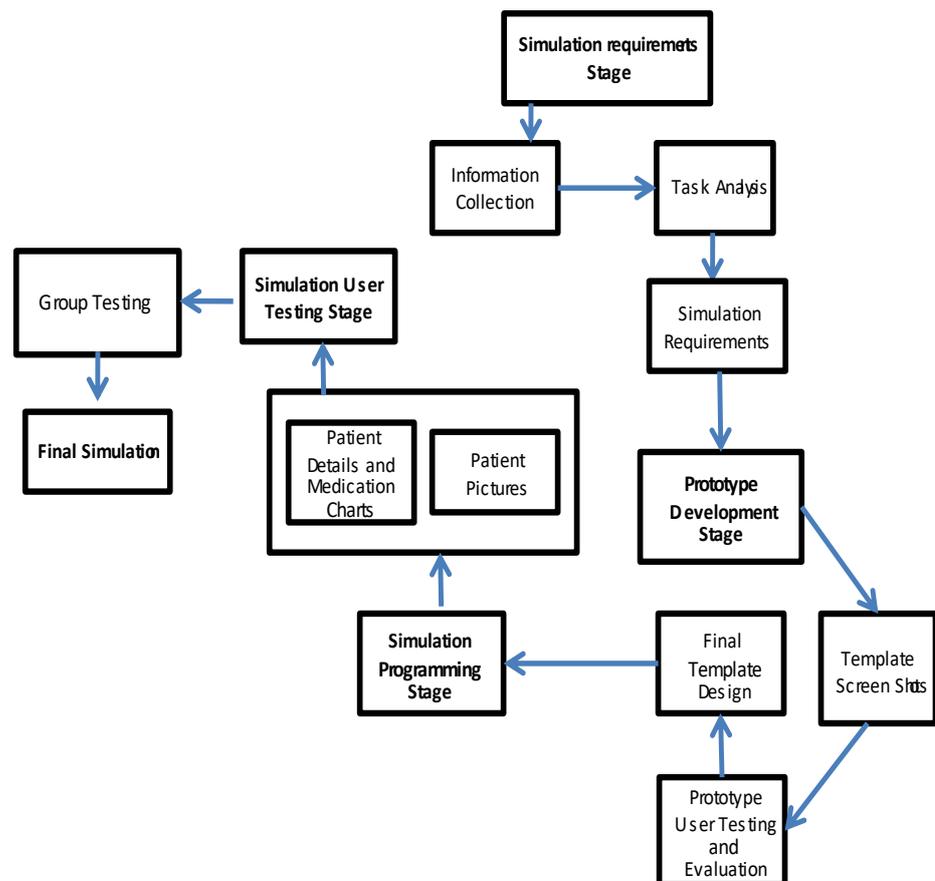


Figure 4. Simulation Development Process Overview

The simulation requirements stage was the first stage and identified what the simulation required to reflect an 8 am oral medication administration round, and enable participants to administer medication administrations according to the five rights. The next stage was the prototype development stage in which the requirements were incorporated into provisional template screen shots. This set out the initial structure, content, page layout and functionality of the simulation.

The screen shots were user tested and redesigned by registered nurses to ensure the simulation provided a realistic representation of medication administration. The next stage was the simulation programming stage in which the final templates were programmed into the simulation and paired with patient details and pictures. During the final simulation user testing stage, the simulation was tested again by registered nurses to make sure it was suitable for purpose. It was also group tested, to ensure the simulation could cater for multiple users simultaneously.

5.4.1 Simulation Requirements Stage

The requirements stage identified what the simulation needed to reflect the salient cognitive elements and theoretical components of medication administration using the five rights. Information was collected through a literature search and contextual observations. Findings were collated and placed into a hierarchical task analysis to ensure all aspects of the task were identified.

Information Collection

There were two parts to the information collection: medication administration teaching materials and contextual observations of medication administrations within clinical practice. Medication administration teaching materials from the Florence Nightingale School of Nursing and Midwifery at KCL, and medication charts from three London teaching hospitals were analysed to identify the information and equipment required to administer medications safely. The NMC 'Standards for Medicine Management' (2015b) were used to form the substance of the requirements in particular Section 1, Method of supplying and/or administration of medicines: Standard 2: Checking, which states:

‘As a registrant, before you administer a medicinal product you must always check that the prescription or other direction to administer is: 2.1. not for a substance to which the patient is known to be allergic or otherwise unable to tolerate, 2.2 based, whenever possible, on the patient’s informed consent and awareness of the purpose of the treatment, 2.3 clearly written, typed or computer-generated and indelible, 2.4, specifies the substance to be administered, using its generic or brand name where appropriate and its stated form, together

with the strength, dosage, timing, frequency of administration, start and finish dates, and route of administration, 2.5 is signed and dated by the authorised prescriber' p 18.

This relates most specifically to what should be incorporated on the patient's medication chart and included within the prescription. All aspects were incorporated into the simulation. The second section incorporated into the simulation was Section 4, Standards for practice of administration of medicines: Standard 8: Administration. This relates more specifically to effective medication administration. It requires the nurse to verify the identity of the patient, allergy status, check the expiry date, dose, route, time and that the prescription or the label on medicine dispensed is clearly written and unambiguous. It also stipulates the need to make a clear and immediate record of administered medications.

There were a number of NMC 'Standards for Medication Management' not incorporated into the simulation, for example Section 4: Standard 9: Assessment which states nurses have 'continuing responsibility for recognising and acting upon changes in a patient's condition with regards to safety of the patient and others' p 26. These standards relate to the more expansive versions of checking procedures, for example, the ten rights, which include the ongoing assessment of patients to monitor the therapeutic effects of medications. They were not incorporated into the simulation because they were difficult to incorporate into a low-fidelity design and they were supplementary to the focus of the medication administration tuition received by the target population (see section 5.2).

To enable a realistic and ecologically valid representation of medication administration, contextual observations of registered nurses administering medications to patients were completed (see section 4.10.1). With the verbal permission of the nurse in charge, three nurses and patients on a medical ward from one London teaching hospital were approached and asked if they could be observed administering and receiving oral medications. They were informed of the purpose of the simulation and the need to identify the process of completing medication administration within the clinical context and informed that their participation would be anonymous. All three nurses and patients approached provided verbal consent.

Nurses and patients were asked to comment aloud their thoughts and actions pertaining to the medication administration task (Appendix C). Examples of observations include:

"Sometimes I check who the patient is first and sometimes I look at the drug chart first, especially if the patient is asleep. It really depends..."

“If I know the patient, I don’t check their details, although if I have loads of drug charts with me, I may do a quick check...don’t want to get it wrong”

“I always ask if they are allergic to anything, when I introduce myself to the patient... when I first give drugs to a patient. I do it now as small talk, for something to say. It is an easy way of checking without having to think about it!”

Task Analysis

The information collected was placed into a hierarchical task analysis. A hierarchical task analysis is a diagrammatic representation of a task and its composite subtasks (Kirwan and Ainsworth 1992). In the task analysis, medication administration was broken up into all the individual tasks and subtasks, for example, wash hands, check medication chart, check medications are due. The process was repeated for each subtask until no further useful information was identified. The task analysis served as the framework for the simulation. It informed the components of the medication administration task, the preliminary structure and the initial medication administration storyboard. All subtasks, even those that were initially considered to be inappropriate to depict in the simulation, for example, wash hands, were included in the task analysis to ensure that no exclusions were made prematurely from the simulation.

The task analysis was examined by three nurse lecturers who identified what should be added, removed, subdivided further or regrouped. An email was sent to academic and teaching members of staff from KCL’s Florence Nightingale School of Nursing and Midwifery department to ask for volunteers to evaluate the task analysis and simulation development (see section 4.10.1). Their responses are detailed in Appendix C. The agreed task analysis is presented in Figure 5.

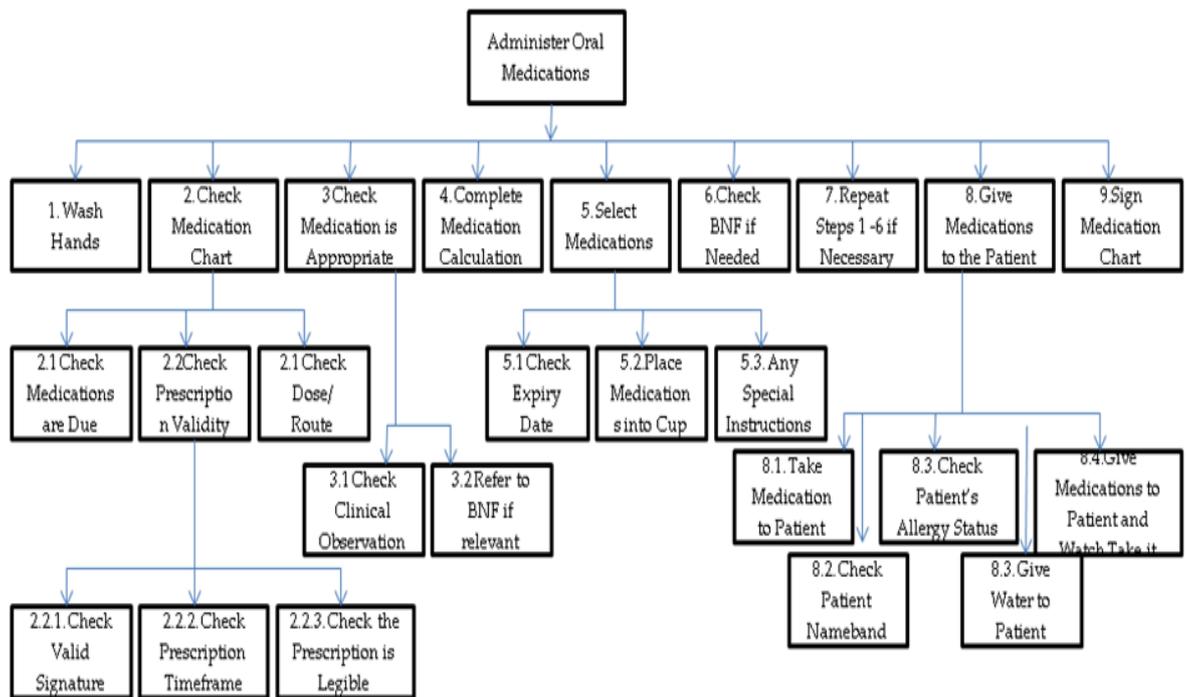


Figure 5. Task Analysis of Medication Administration

The nurses considered all the tasks included in the task analysis to be pivotal to provide an accurate representation of medication administration in the simulation with the exception of ‘wash hands’, ‘use diluent as appropriate’ and ‘give water to patient’. Although these are key aspects of medication administration included within the ‘five moments of handwashing’ (Sax et al 2007), they were deemed to be excessive for the aims and objectives of the simulation. They argued that these tasks would be difficult to replicate in the simulation and potentially subtract from the focus of the simulation of checking procedures. The nurses felt that they were supplemental and unnecessary. They were therefore removed and excluded from the subsequent development.

The nurses discussed whether a link to the British National Formulary (BNF) should be included within the simulation. This related to Standard 8: Administration, part 2.3. of the NMC’s ‘Standards for Medication Management’ (2015b) which states that the nurse must know the therapeutic uses, dose, side effects, precautions and contra-indications of medicines. The simulation was designed to focus on the medication administration process, and the five rights of medication administration, and not a pharmacological assessment of the appropriateness of the medications. The nurses were informed that the simulation would contain only appropriate prescriptions for patients. The nurses agreed that if students were informed that all prescribed medications were appropriate to administer, access to the BNF would not be required. Consequently, the task of ‘check BNF if appropriate’ was also excluded.

The nurses also stated that national regulatory standards require nurses to be aware of the patient's care plan when administering medications. They recommended the simulation should also include patient observations, medical history, diagnosis, drug expiry date and allergy status which should be suitable for all medications prescribed. This ensured that Standard 8: Administration, part 2.4 and 2.8. of the NMC's Standards for Medication Management (2015b) in which nurses were aware of the patient's care plan and the requirement to administer or withhold medication in the context of the patient's condition was incorporated into the simulation. All nurses agreed that the simulation should enable students to administer medications, and complete the five rights in a flexible order. Below is the list of all of the agreed simulation requirements.

Final Simulation Requirements

The final simulation requirements identified for the simulation were:

1. The participant must be able to administer oral medications according to NMC guidelines.
2. The simulation must enable the participant to identify patients, check their details and administer medications in a flexible manner.
3. The simulation must inform the participants of what time medication round they are completing.
4. The simulation must inform the participant which patient to whom they are to administer medications.
5. The participant must be able to check and recheck the patient's name band, allergy status, medication chart, past medical history and most recent clinical observations at will.
6. The patient's medication chart, diagnosis and past medical history must be realistic patient presentations and enable the nurse to check between them easily.
7. The simulation must allow the participant to choose from a variety of doses for a given medication.
8. The simulation must inform the participant what medication and dose they have selected.
9. The participant must be able check the medication expiry date.
10. The participant must be able to remove any medications if they have been placed in error.

11. The participant must be able to administer the medications to a patient and observe that they have been taken.

12. The participant must be able to sign the medication chart when the patient has taken their medications.

The final requirements informed the next stage of the design process. They provided a framework from which to design the prototype screen shot templates which were then tested and evaluated.

5.4.2 Prototype Development Stage

The requirements and task analysis informed the design of template screen shots created using Microsoft Visio templates (2007). A number of preliminary screen shots were created to determine the potential structure, interface, content and page layout of the simulation. The following section provides the initial screen shots that were produced and then discusses how they were tested and evaluated for their suitability.

Template Screen Shots

The following section details the template screen shots produced. Figure 6 informs the participant of their task, the time and date.

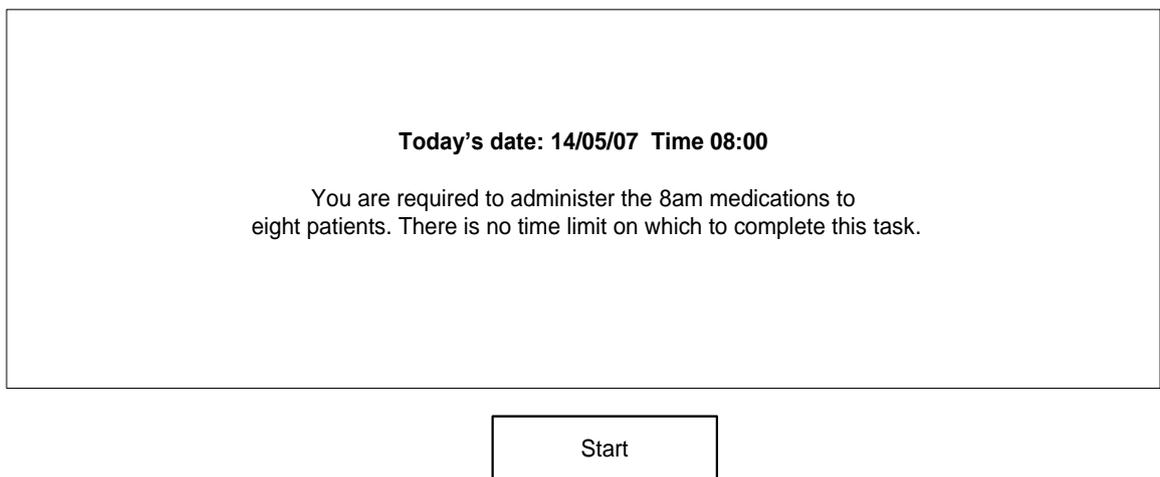


Figure 6. Template Information Screen

Figure 7 displays the template patient presentation screen. This screen displayed pictures of three patients. Alongside each patient, there was a link to their name band, patient details (past medical history, diagnosis and allergy status), and medication chart. At the top of the screen was an instruction stating the name of the target patient who the participant should administer medications. At the bottom of the screen shot was a medication cup. The medications were

administered when the cup was dragged over the picture of the selected patient. The date and time were also displayed.

Date: 14/05/07 Time: 08:00

Digital Clock

Task: Please administer drugs for patient **John Smith** for the 8am drug round

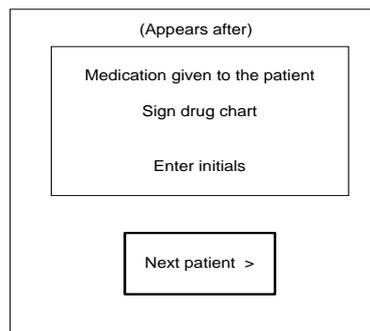
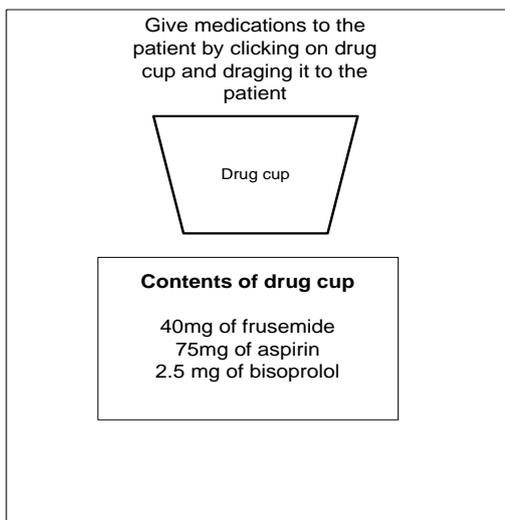
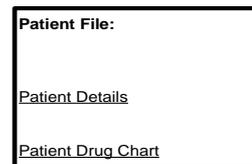
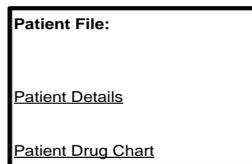
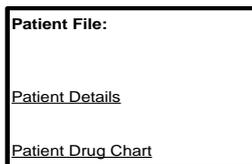
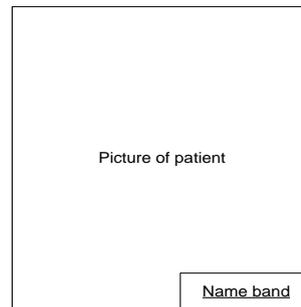
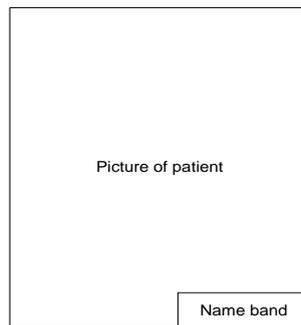
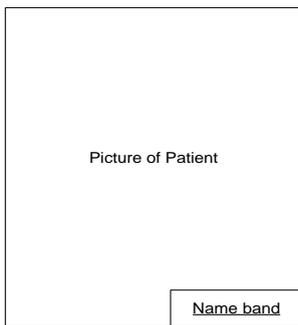


Figure 7. Template Patient Presentation Screen

Figure 8 displays the template medication chart. On the left-hand side was the patient's hospital details, medications, dose, route, start time, doctor's signature and any additional instructions. In the central section, participants selected the medication, dose and number of tablets required. To the right was a box which informed participants what they had selected. The participant selected the 'add to cup' box, and the selection appears in the medication cup. There was also a link to the medication pack to enable the user to check the expiry date.

Date: 14/05/07 Patient one out of eight

Task: Please administer drugs for patient John Smith for the 8am drug round

Digital Clock

Contents of drug cup

40mg of frusemide
75mg of aspirin
2.5 mg of bisoprolol

Finished adding drugs >

Drug Chart				
Patient Name	Hospital Number	Date of Birth	Drug Allergies	
John Smith	d123456	14/08/45	None known	

Drug				
Frusemide				
Dose	Route	Start Date	Valid Period	
40mg	PO	13/05/07		
Signature				
Additional Instructions				

8
12
14
18
22

Select drug round
08:00
12:00
14:00
18:00
22:00

Select drug and dose available
Frusemide 20mg
Frusemide 40mg

Select number of tablets of drug required
0.5
1
1.5
2
2.5

Amount of drug selected

Add to cup

[Frusemide pack details](#)

Drug				
Aspirin				
Dose	Route	Start Date	Valid Period	
75mg	PO	13/05/07		
Signature				
Additional Instructions mix with water, have after food				

8
12
14
18
22

Select drug round
08:00
12:00
14:00
18:00
22:00

Select drug and dose available
Aspirin 75mg
Aspirin 300mg

Select number of tablets of drug required
0.5
1
1.5
2
2.5
3

Amount of drug selected

Add to cup

[Aspirin pack details](#)

Drug				
Bisoprolol				
Dose	Route	Start Date	Valid Period	
2.5mg	PO	13/05/07		
Signature				
Additional Instructions				

8
12
14
18
22

Select drug round
08:00
12:00
14:00
18:00
22:00

Select drug
Frusemide 20mg
Frusemide 40mg

Select number of tablets of drug required
0.5
1
1.5
2
2.5
3

Amount of drug selected

Add to cup

[Bisoprolol pack details](#)

S
C
R
O
L
L

B
A
R

Figure 8. Template Medication Chart

Figure 9 displays the additional template patient details, drug cup and drug pack details pop up boxes.

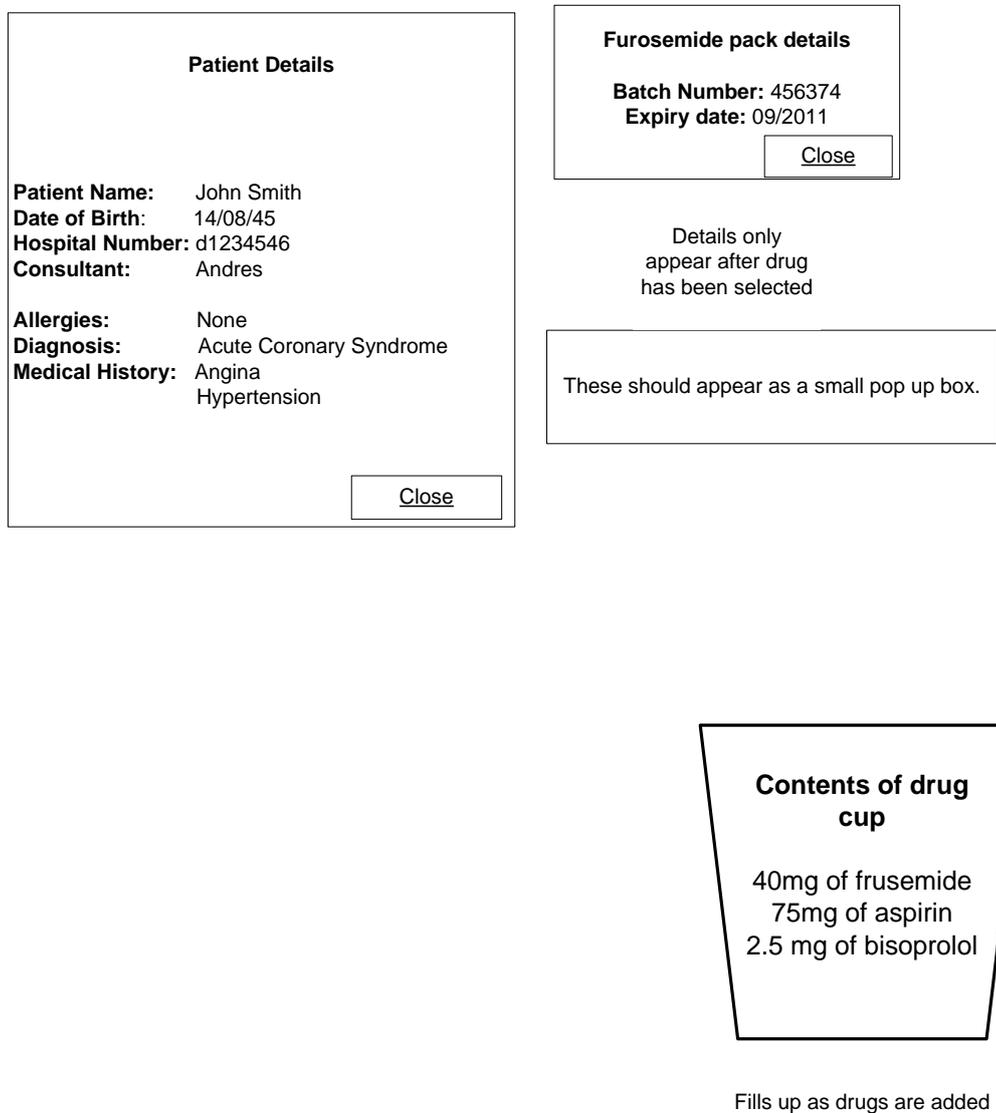


Figure 9. Template Additional Boxes

Templates User Testing and Evaluation

The screen shot templates were evaluated by registered nurses to ensure they provided an accurate reflection of the cognitive elements of medication administration and to define the structure of the simulation. An email was sent to academic and teaching members of staff from KCL's Florence Nightingale School of Nursing and Midwifery department to ask for volunteers to

evaluate the template screen shots. Three members of staff volunteered, two of whom also evaluated the task analysis (see section 4.10.1). They were informed that the simulation was designed to replicate the 8 am medication round. They were also informed that their participation would be anonymous and that they could withdraw their assistance. The staff were asked to look at the screen shots in order and vocalise aloud what they considered should be retained, removed or altered to maximise the simulation's similarity to clinical practice. Their responses were written down by the researcher and detailed in Appendix C. Examples of the feedback include:

"I need to know where the obs. are"

"The valid period hasn't been completed"

"I am confused, is the patient name band the same as the patient details? I would look at both"

This stage produced two significant alterations. The nurses felt that the name band and patient details were a potential source of confusion. It was recommended that the content of the patient name band and patient details should be amalgamated into one 'name band' section to ensure that the participant only needs to open one to identify the target patient. The name band section therefore comprised the patient's name, date of birth, hospital number, allergy status, diagnosis and past medical history. In addition, the nurses felt that the patient should be situated in a clear bed space with a corresponding bed number to emphasise the change of patients between bed spaces.

Template Site Map

A site map was produced to detail the participant's journey through the simulation and is displayed in Figure 10.

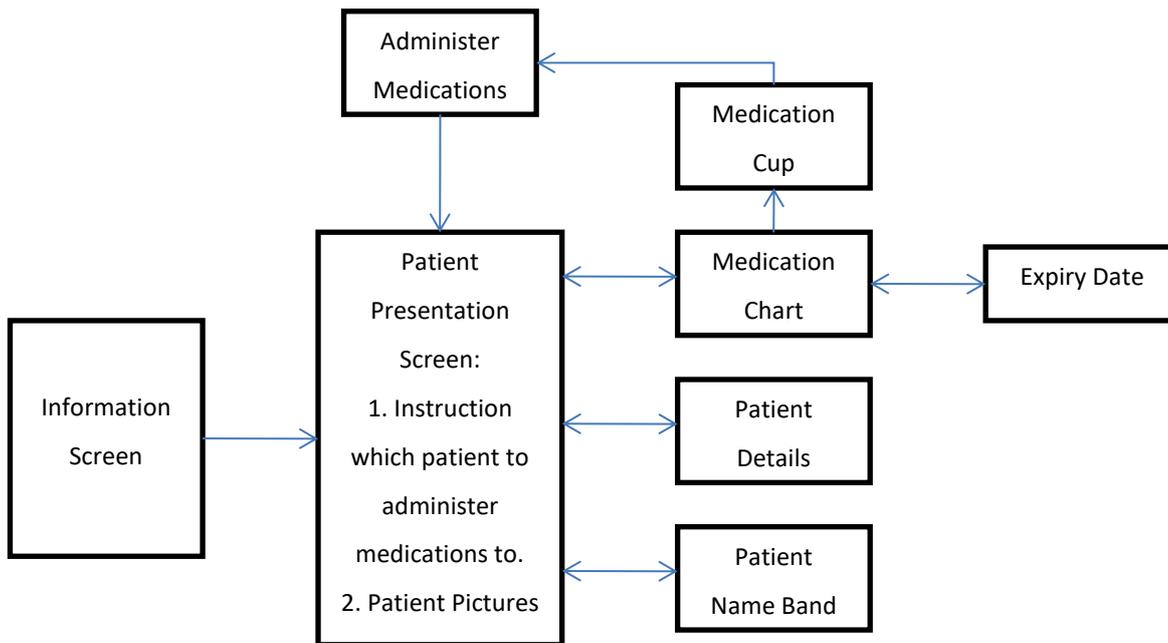


Figure 10 Medication Administration Site Map

All of the nurses stated that it was important for participants to be able to switch easily between the patient presentation screen, patient details, patient name band and medication chart. Therefore, the patient presentation screen formed the central base of the simulation from which the patient name band, patient details and medication chart could be accessed simultaneously.

5.4.3 Simulation Programming Stage

The simulation was programmed to incorporate the requirements identified in section 5.4.1. More intricate aspects of the simulation, for example, terminology, functionality and colour were also evaluated. To ensure the simulation was as realistic as possible, the simulation was programmed using photographs and patient profiles from real patients. The templates, site structure, patient profiles, medication charts and photographs were programmed into the simulation by a computer specialist at KCL

Patient Profiles and Medication Charts

Forty medication charts, past medical histories and diagnoses were programmed into the simulation. The majority were obtained with the consent of the nurse in charge from patients who attended an inner London Accident and Emergency department. A minority were obtained from Wyatt et al (2006). Only oral medications were included and any medications prescribed

using a different route were changed to oral where appropriate. Recent clinical observations were invented by the researcher to ensure that all medication administrations were suitable to be administered and reflected realistic patient presentations. All medication charts were written according to legislative requirements. Names and ages used in the simulation were fictitious and created by a researcher. The medication charts, past medical histories and diagnoses were examined and paired with photographs of 'patients' who feasibly could suffer from the specific illness and be prescribed the medications. To ensure all medications were suitable for administrations, all patients were designated as having 'no known drug allergies'.

Patient Pictures

Sixty patient photographs were taken of residents from three residential homes in South East London, and of friends, family and work colleagues of the researcher and supervisor of this study. 23 photographs were of individuals over 65 years, with the remaining photographs of individuals aged between 65 and 18 years.

The managers of five residential homes in South East London were contacted by telephoned and informed of the purpose of the study and the need for photographs (for further information about the ethical considerations of approaching the residents see section 4.10). They were asked if they considered their residents would consent for their photograph to be taken. Three managers felt their residents would be both keen to take part and competent to consent, and gave verbal permission to approach their residents. The researcher went to the three residential homes on arrangement with university and hospital identification clearly displayed.

The researcher explained the purpose of the study and the need for photographs. It was underlined that personal details would remain anonymous. It was explained that the photographs would be used solely for university purposes. All those approached in the residential homes, with the exception of four individuals consented, including four staff. All signed the university photography consent form (Appendix D). To ensure uniformity, the photographs were black and white, composing of the face, neck and shoulders.

5.4.4 Simulation User Testing Stage

Four registered nurses evaluated the programmed simulation to ensure it was effective for purpose, efficient and satisfying to use (ISO 2010) They were asked to vocalise aloud their thoughts and feelings about the simulation. They were asked to particularly focus on areas that

were suitable for purpose and areas that need to be altered. They were asked to critique the simulation and identify where and how it could be improved. Nurses were also asked to consider recommendations by nurses who had already evaluated the simulation. Their responses were written down by the researcher (Appendix C). Examples of the feedback included:

“I like being able to flit from drug chart to patient details”

“The chart is like the one at work”

The simulation was deemed by the final nurses to effective for purpose, efficient, satisfying to use and provided a psychologically valid representation of medication administration.

5.4.5 Group Testing

Nine members of academic and teaching staff at King’s College London group tested the simulation to ensure it could be used by multiple users simultaneously.

5.5 Final Simulation

The final simulation comprised five sections: an information screen, a patient presentation screen, a patient name band box, a drug pack details box, a medication chart screen and a medication cup box. This section will provide an overview of the final simulation. The following details the final simulation and how a right drug, wrong patient medication administration error was generated (located in the attached CD).

Information Screen

The first screen was the information screen (Figure 11) which informed participants that they were to administer the 8am oral medications to ten patients in ten minutes. It provided brief information about how to administer medications. Participants were informed that they could complete practise administrations before commencing the timed simulation. Participants clicked the ‘begin’ button and go to the central screen of the simulation.

Medicine Administration Simulation

Instructions

There are 10 tasks to complete within 20 minutes.

For each task, you will be instructed to administer the appropriate medication to one of a set of patients. You will need to check the patient's identity, open their prescription chart, prepare the medication and administer it.

You can do as many practice tasks as you want before you start the timed exercise.

Most medications are available in a variety of standard doses e.g. 10mg but some prescribed and available doses are given in Roman numerals i.e. I or II. All prescribed medications are to be given. You can assume that all special instructions for medications e.g. 'dissolve in water' are fulfilled.



Begin

Figure 11. Information Screen

Patient Presentation Screen

The patient presentation screen is displayed in Figure 12. It comprised the central screen of the simulation and provided links to the patients' details, medication chart and medication cup. A clock displayed the time of 08:00 to remind participants that it was the 8 am medication round and a timer to indicate the length of time remaining to complete the simulation. A green box informed participant whom was the target patient. Beneath the green box were pictures of three patients, their bed number, name band and medication chart. In this example, the participant is directed to administer medications the 8 am medications to the target patient, Abigail Laker in bed 22.

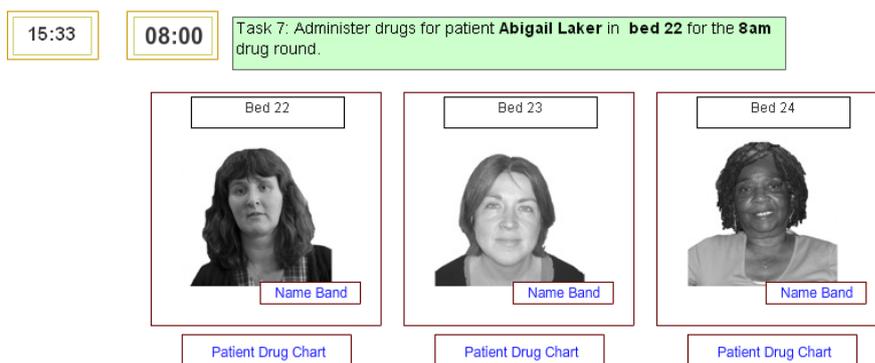


Figure 12. Patient Presentation Screen

Name Band

The name band link opened up a box which contained the patient's name, date of birth, hospital number, allergy status, diagnosis, medical history and most recent observations: blood pressure, pulse, temperature, respiratory rate and oxygen saturations.

Medication Chart Screen

The patient medication chart link opened the medication chart and is displayed in Figure 13. When opened, the chart covered and obscured the pictures of the patients. At the top of the chart was a 'Close drug chart' button, where participants could close the chart and return to the patient presentation screen at will. At the top were the patient details: name, date of birth, hospital number and allergy status. Underneath was a list of all the medications prescribed for the patient with the administration time circled in red. To the right of the page was a scroll bar which enabled participants to view all the medications. Every medication was housed in its own box with the following information: medication, time, dose, route, start date, validity period, doctor's signature and any additional instructions.

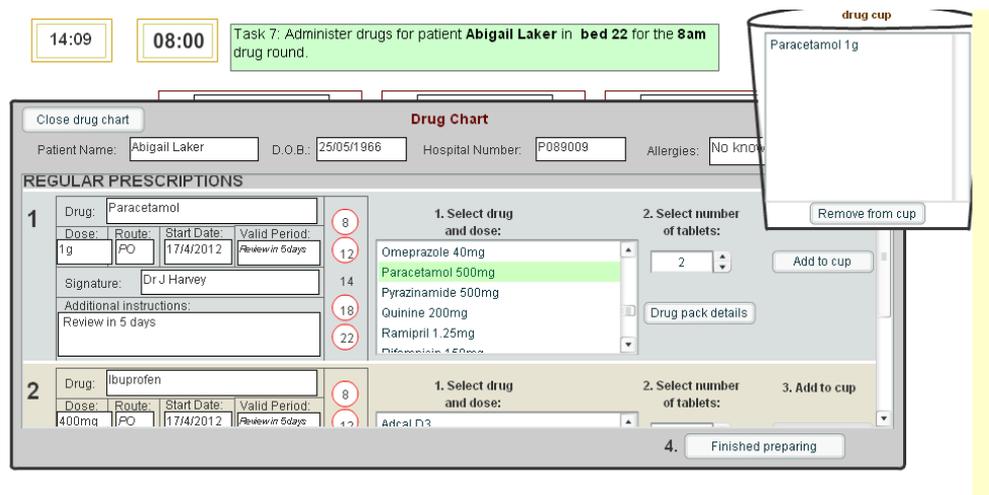


Figure 13. Medication Chart Screen

Next to every medication prescription was a box with '1. Select drug and dose' written on it. This box represented the hospital medication trolley. All medications available to be selected were listed in alphabetical order with available doses. To the right of this was an instruction '2. Select number of tablets'. This is where participants selected the number of tablets required. Next to this was an 'add to cup' button. This becomes activated when both the medication and number of tablets was selected. The participant clicked on this button to transfer the selected medications into the cup. At the bottom of the cup, was a 'Remove from cup' button. This became activated when a medication was placed in the cup. Participants were able to remove medications in the cup by highlighting them and clicking on the 'Remove from cup' button. There was also a 'Drug pack details' link which opened up a box with the name of the medication, batch number and expiry date.

Participants scrolled down the medication chart and repeated this process until all 8 am medications were placed in the cup. At the bottom of the medication chart was a button which had '4. Finish Preparing' written on it. When this was selected, the medication chart disappeared and participants returned to the central patient Laker presentation screen with the drug cup still on display.

5.6 Generating the Error in the Simulation

The error generating scenario based on the change blindness phenomenon occurred when the medication chart was opened. Whilst the participant prepared the medications and the medication chart obscured pictures of the patients, the target patient changed position with a decoy patient. In this example, Abigail Laker in bed 22 changed position with the decoy patient

who was in bed 23. In the scenario, the patients' name band remains with the patients to enable participants to correctly identify the patients if they apply the five rights.

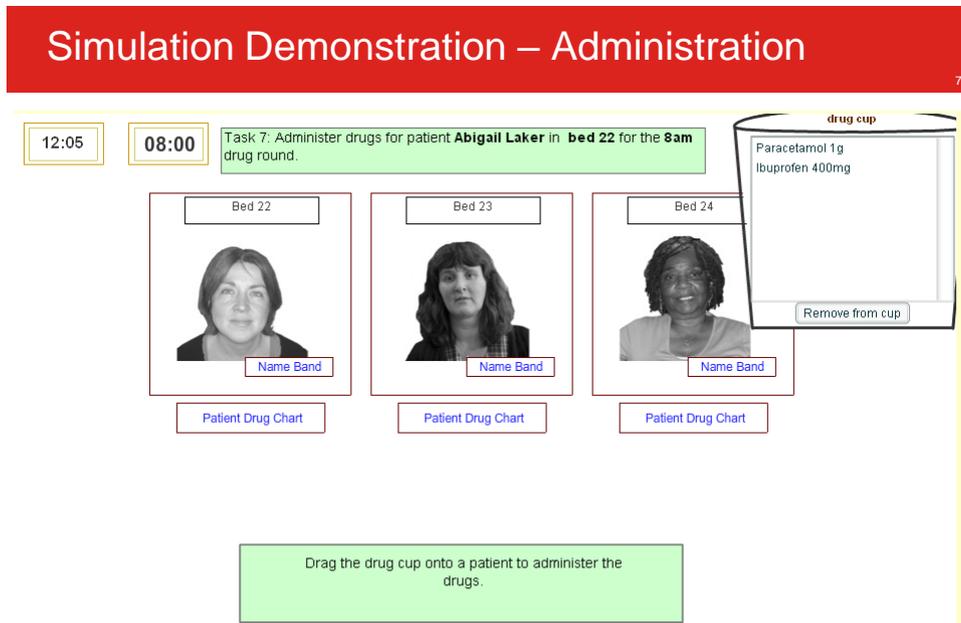


Figure 14. Target and Decoy Patient Change Screen

To administer the medications, participants dragged the cup onto the patient picture. A right drug, wrong patient error occurred if the participant failed to apply the five rights, did not notice the patient change and administered the medications to the decoy patient now in bed 22 as displayed in Figure 14. When participants administered the medications, a box appeared informing them that the medications have been given to the patient, with a button that stated 'Sign drug chart'. When this was clicked, participants were presented with a second administration task. When participants completed all of the administrations, they were presented with their score.

5.7 Simulation Development Phase Summary

The simulation was developed using usability engineering design methods to ensure that it incorporated all theoretical and cognitive elements of medication administration and was effective, efficient and satisfying to use. The simulation was based on an 8 am hospital medication round which is an authentic commonly occurring scenario for first-year nursing

students. The simulation incorporated the psychological phenomena of change blindness to generate a 'right drug, wrong patient' medication administration error. This uses change and cognitive load in the form of workload and complexity of medication administration (REF) which are real life causes of error, to generate the error. The usability engineering design methods, the authentic medication administration scenario and the use of real life causes of error to generate the medication administration error were used to create a low-fidelity simulation which had high levels of psychological fidelity and be realistic to nursing students.

Chapter 6: Phase Two: Titration Phase

6.1 Introduction

Chapter 5 detailed how the simulation was designed to generate a right drug, wrong patient error using the psychological phenomena of change blindness. Titration theory is derived from chemistry and refers to the process in which small amounts of a solution are incrementally added to determine a given or desired concentration of a solution. The titration phase reflects this same incremental process in which levels of the change and cognitive load elements, inherent in change blindness, were titrated to determine conditions to generate high and low rates of the right drug, wrong patient error. These conditions were then incorporated into the comparative study detailed in Chapter 7. The high error generating condition was incorporated into the simulation to maximise the likelihood that participants would make the error. The low error generating condition was incorporated for two reasons: to maximise the likelihood that participants would notice the risk of error, and help participants to avoid the phenomenon of change blindness (Levin et al 2002) enabling participants to reflect and learn from their error. This relates back to the underlying premise of the simulation (section 3.6). Using the principles of experiential and constructionist learning theory (Kolb 1984 and Bruner 1986), the active experience of error would generate affect and makes salient and available over the long-term the risk of error importance of applying checking procedures for safe medication administration practice. This would support students to have an internal locus of control and identify the importance of their role to promote safe medication administration practice.

Section 6.2 introduces the levels of the change and cognitive load elements titrated to generate high and low error generating conditions for the comparative study. Section 6.3 describes the titration phase method. Section 6.4 provides the results of the titration phase and participant feedback on the simulation. Section 6.5 details the high and low error generating conditions determined for the comparative study in Chapter 7.

6.2 Change and Cognitive Load Elements

There were two change and two cognitive load elements incorporated into the simulation. The change elements related to the degree of change to the visual scene once the target and decoy patients changed position. The elements manipulated were the visibility of the patient change and the physical similarity between the target and decoy patients. This was calculated by the number of shared similar physical characteristics, for example, age, sex, ethnicity and hair colour.

The two cognitive load elements manipulated were more intrinsic to the medication administration task and comprised the number of the medications to be administered and the complexity of the medication calculations.

6.2.1 Change Elements

The change elements were selected because they were practical to integrate into the simulation and manipulate for the purposes of the titration phase. The visibility of the patient change element was the mechanism of change to the visual scene and closely resembled Simons and Levin (1998). In this study, the first actor asked a pedestrian for directions. During the conversation two more actors pretending to be moving furniture carried an opaque door between the pedestrian and first actor, which momentarily prevented them from seeing each other. Whilst the door obscured the pedestrian's view, the first actor changed position with a fourth who continued on the conversation. 8/15 (53%) of pedestrians failed to notice the actor had changed. In the simulation, the medication chart replicated the door and was used to obscure the patient change. There were three levels of the visibility of the patient change: hidden, subtle and obvious:

- **Hidden** - the patient change occurred behind the medication chart which covered the whole screen and was completely hidden from view.
- **Subtle** – the patient change was partially obscured by the medication chart and the change occurred slowly over a few seconds.
- **Obvious** – the change was clearly obvious behind the medication chart which covered only a portion of the screen.

The second change element was the level of physical similarity between the target and decoy patients. This related to the degree of change to the visual scene once the target and decoy patients changed position. This refers back to the literature on salience and how it affects the ability to discriminate between items (Malera and Algom 2003). This states that the more salient the difference, the more likely it will be noticed. This suggests that patients with similar physical characteristics are less likely to be discriminated from one another. In the simulation, this was defined by the number of physical characteristics shared by the target and decoy patients. The characteristics were age, sex, ethnicity, hair length and hair colour. These were selected because they were identifiable characteristics from the patient photographs.

To determine the level of similarity, the sixty patient photographs were independently categorised by the researcher and supervisor according to their perceived physical characteristics.

The categories are displayed in Table 5. A Kappa analysis was conducted to determine inter-rater agreement. A high level of agreement for all categories was achieved. An inter-rater agreement of 100% was attained for sex, 92% for age, 97% for ethnicity, 90% for hair colour and 92% for hair length.

Table 5. Patient Physical Characteristics Categories

Sex	Male
	Female
Age	18 – 29 yrs
	30 – 39 yrs
	40 – 50 yrs
	51 – 64 yrs
	65 yrs+
Ethnicity	Asian
	Black
	Oriental
	White
Hair colour	Light
	Dark
Hair length	Bald
	Short
	Medium
	Long

There were two levels to the similarity of patients' physical characteristics; similar and dissimilar:

- **Similar** - where the target and decoy patient shared 4 or more physical characteristics
- **Dissimilar** - where the target and decoy patients shared any 3 or fewer physical characteristics.

6.2.2 Cognitive Load Elements

Instructional design of a simulation can affect the cognitive load and educational outcomes (Haji et al 2015 and Reedy 2015). The cognitive load elements incorporated into the simulation relates to intrinsic load (Sweller 1988) and were the medication administration calculations required and the number of medications required to administer. These were selected because they are integral to the medication administration process. They form the workload and calculations required in the simulation which are both prominent causes of medication administration error, (Mayo and Duncan 2004, Wirtz et al 2003, Oldridge et al 2004, Tang et al 2007, Beyea et al 2003 and Picone et al 2008).

For the number of medications element, there were two levels; few and many:

- **Few** – There were two or fewer medications on the medication chart.
- **Many** – There were three or more medications on the medication chart.

For the complexity of calculation element, there were two levels; easy and hard:

- **Easy** – Medication calculations result in the administration of one or two whole tablets of equal dosage
- **Hard** – Medication calculations result in the administration of three or more tablets or half a tablet. Although it is not ideal clinical practice, tablet-splitting is a widespread practice internationally in all sectors of health care (Verrue et al 2011), was sanctioned in and reflected the clinical placement experience of participants. It also enabled more complex calculations to be incorporated into the simulation to provide sufficient cognitive load. This only occurred in medications that were scored and suitable for splitting as defined in the British National Formulary.

6.2.3 Effect of Administration Time

Error rates between the first and second patient administrations were analysed to determine practise effects and identify if error rates changed upon exposure to the simulation.

6.3 Method

6.3.1 Design

The combination of change and cognitive load elements: the visibility of the patient change (three levels), the similarity of patient characteristics (two levels), the number of medications on the medication chart (two levels), and the complexity of medication calculations (two levels), produced a 3x2x2x2 factorial design with 24 permutations.

It was important that the high and low error generating conditions identified from the 24 permutations were robust. It was estimated with bivariate tests (Chi Square), that running the 24 permutations twice would be sufficient to distinguish between a high error condition of 60% or more errors and a low error rate of 20% or fewer errors, (power 0.8, alpha 0.05). Budgetary resources permitted 96 participants to complete the titration phase. This enabled the 24 permutations to be run four times ($24 \times 4 = 96$).

Using a repeated-measures design, 96 participants administered medications to ten 'target' patients. During the first patient administration, the 24 permutations were aimed to be presented in a balanced design and run four times across the 96 participants. However, as the medication charts were taken from real hospital patients it was not possible to integrate equal amounts of 'few' and 'many'. During the second to the tenth patient administrations, participants were exposed to random combinations of the change and cognitive load levels. Only the first two patient administrations were examined which resulted in a total of 192 administrations to be analysed.

6.3.2 Participants and Recruitment

All staff and pre and post-registration students with medical related backgrounds at KCL were eligible to participate in the titration phase, with the exception of first-year pre-registration nursing students as they were participant population of phase three and four of the study. A generic email was sent out via the KCL ethics committee requesting for participants with nursing, midwifery, medical and pharmacy backgrounds to test an online medication administration simulation (see section 4.10.2).

73 individuals responded to the email and 54 met the eligibility criteria and took part. Individual sessions were organised for them to complete the simulation in a university computer room. An additional 42 participants who also met the criteria were opportunistically recruited in the

computer room where the sessions were conducted. A total of 96 participants took part in the titration phase. The individual breakdown of the participants' background subject is provided in Table 6.

Table 6. Titration Phase Participants

Participant Type	Background Subject	Number
Lecturer	Nursing	13
	Dietetics	1
Student	Nursing (not first year)	22
	Medical	28
	Pharmacy	19
	Midwifery	7
	Cardiovascular	1
	Nutrition	2
	Biochemistry	2
	Forensic Science	2
Total		96

6.3.3 Experimental Procedure

Participants were provided with an information sheet (Appendix E) which stated that they were testing a new medication administration simulation designed for first-year nursing students. They were informed that their participation in the study was voluntary, their results would remain anonymous and they would be paid £10 in vouchers. Participants were told that the simulation was designed to replicate the 8am medication round and their task was to administer medications for ten target patients within ten minutes. They were informed that all the medication charts and past medical histories were from real hospital patients, that all prescriptions were correct and that all medications should be administered as prescribed. Participants were invited to complete practise administrations until they were confident using the simulation. At the end of the simulation, participants were informed of error rates.

6.4 Results

This section reports the descriptive and inferential statistics of error rates across the first two patient administrations, where error was most likely to occur. The remaining eight patient administrations were not included in the analysis. For the purposes of this phase, only the target right drug, wrong patient error was analysed and the results of this phase are located in Appendix F.

6.4.1 Changes to the Titration Phase Design

There were two changes to the titration phase design. The first few participants found it difficult to complete all ten administrations within ten minutes. The timeframe was extended to 15 minutes for all other participants.

Due to a computer error, there was an alteration to the 24 x 4 permutations design for the first patient administration. 16 of the 24 permutations were replicated the intended four times, however, two permutations were replicated five times, five permutations replicated three times, and one permutation was replicated seven times. During the second patient administration, the target and decoy patients failed to change positions on five occasions. These administrations were consequently excluded from the analysis. The remaining 187 medication administration error rates recorded comprised all 96 administrations from the first patient administration and 91 from the second.

6.4.2 Statistics

The number of presentations of the levels of the change and cognitive load elements across the first two patient administrations is displayed in Table 7 and the statistical output is in Appendix G.

Table 7. Presentations of Change and Cognitive load Levels Across the First Two Patient Administrations

Change Blindness Elements	Number of Presentations of Change and Cognitive Load Levels			N
	Obvious	Subtle	Hidden	
Visibility of Patient Change	64 (32.2%)	61 (32.6%)	62 (33.2%)	187
Similarity of Patients' Physical Characteristics	Dissimilar 92 (49.2%)	n/a	Similar 95 (50.8%)	187
Complexity of Calculation	Easy 89 (47.6%)	n/a	Hard 98 (52.4%)	187
Number of Medications on the Chart	Few 44 (23.5%)	n/a	Many 143 (76.5%)	187

There was an equal number of change and cognitive load levels presented across the first two patient administrations except for the number of medications on the chart, where there were approximately three times as many 'more' presentations compared to 'few'.

Statistical analysis was completed using SPSS version 15 to determine which a combination of the change and cognitive load elements generated statistically significant high and low rates of error across the first two patient administrations. The simulation produced an overall medication administration error rate of 24.6% (n = 46). Tables 8-11 present rates for each level of the change and cognitive load elements.

Table 8. Medication Administration Error Rates for the Visibility of Patient Change

The Visibility of Patient Change	No Error n (%)	Error n (%)	All n (%)
Hidden	42 (65.6%)	22 (34.4%)	64 (34.2%)
Subtle	47(77.1%)	14 (22.9%)	61 (32.6%)
Obvious	52 (83.9%)	10 (16.1%)	62 (33.1%)
N	141	46	187

The results of the visibility of the patient change element are displayed in Table 8. The hidden level generated most medication administration errors, followed by subtle. The obvious level generated the fewest errors. There was a twofold increase in the medication administration error rates using the hidden level compared to the obvious level. However, using Pearson’s Chi-Squared Analysis, there was no significant difference in error rates between the three levels of how the patients changed position, $\chi (2) = 5.785, p = 0.055$ one sided (>0.05).

Table 9. Medication Administration Error Rates for the Similarity of Patients’ Physical Characteristics

Similarity of Patients’ Physical Characteristics	No Error n (%)	Error n (%)	All n (%)
Similar	63 (68.5%)	29 (31.5%)	92 (49.1%)
Dissimilar	78 (82.1%)	17 (17.9%)	95 (50.8%)
N	141	46	187

The results of the similarity of patients’ physical characteristics element are displayed in Table 9. The similar level generated almost double the amount of medication administration error rates as compared to the dissimilar level. Using a Fisher’s Exact test univariate analysis, there was a

significant difference in error rates between the similar and dissimilar levels, $\chi (1) p = 0.023$ one sided (<0.05).

Table 10. Medication Administration Error Rates for the Number of Medications on the Chart

Number of Medications	No Error n (%)	Error n (%)	All n (%)
Few	35 (79.6%)	9 (20.4%)	44 (23.5%)
Many	106 (74.1 %)	37 (25.9%)	143 (76.5%)
N	141	46	187

The results of the number of medications element are displayed in Table 10. Participants made marginally more medication administration errors in the many condition compared to few. However, using a Fisher’s Exact test univariate analysis, there was no significant difference in error rates between the two levels, $\chi (1) p = 0.263$ (> 0.05).

Table 11. Medication Administration Error Rates for the Complexity of Calculation

Complexity of Calculation	No Error n (%)	Error n (%)	All n (%)
Easy	74 (83.1%)	15 (16.9%)	89 (47.6%)
Hard	67 (68.4%)	31(31.6%)	98 (52.4%)
N	141	46	187

The results of the complexity of calculation element are displayed in Table 11. The level of hard generated almost twice as many medication administration errors compared to the easy level. Using a Fisher’s Exact test univariate analysis, there was a significant difference in error rates between the many and few levels, $\chi (1) p = 0.014$ one sided (<0.05).

Table 12. Medication Error Rates for the First Two Patient Administrations

Administration Time	No Error n (%)	Error n (%)	All n (%)
One	71 (74.0%)	25 (26.0%)	96 (51.3%)
Two	71 (78.0%)	21 (22.0%)	91 (48.7%)
N	141	46	187

The results across the first two patient administrations are displayed in Table 12. There were marginally more medication administration errors generated during the first patient administration compared to the second. Using a Fisher's Exact test univariate analysis, there was no significant difference in error rates between the many and few levels, $\chi (1) p = 0.366$ one sided (<0.05).

In the univariate analysis, only the similarity of patients' physical characteristics and the complexity of calculation elements generated significantly different high and low rates of error. It was fundamental that the titration phase identified conditions that generated high and low rates of medication administration error across all elements. Therefore, a multivariate regression analysis for correlated data, a Generalising Estimated Equation (GEE), was completed. Within a correlation matrix framework, an estimated mean parameter of a variable condition is produced in which the within-group variable is compared to ascertain an average response over a population. GEE was used because it is a multivariate analysis appropriate for a binary dependent variable. Table 13 presents the result of the GEE analysis.

Table 13. GEE Multivariate Analysis of All First Two Patient Administrations

				95% Wald Confidence Interval				
	Parameter	B	Std. Error	Lower	Upper	Df	Wald Chi- Square	P
Complexity of Calculation								
0	Easy	0.516	0.258	0.11	1.022	1	4.004	0.045*
1	Hard	0						
Number of Medications								
0	Few	0.524	0.458	-0.374	1.423	1	1.309	0.253
1	Many	0						
Visibility of Patient Change								
0	Hidden	-0.311	0.3262	-0.951	0.328	2	0.912	0.340
1	Subtle	0.460	0.364	-0.252	1.172		1.601	0.206
2	Obvious	0						
Similarity of Patient's Physical Characteristics								
0	Similar	-0.447	0.3005	-1.036	0.142	1	2.210	0.137
1	Dissimilar	0						
Administration Time								
0	First	-0.286	0.234	-0.745	0.173	1	1.487	0.223
1	Second	0						

In the multivariate GEE analysis, only the complexity of the calculation element generated significantly different high and low medication administration error rates, $\chi^2(1) = 4.004$, $p = 0.045$ ($p < 0.05$).

The visibility of patient change and the number of medications elements did not generate significantly high and low rates of error across either the univariate or multivariate analyses.

These elements were therefore redefined and reanalysed. For the visibility of the patient change element, the levels of hidden, subtle and obvious achieved an error rate of 34.4%, 22.9% and 16.1% respectively. As subtle achieved the middle rate of error it was removed from analysis. Using the Fisher's Exact Test, the difference in error rates between the hidden and obvious presentation became statistically significant, $\chi (1) p = 0.017$ one sided ($p = <0.05$). Therefore, for the final simulation, subtle was excluded and only hidden and obvious were used.

The number of medications was also reanalysed with the level of subtle excluded as it was not to be included in the final simulation. This remained not significant in the univariate analysis $\chi (1) p = 0.13$ one sided ($p = <0.05$). Therefore, the number of medications element was redefined to: many = 3 or more and few = 2 or fewer and reanalysed to see if this generated statistically significant high and low rates of error. The results of this are displayed in Table 14. Using Fisher's Exact Test, this also remained not significant see $\chi (1) p = 0.078$ one sided ($p = <0.05$).

Table 14. Number of Medications on the Chart Element – New Definition

Number of Medications: New Definition	No Error n (%)	Error n (%)	All n (%)
Few	25 (86.2%)	4 (13.8%)	29 (23.0%)
Many	69 (71.1 %)	28 (28.9%)	97 (77.0%)
N	94	32	126

The new definitions for the visibility of the patient change and number of medications elements were included into a second GEE multivariate analysis and the results are displayed in Table 15. There was a significant difference in error rates between the levels of few and many, $\chi (1) \text{ Chi} = 6.009$, $p = 0.014$ ($p = <0.05$). There was also a significant difference in error rates for administration time $\chi (1) \text{ Chi} = 6.507$, $p = 0.011$ ($p = <0.05$).

Table 15. GEE Multivariate Analysis with New Definitions

				95% Wald Confidence Interval				
	Parameter	B	Std. Error	Lower	Upper	Df	Wald Chi- Square	P
Complexity of Calculation								
0	Easy	0.242	0.278	-0.304	0.788	1	0.752	0.386
1	Hard	0						
Number of Medications on the Chart								
0	Few	1.220	0.498	0.244	2.195	1	6.009	0.014*
1	Many	0						
Visibility of Patient Change								
0	Hidden	-0.560	0.3267	-1.220	0.100	1	2.768	0.096
1	Obvious	0						
Similarity of Patient's Physical Characteristics								
0	Similar	-0.661	0.310	-1.270	-0.053	1	4.541	0.033*
1	Dissimilar	0						
Administration Time								
0	First	-0.718	0.282	-1.271	-0.166	1	6.507	0.011*
1	Second	0						

6.4.3 Participant Simulation Feedback

Titration phase participants were also asked to provide feedback about the simulation. All participants stated that they found the simulation effective and satisfying to use and there were no changes made to functionality.

Participants also completed a prototype of the comparative study questionnaire to evaluate appropriateness and wording. 86 of the 96 participants completed the questionnaire and no one recommended alterations, additions or subtractions to the questionnaire. One question was

particularly relevant to most of the titration phase participants, who would administer medications in clinical practice. The question asked “What I have learned about medication administration errors in the simulation is likely to reduce the chances that I will make a medication error in the future”. 76.6% of participants considered the simulation to be likely to help reduce future medication administration errors.

A minority of participants provided qualitative feedback about their views of the simulation and their experience and is located in Appendix F. All of the feedback provided was positive and indirectly implied the simulation provided a psychologically valid representation of medication administration and reinforced the importance of the five rights in clinical practice. For example;

“A good extra tool”

“It’ll make me pay more attention even towards the end of the task”

“Provides a realistic opportunity to consider the skill as if qualified and provides a good basis on which to reflect”

Other feedback related to the underlying premise of the simulation to support the use of the five rights in clinical practice, and was clearly recognised by participants for example;

“Double check patient id”

“Checking and double checking again”

“Need to continue to be careful at all times”

6.5 Error Generating Conditions for the Comparative Study

The titration phase identified levels of the change and cognitive load elements that generated significantly different high and low rates of medication administration error in either the univariate or multivariate analyses. The average error rate attained in the high and low error generating conditions was 31.6% and 16.2% respectively. The identified high and low error generating conditions were programmed into the simulation for the comparative study and are presented in Table 16. In addition, the results highlight that participants are significantly more likely to make an error on the first patient presentation. Therefore, to maximise the likelihood that participants could make an error in the comparative study, the high error generating condition were presented before the low error generating condition.

Table 16. High and Low Error Generating Condition for the Comparative Study

High Error Generating Condition	Name	Definition
Visibility of the Patient Change	Hidden	The patients change position whilst completely obscured by the medication chart
Similarity of Patient's Physical Characteristics	Similar	The target and decoy patients share four or more physical characteristics
Number of Medications on the Medication Chart	Many	Three or more medications on the medication chart
Complexity of Medication Calculation	Hard	Administering three or more, or half a tablet
Low Error Generating Condition	Name	Definition
Visibility of the Patient Change	Obvious	The patients change position clearly visible behind the medication chart.
Complexity of Medication Calculation	Easy	Administering two or less tablets
Number of Medications on the Medication Chart	Few	Two or less medications on the medication chart
Similarity of Patient's Physical Characteristics	Dissimilar	The target and decoy patients share three or less physical characteristics

6.6 Titration Phase Summary

The purpose of the titration phase was to determine conditions that generated high and low rates of the target right drug, wrong patient error for the comparative study. This was to maximise the opportunity that participants made the right drug wrong patient error and also noticed the potential for error in the simulation. The titration phase successfully identified

significantly high and low error generating conditions to be programmed into the simulation for the comparative study.

Chapter 7: Phase Three: Comparative Study

7.1 Introduction

This chapter describes the comparative study where the simulation was integrated and evaluated in the educational setting for the first time. The comparative study compared the effectiveness of the simulation with two other teaching sessions. At the end of the three teaching sessions, participants completed a post session questionnaire. This phase took place in April 2008. Section 7.2 describes the aims and objectives of the comparative study. Section 7.3 details the comparative study methods and questionnaire design. Section 7.4 provides the results of the simulation and the error rates attained in the simulation and the results of the questionnaire. Section 7.5 provides a summary of the results of the comparative study.

7.2 Aims and Objectives

The aim of the comparative study was to evaluate the effectiveness of the medication administration simulation as a salient learning experience for nursing students compared to two other teaching sessions. Each of the three sessions comprised the same learning components but differed in their presentation format. The learning components were; the simulation, the experience of error through change blindness, causes of medication administration error and the importance of the five rights. The objective was to identify what teaching session provided the most effective learning experience.

7.3 Method

7.3.1 Design

Participants were randomised to one of three teaching sessions; the simulation session, the specific knowledge session and the theory only session. The simulation session served as the experimental teaching session in which the learning components were taught in an active format. Participants were given the opportunity to experience the simulation and the active experience of error in conjunction with experiential and constructionist learning theory (Kolb 1984 and Bruner 1986). At the end of the simulation, they were informed of their error rates and the rates of titration phase participants. The specific knowledge session served as an intermediate teaching session which combined the theory only teaching session and knowledge about the medication administration simulation and performance of others, but did not experience the simulation. The

theory only teaching session served as a control teaching session in which the learning components were taught in a more traditional teaching format.

7.3.2 Teaching Sessions Overview

In the simulation session, participants completed the simulation with the high and low error generating conditions determined in the titration phase programmed in. At the end of the simulation, participants were informed of their error rates and the error rates of titration phase participants. The specific knowledge session comprised a more traditional lecture format (Appendix H). Within the lecture, participants were taught the importance of the five rights using real life causes of medication administration error. Participants also watched a video of change blindness scenario from the original change blindness literature to experience making an error using change and cognitive load. The change blindness error made was then linked to change and cognitive load and medication administration error in clinical practice. This is because the teaching session was incorporated into the first-year nursing curriculum to teach safe medication administration practice, and therefore was designed to also give the participants an opportunity to learn from error (Homsma et al 2009 and Lorenzet et al 2005). Participants were informed of the simulation, the underlying theory of the simulation and the experience of error, and the performance of titration phase participants. The theory only session was identical to the specific knowledge session, apart from the information given to participants about the simulation. Participants were informed that the simulation existed, but not of its underlying theory and results.

At the end of the three teaching sessions, participants completed a post session questionnaire which examined the educational impact, perceived value and significance of the teaching session and perceived relevance of learning to the participants own medication administration clinical practice. The same questionnaire was used for all three sessions, but was tailored to reflect the teaching session experienced. There were three categories of questions:

1. Participant's previous experience of medication administration error in clinical practice and attitude to the topic of medication administration.
2. The educational impact of the teaching conditions and the simulation on future clinical practice.
3. Perceptions of the causes and emotional consequences of medication administration error.

7.3.3 Participants

Participants were first-year diploma, accelerated diploma and degree nursing students across the adult, child and mental health branches of the pre-registration programme at King's College London, University of London. 124 first-year students participated in the study. In the simulation session, 49 students completed the simulation and consented for their results to be used to form part of the evaluation. Of these, 14 were degree students and 35 were diploma students. In addition, 46 returned the questionnaire. To maintain anonymity, participants in the theory only and specific knowledge sessions were not required to register their attendance and therefore their programme of study remains unknown. 37 specific knowledge and 38 theory only session participants returned the questionnaire.

7.3.4 Procedure

Session Organisation

The teaching sessions took place at KCL during the participants' third term of their first year of study, after they had been taught medication administration in university and in clinical placement. The comparative study was a compulsory teaching session and took place after a pharmacology lecture. This was selected because pharmacology is a subject related to medication administration, was available on the timetable and provided the opportunity to recruit the highest number of participants. All teaching sessions were approximately one hour in length.

Participants were randomised to one of the three teaching sessions using a randomisation chart. At the end of the pharmacy lecture, students were informed they were going to participate in one of three novel teaching sessions. They were informed of which session they were allocated to and room location.

Simulation Session

The simulation session was delivered by a university lecturer. Participants were informed that they were to use and evaluate an online medication administration simulation as part of their medication administration curriculum. When the participants logged onto the simulation, the simulation introduction screen informed participants that they were to administer medications to 10 patients within 15 minutes. Within the simulation, participants were presented with a consent button and asked to click on the button if they consented for their results to be available for later

analysis. Clicking on this button was taken as consent and only the results of participants who clicked on this button were made available. To ensure participants were clear how to navigate the simulation, they were given the opportunity to complete some practise medication administrations before the timed simulation commenced.

The order in which the high and low error generating conditions determined in the titration phase were presented in the simulation is displayed in Table 17. Simulation session participants were randomly divided into two groups. Group one was presented with the high error generating condition for the first patient administration and a no patient change condition for the second. Group two was presented with a no patient change condition for the first patient administration and the high error generating condition for the second. This was designed to both identify and mitigate potential practise effects. However, all participants were presented with the high error generating condition for their first administration which involved a patient change condition. The third and fourth patient administrations comprised a random combination of change and cognitive load levels and the low error generating condition respectively. The order of these conditions made it progressively easier for participants to notice the patient change. The remaining 5-10 patient administrations comprised a random combination of the levels of the change and cognitive load elements.

Table 17. Patient Administration Presentation Order

Medication Administration	Group 1	Group 2
1	High error generating condition	No patient change condition
2	No patient change condition	High error generating condition
3	Random combination of change and cognitive load levels	Random combination of change and cognitive load levels
4	Low error generating condition	Low error generating condition
5-10	Random combination of change and cognitive load levels	Random combination of change and cognitive load levels

At the end of the simulation, participants were informed of their error rates and those of titration phase participants. At the end of the teaching session, participants completed the post session questionnaire. The return of a completed questionnaire was taken as consent for analysis.

Specific Knowledge and Theory Only Sessions

The specific knowledge session was delivered by the researcher and the theory only session was delivered by a university lecturer. The two teaching sessions used the same 40-minute power point presentation. Participants were taught about the extent, causes and consequences of medication administration error in clinical practice, and the importance of the five rights to mitigate error. They did not experience making an actual medication administration error, but were given the opportunity to make an error using footage from two well-known change blindness experiments (Simons and Chabris 1999 and Levin and Simons 1997), which was then related to medication administration error (Appendix H).

Participants were shown video footage of two teams passing a ball to each other and were asked to count how many times a designated team passed the ball. Whilst participants counted the passes, an actor dressed in a gorilla suit walked in between the two teams. In this scenario, the counting formed the cognitive load component which took their concentration and the gorilla formed the change component. At the end of the footage, participants were asked to state how many times the ball was passed between the designated team and if there were other comments they would like to share with the group about what they observed. This was to identify participants were sufficiently distracted not to notice the gorilla. Participants were informed about the gorilla and asked whether they believed this to have been true. Participants were shown the footage for a second time to ensure participants noticed the gorilla and realised they had made the error. There was a class discussion how the change blindness phenomena works and was actively related to causes of medication administration error and clinical practice. The class were then shown two more videos. The first one depicted two women sitting at a table chatting where nine changes occurred when the camera shot cut to a different angle. The second one depicted a man at an office table who stands up when a telephone rings. The video then cuts to a man walking to the phone and picking it up. The lecturer emphasised the role of change and cognitive load in medication administration error and how nurses are subject to such errors through change blindness. The importance of the five rights was underlined as a mechanism to minimise such errors in clinical practice.

The two teaching sessions differed in the information about the simulation given to participants. Specific knowledge session participants were informed about the background theory of the simulation, how the medication administration error was generated and the 31.6% error rate attained by participants in the titration phase in the high error generating condition. Theory only session participants were informed of the existence of the simulation without any further information. At the end of the teaching session, participants completed a post session questionnaire. The return of a completed questionnaire was taken as consent for analysis

7.3.5 Questionnaire Design

A questionnaire was used to assess the educational outcomes of the teaching session experienced because it is a quick, economical and efficient method for eliciting structured information from a large number of people (Bowling 1997). Participants completed the same questionnaire, which was tailored to the individual teaching session where relevant. The questionnaires for the three teaching sessions are located in Appendix I.

Question Generation

The questionnaire was specifically designed to assess the immediate impact of the teaching sessions. Oppenheim (1998) and Bowling (1997) state a questionnaire should be derived from theoretical areas of interest. For this study they were: perceived relevance of the simulation to clinical practice, perceived importance of the topic of medication administration to clinical practice, perceived likelihood of making a future medication administration error and perceived salience in terms of affect. This approach is supported by the literature. For example, Rattray and Jones (2007) recommend researchers refer constantly to the original research question and retain items that reflect the underlying theory, even if they lean poorly for psychometric analysis. The items in the questionnaire related to the theoretical underpinnings of the study and therefore were not suitable for psychometric analysis.

Two supervisors assessed the questionnaire for content validity. Predictive validity was assessed by the results of the long-term qualitative study. The questionnaire was also refined by the qualified nurses who helped design the simulation. It was finally piloted by titration phase participants, where the wording and order was finalised. The questions were grouped into the following categories: to identify the participants' baseline experience of medication administration error, perceptions of medication administration error and medication education,

perceived impact of the teaching session on the participants' clinical practice, and emotional response to making or witnessing error.

Baseline Experience of Error

Participants were asked whether they had either made or observed a medication administration error in clinical practice. Slovic et al et al (2004) suggested strong emotional experiences with hazards, such as making an error are an important factor determining risk perception. Siegrist and Gutscher (2005) reported that past experience with a problem increased the perceived likelihood that the problem would reoccur. These questions were incorporated to determine participants' previous experience of medication administration error to identify whether responses in the questionnaire reflected solely the experience of error in the teaching session or were potentially affected by a previous experience of medication administration error.

Perceptions of Medication Administration Error and Medication Administration Education

Participants were asked whether the topic of medication administration was important. The literature suggests that nursing students often experience difficulty linking what they are taught in university to clinical practice (Jarvis and Gibson 1997, Gregory et al 2009 and Jones and Treiber 2010). The premise of the simulation is that the simulation and the experience of error will provide an active learning experience to underline the importance of the five rights to clinical practice. The question was incorporated to determine the level of perceived relevance of medication administration to clinical practice.

Participants were asked about the perceived frequency and severity of medication administration error. The literature, for example, Weinstein (1989), Jackson (1991) and Siegrist and Gutscher (2008) suggests that experiencing a negative event increases the perceived risk of the event in terms of frequency and seriousness is an important factor in implementing protective behaviours. The question served to determine whether the teaching sessions affected the perceived risk and of error. In terms of the medication administration, the experience of error may increase the perceived frequency and severity of error and underline the importance of the five rights to mitigate a reoccurrence.

Participants were asked to rate the most important causes of medication administration error highlighted in the literature, (for example, Reason 2000, Hicks et al 2004, Fahimi et al 2008). Central to this question was to determine whether experiencing a medication administration

error in the simulation, such as through workload, affected how important it was perceived to be as a cause of error.

Participants were asked whether knowing / participating in the simulation helped them with their learning about medication administration. To be effective, education needs to be perceived to be relevant to students (Rafferty et al 1996). This was to identify whether participants considered the simulation as a teaching format to be useful and relevant to their learning.

Perceived Impact of Teaching Session on Clinical Practice

These questions were incorporated into the questionnaire because the central component of simulation education is to be salient and inform clinical practice over the long-term (Alinier 2004 and Siddiqui et al 2014). The main purpose of the simulation experience was to support participants in using the five rights to promote safe and effective medication administration. Therefore, participants were asked if what they learned about medication administration errors in the simulation will reduce the chance of making a medication administration error in clinical practice. Participants were also asked whether recent sessions in college about medication administration error will reduce the chance that they would make a medication administration error in practice. This was to determine whether participants differentiated the experiences of the simulation between other forms of teaching experienced at university and to determine how effective they were in supporting participants in safe medication administration practice.

Participants were asked if they believed they will make a medication administration error on a regular basis when they first qualify. To determine consistency on participants' prediction of error, they were also asked to estimate how many errors they would make during their first year of practice. This relates to the literature on the salience in which the experience of a negative event, such as making an error, increase the perception that it is more likely to occur and in turn, underline the importance of theory of safe medication for example, Siegrist and Gutscher (2008).

Participants were also asked as to whether they considered themselves to be less likely to make a medication administration error compared to other nurses of similar education and experience. This relates back to the change blindness literature in which participants over emphasised their ability to not be subject to the phenomenon (Levin et al 2002). This question was incorporated to identify if making an error in the simulation underlined to participants that they are as vulnerable as their colleagues to making an error.

Emotional Response to Making or Witnessing Error

The literature suggests that nurses who make a medication administration error commonly feel an 'affective' response to error, for example, Mayo and Duncan (2004) and Gladstone (1995). Affect plays an important role in salience and perception of risk (Slovic and Weber 2002). The question identified whether making an error in the simulation session generated a more salient emotional response compared to the other two teaching sessions. The emotional responses included in the questionnaire were anxious, angry, embarrassed, fear and sad (happy) and are emotions reported by personnel from making medication errors in clinical practice, (for example, Schelbred and Nord 2007, Santos et al 2007, Kroll 2008, Chard 2008, Padilha et al 2002, Pazokian et al 2014, and Wolf and Hughes 2008).

Format of the Questionnaire

The questionnaire was designed to measure a mixture of attitude, emotion, intention and behaviour to medication administration. To ensure that the questionnaire was clearly understood, the wording of the questions was simple and unambiguous (Rattray and Jones 2007) and pilot tested with titration phase participants. The majority of questions were composed of Likert scale questions and a visual analogue question. Dichotomous yes/no questions were used with specific closed questions Q1 and Q2 as they were related to factual questions of participants' previous experience of error.

Within nursing research, Likert type scales and frequency scales are most commonly used (Rattray and Jones 2007). The Likert scale is a highly structured attitude scale and comprises a variety of statements for respondents to agree or disagree with. The questionnaire aimed to identify participants' attitudes and intentions immediately after their teaching session and not what they were specifically taught and therefore an attitude scale was selected. Participants were asked to select which scale item most accurately reflected their opinion about the statement from strongly agree to strongly disagree. As discussed by Cooligan (2004), an equal number of favourable and unfavourable terms about each statement were produced. Burns and Grove (1997) suggests including a neutral option in the scale so that respondents are not forced to choose a response they do not necessarily agree with. Therefore, a neutral response was included for all questions.

The questionnaire was composed of both positive and negative statements to avoid the 'response acquiescence set'. This is the tendency to agree rather than disagree with items in a questionnaire. This facilitates respondent to think about each individual statement afresh and

without bias (Rattray and Jones 1997). Each response was converted into a number to enable the responses to the questions be statistically analysed. There was no assumption that the scale items had equal distance between them, but they did denote an ordering of the attitudes of respondents (Rattray and Jones 2007). The statements were also closed-ended, limiting the amount of information that can be collected. However, participants were also given the opportunity to add anything to the questionnaire which may not have been covered in the questions posed. Free text areas were provided to allow for more in-depth and expansive responses to individual questions. A Likert scale was used for Q3 - Q10. Q11 comprised as estimation of future rates of error and Q12 comprised a rank scale of causes of error.

The questionnaire also used a visual analogue scale (VAS), which is used to investigate mood and affect. Often it is a measurement of the intensity of an experience. VAS questions typically are anchored with extreme ratings at either end. VAS was used for Q13 as this question was related to affect. A minority of questions required binary yes/no answers to elicit statement of facts regarding past events or estimations of future performance.

7.4 Results

This section is divided into two. The first section details the results of the simulation (see Appendix J) and the second section details the results of the questionnaire (see Appendix K and L).

7.4.1 Simulation Results

Participants completed a total 382 administrations. 35 (8.4%) right drug wrong patient medication administration errors were made across all administrations completed and 17 (35%) of participants made at least one of this type of error. A wrong dose error was the only other form of medication administration error made and occurred during 24 (6.28%) patient administrations. All participants completed the first two patient administrations, 45 (91.82%) completed the first four, but only 25 (51%) completed all ten.

There were some discrepancies between how the high and low error generating conditions were programmed in the simulation and how they presented to participants. During the high error generating condition, three participants were presented with a dissimilar patient change instead of the intended similar patient change. In addition, in the low error generating condition, three participants were required to complete hard instead of easy medication calculations.

The percentage of errors in the high and low error generating conditions in the titration phase and comparative study are displayed in Table 18. There were more errors made in the high error generating condition and fewer errors made in the low error generating condition in the comparative study compared to the titration phase.

Table 18. Medication Administration Error Rates in the Titration and Comparative Study

Error Rates	Titration Phase	Comparative Study
High Error Generating Condition	30.8%	34.7%
Low Error Generating Condition	13.9%	6.5%

The simulation results section analyses the results of the first four patient administrations only. This is because the first four patient administration tasks were specifically ordered to both generate a medication administration error and to maximise the likelihood that the error would be noticed.

First Four Medication Patient Administrations Error Rates

The error rates for the first four patient administrations are displayed in Table 19.

Table 19. Medication Administration Error Rates: First Four Patient Administrations

Medication Administration Presentation	Error n (%)	No Error n (%)
First (mixture of the high error generating and the no patient change conditions)	9 (18.4%)	40 (81.6%)
Second (mixture of the high error generating and the no patient change conditions)	10 (20.4%)	39 (79.6%)
Third (random condition)	8 (17.4%)	38 (82.6%)
Fourth (low error generating condition)	3 (6.5%)	43 (93.5%)
N	30	160

Error rates were similar across the first three patient administrations. However, there was a decline in error rates in the low error generating condition during the fourth patient administration 3 (6.5%). If there were practise effects using the simulation, the expectation was that there would be lower rates of error during the second patient administration. The similarity of error rates between the first and second administration task suggests error rates were not subject to purely practise effects.

The results of the first four patient administrations were reorganised into the first four administration conditions: the high error generating condition, no patient change, random combination of levels of the change and cognitive load elements and the low error generating condition. The results of the administration conditions for the first four administration conditions are displayed in Table 20. 17 (34.7%) of participants made an error in the high error generating condition compared to 2 (4.1%) in the no change condition.

Table 20. Medication Administration Error Rates: First Four Administration Conditions

Medication Administration Condition	Error n (%)	No Error n (%)
High error generating condition (first and second administration presentation)	17 (34.7%)	32 (65.3%)
Random condition (third presentation)	8 (17.4%)	38 (82.6%)
Low error generating condition (fourth condition)	3 (6.5%)	43 (93.5%)
No change condition (first and second administration presentation)	2 (4.1%)	47 (95.9%)
N	30	160

7.4.2 Post Session Questionnaire Results

The results are divided into four sections: pre teaching session experience of medication administration error, perceptions of medication administration and medication administration error; perceived impact of teaching session, and the simulation on future clinical practice and emotional responses to medication administration error.

All statistical tests were completed using SPSS version 21. The majority of the questions were analysed using Pearson's Chi-Square test because it identifies associations between categorical data and is suitable for an unbalanced design. However, the Pearson's Chi Square test specifies that each expected count in the analysis must be a minimum of 5. A majority of questions using the Likert scale did not achieve a minimum count across every response in the five-point Likert scale. Therefore, for the majority of questions, scores were combined and analysed as two groups; strongly agree with agree, and disagree with strongly disagree. For each question, the score of undecided (neutral) was amalgamated into one of these two groups dependent on the desired response for each question. This has been specified in the text where required. Two questions (the importance of medication administration and the number of predicted medication

errors made in the first year as a qualified nurse) did not achieve an expected minimum count of 5 using two groups. Therefore these questions were analysed using Fisher’s Exact test. For two of the questions: ranking the causes of error and the emotional response to error, a Kruksal-Wallis test was used. This is because it compares the rankings of variables across groups, including in an unbalanced design.

Pre Teaching Session Experience Questions

The participant’s previous experience of medication administration error is detailed in Table 21.

Table 21. Previous Experience of Medication Administration Error in Clinical Practice

Previous Experience of Medication Error in Clinical Practice	Simulation Session n (%)	Specific Knowledge Session n (%)	Theory Only Session n (%)	All n (%)
Made an Error	1 (2.2%)	1 (2.7%)	3 (8.1%)	5 (4.3%)
Witnessed an Error	17 (36.9%)	14 (37.8%)	10 (27.0%)	41 (33.9%)
N	46	37	37	120

5 (4.2%) participants from the three teaching sessions previously made a medication administration error, whereas approximately one third of participants previously witnessed a medication administration error, 41 (34.5%). This is important because it identified the participants baseline experience of error. Ffor the majority of participants, experiencing error in the simulation or in the other two teaching sessions was be their first ‘active’ learning experience of making an error in the context of medication administration. Therefore responses in the questionnaire, for example their emotive response to error and perceived frequency and severity of error reflected solely on their experiences in the teaching sessions and not due to a previous experience external to the simulation. In addition, approximately one third of all participants

witnessed an error. Therefore, only a minority of participants would have previous, vicarious understanding of error and how it relates to clinical practice.

Perceptions of Medication Administration Error and Medication Education

Participants were asked whether the topic of medication administration was important to their clinical practice, and the results are displayed in Table 22. 116 (95.8%) of participants agreed or strongly agreed the topic of medication administration to be important to their clinical practice, with only 5 (4.2%) of participants from the simulation and theory only session who disagreed, strongly disagreed or were neutral. Using Fisher's Exact Test, there was no significant difference between teaching sessions, $\chi^2 (1) 1.041, p = 0.706$ two sided ($p = >0.05$).

Table 22. Importance of Medication Administration

Participant Response	Simulation Session n (%)	Specific Knowledge Session n (%)	Theory Only Session n (%)	All n (%)
Strongly agree / Agree	43 (93.5%)	36 (97.3%)	35 (92.1%)	114 (94.2%)
Undecided / disagree / strongly disagree	3 (6.5%)	1 (2.7%)	3 (7.9%)	7 (5.8%)
N	46	37	38	121

Participants were asked whether they perceived medication administration error to be rarely serious and the results are displayed in Table 23. This answer examined the perceived risk of the consequences of error, and therefore there was no clear desired answer, but a reflection on the concerns of participants. As such, responses are displayed in their full categories. The majority of participants across all three teaching sessions either disagreed or strongly disagreed that medication administration error was rarely serious. To enable the Chi Square statistical analysis to be conducted, neutral was combined with agree and strongly agree as medication administration error is a serious concern. There was no significant difference between teaching sessions, $\chi^2 (2) 1.069 p = 0.586 (p = > 0.05)$ on how serious medication errors were considered to be.

Table 23. Responses to the Statement Medication Administration Errors are Rarely Serious

Participant Response	Simulation Session n (%)	Specific Knowledge Session n (%)	Theory Only Session n (%)	All n (%)
Strongly Agree	1 (100%)	0 (0%)	0 (0%)	1 (0.8%)
Agree	5 (71.4%)	0 (0%)	2 (28.6%)	7 (5.8%)
Undecided	9 (37.5%)	9 (37.5%)	6 (25.0%)	24 (20%)
Disagree	21 (33.9%)	20 (32.3%)	21 (33.9%)	62 (51.7%)
Strongly Disagree	10(38.5%)	7(26.9%)	9(34.6%)	26 (21.7%)
N	46	36	38	120

Participants were asked if they considered medication administration errors to be a frequent occurrence and their responses are displayed in Table 24. Responses of undecided were grouped with disagree and strongly disagree as it was important that participants understood that medication administration errors are a frequent occurrence. 28 (60.9 %) of the simulation session participants, 30 (81.0%) of the specific knowledge session participants and 33 (89.9%) of the theory only session participants, agreed or strongly agreed that the medication administration errors were a frequent occurrence. There was a statistical difference between teaching sessions ($\chi^2(2) = 9.78$, $P = 0.008$ two-sided $p < 0.05$). Participants from the simulation session were less likely to consider medication administration errors to be a frequent occurrence compared to participants from the other two teaching sessions.

Table 24. Responses to the Statement Medication Administration Errors are a Frequent Occurrence

Participant Response	Simulation Session n (%)	Specific Knowledge Session n (%)	Theory Only Session n (%)	All n (%)
Strongly agree / agree	28 (60.9%)	30 (81.1%)	32 (89.2%)	90 (75.8%)
Undecided / disagree / strongly disagree	18 (39.1%)	7 (18.9%)	5 (10.8%)	30 (24.2%)
N	46	37	37	120

Participants were asked to rank in order of importance causes of medication administration error. 1 was classified as the most important cause of error and 5 the least important. The means are displayed in Table 25.

Table 25. Mean Rank of Causes of Medication Administration Error

Causes of Medication Administration Error	Simulation Session	Specific Knowledge Session	Theory Only Session
Distraction	1.8	2	1.5
High workload / Time Pressure	2.2	2.2	1.9
Illegible Prescription	2.6	2.9	2.5
Lack of Knowledge	3.2	2.8	2.9
Incompetence	3.4	2.9	3.5
N	42	36	36

Distraction was rated the most important cause of medication administration error across all three teaching sessions, with incompetence as the least important overall. The other causes of medication administration error received similar rankings across the three teaching sessions. A Kruksal-Wallis test was completed to see if there was a statistical difference in ranking between the three teaching sessions and the results are presented in Table 26. There was no significant difference between teaching sessions in how they rated the importance of any of the causes.

Table 26. Causes of Medication Administration Error

Kruksal-Wallis Chi Square Test	Df	Chi-Square	P Value
Distraction	2	1.660	0.436
High Workload / Time Pressure	2	0.763	0.683
Illegible Prescription	2	2.284	0.319
Lack of Knowledge	2	0.364	0.834
Incompetence	2	2.922	0.232

Perceived Impact of Session on Future Clinical Practice

Participants were asked if they felt what they had learnt in recent sessions in college would reduce the chances they would make a medication administration error in clinical practice. This question encompassed the full content of the three teaching sessions, and other medication administration teaching within the university. The results are displayed in Table 27. 41 (89.1%) of simulation session participants 29 (78.4%) of specific knowledge session participants and 34 (91.89%) of theory only session participants agreed or strongly agreed that recent sessions in college would reduce the chances they would make a medication administration error in clinical practice. There was no significant difference between teaching sessions, ($\chi^2 (2) = 3.140, p = 0.219$ $p \geq 0.05$).

Table 27. Response to the Statement Recent Sessions in College Will Reduce the Chances of Future Medication Administration Error

Participant Response	Simulation Session n (%)	Specific Knowledge Session n (%)	Theory Only Session n (%)	All n (%)
Strongly agree / agree	41 (89.1%)	29 (78.4%)	33 (84.2%)	103 (85.1%)
Undecided / disagree / strongly disagree	5 (10.9%)	8 (21.6%)	5 (15.8%)	18 (14.9%)
N	46	37	38	121

Participants were asked if participating in / knowing about the medication administration simulation helped with learning about medication administration error. The results are displayed in Table 28. (60.0%) of the simulation session participants, 29 (78.4%) of the specific knowledge session participants and 15 (44.1%) of the theory only session participants, agreed or strongly agreed that the medication administration simulation helped with their learning. There was a significant difference between teaching sessions in the degree to which knowing about the simulation was perceived as helpful, $\chi^2(2) = 8.8$, $p \leq 0.012$, $p \leq .05$. Participants in the specific knowledge session were more likely to rate their simulation experience helpful compared to simulation session participants, with the theory only session participants least likely.

Table 28. Response to the Statement the Simulation Helped with Learning about Medication Administration

Participant Response	Simulation Session n (%)	Specific Knowledge Session n (%)	Theory Only Session n (%)	All n (%)
Strongly agree / agree	27 (60%)	29 (78.37%)	15 (44.12%)	71 (61.2%)
Undecided / disagree / strongly disagree	18 (40%)	8 (21.62)	19 (55.88%)	45 (38.8%)
N	45	37	34	116

Participants were asked if what they learned about medication administration error in the simulation was likely to reduce the likelihood that they will make a medication administration error in future clinical practice. The results are displayed in Table 29. 40 (86.96%) of the simulation session participants, 29 (78.4%) of the specific knowledge participants and 18 (51.4%) of the theory only session participants, agreed or strongly agreed that the medication administration simulation was likely to help them reduce the likelihood of making a medication administration error in future clinical practice. There was a significant difference between teaching sessions, $\chi^2 (2) = 13.5$. $P \leq 0.01$, $p \leq .05$. Simulation session participants were more likely to consider that their experience of the simulation would reduce the chances that they would make a medication error in future clinical practice compared to specific knowledge participants, with theory only session participants least likely.

Table 29. Likelihood of Simulation to Help Reduce Future Medication Administration Errors

Participant Response	Simulation Session n (%)	Specific Knowledge Session n (%)	Theory Only Session n (%)	All n (%)
Strongly agree / agree	40 (86.96%)	29 (78.37%)	18 (51.43%)	87 (74.6%)
Undecided / disagree / strongly disagree	6 (13.04%)	8 (21.62)	17 (48.57%)	31 (26.4%)
N	46	37	35	118

Participants were asked whether they perceived themselves to be less likely compared to other nurses of a similar background and experience to make a medication administration error. The results are displayed in Table 30. The response of undecided was grouped with disagree and strongly disagree because the teaching sessions were designed to reinforce to participants the likelihood that they are as likely to make an error as their contemporaries. 13 (29.6%) of participants in the simulation session, 16 (44.4%) of participants in the specific knowledge session and 17 (48.5%) of participants in the theory only session perceived themselves to be less likely to make medication administration errors compared to nurses of a similar background and experience. There was no significant difference between teaching sessions, $\chi^2(2) = 2.839, p = 0.242, p \geq .05$.

Table 30. Responses to the Statement Compared to Other Nurses of Similar Training and Experience I am Less Likely to Make a Medication Administration Error

Participant Response	Simulation Session n (%)	Specific Knowledge Session n (%)	Theory Only Session n (%)	All n (%)
Strongly agree / agree	13 (29.6%)	16 (44.4%)	17 (45.5%)	46 (39.3%)
Undecided/ disagree / strongly disagree	31 (70.4%)	20(55.6%)	20 (55.5%)	71 (60.7%)
Total	44	36	37	117

Participants were asked whether they believed that they will make a medication administration error on a regular basis in future clinical practice and the results are displayed in Table 31. The response of undecided was grouped with disagree and strongly disagree because the teaching sessions were designed to reinforce to participants the likelihood that they will make an error. 8 (17.8%) of participants in the simulation session, 4 (10.8%) of participants in the specific knowledge session and 5 (13.5%) of the theory only session participants agreed or strongly agreed they would make a medication administration error on a regular basis in clinical practice. Participants in the simulation session were most likely to state that they would make an error on a regular basis in future clinical practice, with participants from the specific knowledge session least likely, however there was no significant difference between teaching sessions, $\chi^2(2) = 0.281$, $p = 0.87$ $p \geq 0.05$.

Table 31. Responses to the Statement They Would Make a Medication Administration Error on a Regular Basis in First Year as a Qualified Nurse

Participant Response	Simulation Session n (%)	Specific Knowledge Session n (%)	Theory Only Session n (%)	All n (%)
Strongly agree / agree	14 (31.1%)	10 (27.0%)	12 (32.4%)	36 (29.9%)
Undecided / disagree / strongly disagree	31 (68.9%)	27 (73.0.2%)	25 (67.6%)	83 (70.9%)
N	45	35	37	119

Participants were asked to predict how many medication administration errors they would make in their first year as a nurse and the results are displayed in Table 32. 23 (58.9%) of participants in the simulation session, 22 (66.67%) of participants in the specific knowledge session and 23 (63.89%) of theory only session participants believed they would make four or more medication administration errors in their first year as a nurse. Using the Fisher's Exact Test, there was no significant difference between teaching sessions, $\chi^2(4) = 2.250$, $p = 0.706$ two-sided $p \geq .05$.

Table 32 Number of Predicted Medication Errors in the First Year as a Qualified Nurse

Participant Response	Simulation Session n (%)	Specific Knowledge Session n (%)	Theory Only Session n (%)	All n (%)
0-1	6 (15.4%)	7 (21.2%)	6 (16.7%)	19 (17.6%)
2-3	10 (25.6%)	4 (12.1%)	7 (19.4%)	21 (19.4%)
4+	23 (59.0 %)	22 (66.7%)	23 (63.9%)	68 (63.0%)
N	39	33	36	108

Emotional Responses to Medication Administration Error

Participants were asked to state their emotional response from 1-10 to making or knowing about a medication administration error in the simulation. The emotions selected were anxious, embarrassed, fearful, happy and angry. 1 denoted not feeling the emotion and 10 denoted extremely feeling the emotion and the mean rank is displayed in Table 33.

Table 33 Mean Visual Analogue Score of Emotions to Making a Medication Administration Error

Emotion	Simulation Session	Specific Knowledge Session	Theory Only Session
Embarrassed	4	4	3.6
Fear	3.3	3.4	3.3
Anxious	3.25	3	2.7
Angry	1.7	5.1	5.1
Happy	1.9	1.9	1.9
Total	38	33	29

Specific knowledge and theory only session participants were more likely to rank anger as their most prominent feeling to knowing that others made an error in the simulation, whereas simulation session participants' emotional responses to error in the simulation were more evenly distributed, except for anger. Happiness was rated the least felt emotion. A Kruskal-Wallis test was used to compare the ranks across the three teaching sessions and the results are displayed in Table 34. There was no significant difference across the three teaching sessions in how participants ranked any of the selected emotions to either making or hearing about error in the simulation.

Table 34 Statistical Results of Emotional Reaction Between Teaching Sessions

Kruskal-Wallis Test	Df	Chi-Square	P Value
Embarrassed	2	1.966	0.374
Fear	2	0.184	0.912
Anxious	2	0.210	0.900
Angry	2	1.395	0.498
Happy	2	0.312	0.855

Participants were invited to state other emotions that they felt upon making or hearing about the medication administration errors. Four participants in the specific knowledge session stated that they felt it was expected, stupid, they realised that it could happen and disappointed. Eight participants in the theory only session stated that they felt surprise, wary / regret, emotional, became more alert to the possibility of error, worried and scared. Thirteen participants in the simulation session added that they felt surprised, worried, concerned, stupid, annoyed, confused, worried about how easy it is to make an error and worried that they killed a patient.

Additional Comments in the Questionnaire

At the end of the questionnaire, participants had the opportunity to provide any further comments. A minority of participants from all three teaching sessions submitted brief comments. Participants from all three sessions detailed how the teaching session underpinned the importance of checking procedures, the need to be more alert to medication administration error and the need to be vigilant. There was a greater understanding of the causes of medication administration error and a heightened awareness the possibility that they could make an error. Only participants from the simulation session specifically mentioned the simulation and one stated that it was much clearer than medications charts that they encountered in clinical practice. Another stated that the simulation was well informed and that they would like further practise before their practical exam. Another stated that exercises such as the simulation should be encouraged. The majority of comments about the simulation referred to the usefulness of the simulation as an education tool. One comment was negative, and stated the simulation was not realistic. One participant in the specific knowledge session stated that they aimed to work in a critical care unit, and that it was an environment in which they believed errors could not occur.

7.5 Comparative Study Summary

In the comparative study, the simulation was programmed with the high and low error rating conditions determined in the titration phase and experienced by first-year nursing students in the education setting for the first time. The three teaching conditions intended to provide the following learning components in different formats; the simulation, understanding of medication administration checking procedures and the importance of safe medication administration practice, causes of medication administration error and the active experience of error using the change blindness phenomenon. These were provided in a combination of active and theoretical formats across the three conditions. All intended learning components were successfully integrated into the teaching conditions.

The simulation was successful in generating the target right drug, wrong patient error in which over a third of participants made at least one error. The change blindness phenomenon was effective in generating error and the use of change and cognitive load were appropriate contextual causes of error to incorporate into the simulation. In addition, the simulation underlined the risk of medication administration error because a minority of participants made a wrong dose error, which is another form of error, not designed into the simulation. The reduced error rates in the low error generating condition suggest that participants recognised the potential for error and were less likely to be subject to change blindness during that condition. The similarity in error rates across the first two admissions also suggest that there were no practise effects mitigating error rates. The vast majority of participants in the simulation session stated that they had no previous experience of making or witnessing a medication administration error. The simulation was therefore the first opportunity for a minority of participants to experience and learn from medication administration error. The simulation incorporated error as an active learning experience through experiential and constructionist learning theory. The theories require the active experience of the error to enable new learning and insights to occur. Participants were questioned about their pre simulation experience of medication administration error to ensure that any learning derived from error was generated from the simulation and not from a previous experience. Only a minority of participants had previous experience of making a medication administration error in clinical practice or in the simulation. Therefore, only a minority were able to learn from the active experience of error, irrespective of where / how the error occurred.

The results of the questionnaire highlight that overall, participants were positive about the simulation and it did provide an effective learning experience. There were a number of significant

differences between teaching sessions in the post session questionnaire. Participants in the simulation session were more likely to state that the experience of the simulation would help reduce the chances that they would make a medication administration error in future clinical practice. In addition, there was no significant difference between teaching sessions in the perceived effectiveness of recent sessions in college as a mechanism to reduce the chances of future medication administration error. This difference suggests that the simulation session participants viewed the simulation session as a distinct educational experience. It supports the literature, for example, Siddiqui et al (2014) who states that simulation education should inform clinical practice over the long-term. It also supports the literature on error and salience in which the experience of a negative event such as error can support the use of protective measures to mitigate the reoccurrence of the negative event, for example, Keller et (2006), Villegas et al (2013) and Ziv et al (2005).

However, responses to the questionnaire do not unanimously support the literature. Although simulation session participants were more likely to state that the experience of the simulation would help reduce the chances that they would make a medication administration error in future clinical practice, this difference did not transfer to the number of error participants predicted they would make in the first year of clinical practice. Similarly, there was no difference between teaching sessions in participant's perceived individual vulnerability to making an error in comparison to nurses of a similar education and experience. The majority of participants across all three teaching sessions considered themselves as likely as other nurses to make an error. Participants in the specific knowledge session were also more likely to state that the simulation helped them with their learning about medication administration error. This is exemplified in the response to the question regarding the perceived frequency of medication administration error. Participants in the specific knowledge and theory only sessions were more likely to suggest medication administration errors are a more frequent occurrence compared to simulation participants.

There were a number of questions which produced no difference between teaching sessions. With regards to the emotional response to error, there was no difference between teaching sessions between the type and extent of emotional response when making or hearing about error in the simulation. The simulation session did not evoke a stronger emotional reaction compared to the other two teaching sessions, despite being the only teaching session in which a medication administration error was actively experienced. There was also no difference between teaching sessions in the perceived severity of error.

There was no difference between teaching sessions how important the topic of medication administration to their clinical practice. The vast majority of participants considered medication administration to be very important to their clinical practice, despite the clear theory practice gap in medication administration denoted by the extent of error in clinical practice. With regards to the causes of error, distraction was seen as the most important cause of error across all three sessions, despite workload being one of the variables to titrate the medication administration error.

There is a possibility that the similarity of results across the teaching sessions may be related to the variance in experience between administering medications using the simulation compared to paper charts. Although the simulation was closely designed to replicate paper medication administration charts, the low-fidelity nature of the simulation may have resulted in a limited connection between making a real medication administration error. In deed, one participant reported they thought the patient change was due to a computer programming error. This is in contrast to the theory only and specific knowledge sessions in which making an error in the change blindness scenario, was directly related to medication administration error in clinical practice. This may have made the relationship between the education experience and medication error more explicit.

However, a limitation is that not all participants made a medication administration error in the simulation session. The premise of the study is to enable all simulation session participants to have the active experience of error. To this extent, the simulation did not achieve this.

Participants who did not make an error would not have been able to benefit from the experiential and constructionist learning experience from making the error. As making an error in the simulation is so central to the theoretical underpinnings of the study, this may help to explain why there were similar responses from participants across the three teaching sessions for the majority of questions.

In addition, the number of participants who were subject to the change blindness phenomenon in the specific knowledge and theory only sessions was not obtained and therefore a higher proportion of those participants may have made an error, which may have impacted upon their teaching experience. It would be useful for future analysis to have obtained this information to determine if this form of error, which was then actively linked to medication administration, was sufficient to also provide a salient learning experience. The questionnaire responses were anonymous and therefore participant responses could not be linked to whether they directly experienced error. As a consequence, the proportion of participants who were able to actively

experience error and learn from that error, either within the simulation or in the lecture is unknown. Future analysis should determine the impact of making or not making an error across the three teaching session on participants' questionnaire responses.

The results of the questionnaire highlight that the active and theoretical learning components across the simulation and the specific knowledge sessions provided different mechanisms to provide an effective learning experience for participants. A combination of these two teaching sessions would provide a salient learning experience for students. The theoretical learning about medication administration rates, causes and consequences, the active experience of error in the simulation, and knowing about error rates in the simulation would provide the most effective learning combination.

Chapter 8: Phase Four: Long-term Qualitative Interview Study

8.1 Introduction

Chapter 8 describes phase four, the long-term qualitative interview study, in which simulation session participants from the comparative study were interviewed about their experiences of the simulation two years later. Section 8.2 details the aims and objectives of this phase. Section 8.3 provides the method which describes the interview procedure. Section 8.4 describes Thematic Analysis approach used to analyse the interview data. Section 8.5 details the results of the interview and section 8.6 provides a summary of this phase.

8.2 Aims and Objectives

The aim of the long-term qualitative interview study was to investigate the long-term saliency of the simulation and the experience of error for simulation session participants in the comparative study. The specific objectives were to:

1. Determine the impact the simulation and making a medication administration error on participants' learning about the five rights and reported impact on subsequent clinical practice.
2. Identify the levels of realism achieved in the low-fidelity simulation and whether it was considered to be a valuable learning tool for nursing students over the long-term.
3. Examine the emotional response from completing the simulation and, where applicable, making a medication administration errors over the long-term.

8.3 Method

This qualitative interview study and was conducted two years after the comparative and used a combination of face-to-face and telephone interviews.

8.3.1 Participants

26 third-year pre-registration nursing students who participated in the simulation session in the comparative study and were still registered on the course were eligible to participate. An email was sent to the participants inviting them to be interviewed. One participant was recruited using

this method. A classroom-based information session recruited a further 11 participants. The 12 participants comprised nine diploma and three degree students. One participant was male and eleven were female. All participants were compensated £10 for their participation.

8.3.2 Design

A qualitative research approach was selected because it captures descriptive accounts to better understand unknown phenomena (Sinuff et al 2007 and Taylor and Bodgan 1998) and suited to help develop theory (Benoliel 1984 and Asselin 2003). This is central to successfully researching the participants' experience of the medication administration simulation because it was a novel area of research. Data was collected through semi-structured interviews which enabled both the participants' views and experiences to be captured (Rose 1994) and predefined research topics to be addressed (Polit and Tatano Beck 2004). There are a number of disadvantages to using semi-structured interviews including the need to rely on the expertise and ability of the interviewer to respond to chance remarks which might open up a wealth of unforeseen research data (Patton 2002). To counteract this, each interview was reflected upon and analysed immediately after to inform future interviews (Rose 1994) and to ensure a balance of questions.

8.3.3 Procedure

Face-to-Face and Telephone Interviews

The first semi-structured interview was conducted face-to-face. The following 11 were conducted via the telephone. Telephone interviews were used because they were cost and time efficient, convenient, (Ward-King et al 2010), enabled participants to contribute from disparate locations (Smith 2005), and were easy to organise (Worth and Tierney 1993). Historically, face-to-face interviews have been the mainstay of health research (Sturges and Hanrahan 2004). Despite limited methodological discussion on telephone interviews (Novik 2008), their has increased in recent years (Musselwhite et al 2007). Smith (2005) states this reflects wider acceptance of telephone interviews as a valuable data collection method. There were a number of practical reasons why telephone interview was a suitable alternative to the face-to-face interview. Qualitative telephone data has been judged to be rich, vivid, detailed, and of high quality (Chapple 1999, Kavanaugh and Ayres, 1998, Sturges and Hanrahan, 2004 and Sweet 2002). They can provide anonymity (Sweet 2002) and privacy (Sturges and Hanrahan 2004), and interview notes can be taken discreetly (Musselwhite et al 2007).

Long-standing arguments against telephone interviews focus upon the lack of visual cues required to support, expand, develop and contextualise interview communication (Baker et al 1994, Bowling 1997 and Opdenakker 2006). This in turn can restrict the researcher to rely solely on verbal prompts (Smith 2005). Establishing rapport is vital for a successful, authentic and free flowing interview (Marcus and Crane 1986). Robson (1993) argued the lack of visual cues in telephone interviews renders this difficult. In contrast, Ward-King et al (2010) stated there is minimal empirical evidence to support this. Opdenakker (2006) argued participants can feel more relaxed away from the interviewer's presence, and verbal strategies, for example, informally chatting at the beginning of the interview can also establish rapport (Burns 1994) and empathy (Tausig and Freeman 1988). This was important to this study as participants may have considered the researcher to be in a position of authority as a representative of their university. In addition, Burnard (1994) highlighted that non-verbal communication during face-to-face interviews is not always interpreted accurately. Advocates of face-to-face interviews also suggests telephone interviews are of shorter duration, for example, up to 30mins (Lavrakas 1987), which questions the depth and breadth of data collected. This is contested by Smith (2005), Waterman et al (1999) and McCoyd and Kerson (2006) who report telephone interviews of longer durations.

Numerous studies demonstrate little difference between interview data obtained by face-to-face or telephone interview (for example, Smith 2005 and Ward-King et al 2010). Chapple (1999) confirmed telephone interview can elicit 'rich' data. Carr and Worth (2001) argued there is solid support for telephone interviews as a comparable data collection method and should be considered a viable alternative to face-to-face interviews. These argument is supported by the length and richness of the data elicited in this study. For this study, the majority of participants were able to discuss in depth about their education experience.

Interview Procedure

At the beginning of the first interview, the participant was provided with an information sheet to read, which stated the interview would be tape recorded and written notes would be taken, and a consent form was signed (Appendix M).

The remaining eleven participants were contacted by telephone to schedule the interview and were provided with an overview of how the telephone interview would be conducted. It was made clear that the interview would be tape recorded and notes would be taken throughout. The date and time of the telephone was confirmed by email. Participants were posted the information

sheet, consent form, payment and a stamped self-addressed envelope in which to return the signed consent form.

At the beginning of the interviews, the researcher informed the participant how the telephone interview would be organised and its scope, boundaries and rapport were established. The same topic guide (Appendix N) was used for consistency and clarity, and was non-directive (Patton 2002). Whilst questions for the initial interviews were more open-ended, a sub-set of questions became more structured as interviews progressed to explore emerging themes (Rose 1994). At the end of the all interviews, the interviewer ran through their notes with the student to ensure they comprised an accurate reflection of their input and thanked them for their participation.

8.4 Thematic Analysis: Approach and Theoretical Structure

Two broad qualitative analysis approaches were considered for this study, narrative analysis and thematic analysis. Narrative analysis is a form of qualitative research which uses stories or narratives as a method to gain insight into a phenomenon. Riessman (2005) stated a 'narrative' is a sequence and a consequence, whereby events are selected, organised and constructed to be meaningful for a particular audience. Crossley (2000) described a narrative as an organising principle for human life. Narrative research is interpretive and seeks to uncover the authentic story of one person by another in their own words (Frost and Cliff 2004), to better understand an area of interest (Taylor and Bogdan 1998). It is set apart from other qualitative methods because it involves evaluating and analysing the narrative to elicit themes or other relevant details defined by the researcher to answer a research question (Overcash 2003).

Narrative research draws from other qualitative research methods including phenomenological study, interpretive phenomenology and discourse analysis (Frost and Cliff 2004). Over recent decades, there has been an increase in use of narrative research, for example, in the social sciences (Groleau et al 2006), health research and education (Gill 2001), providing varied theory, methods and studies which focus upon different attributes of narrative research. For example, in social history and anthropology, the narrative can refer to an entire life story (Riessman 2003), in social theory, the content of narratives is analysed to identify relevant themes, whereas in literary theory, the focus is to understand the intrinsic story-like structure (Groleau et al 2006). As a consequence, there is no precise definition pertaining to how narratives are used, processed or analysed in research (Launer 2002). The type of inquiry selected depends upon the outcome required by the researcher. Hardy et al (2009) argue that the philosophical basis, intention and purpose of the research is explicitly stated to inform the research methodology used.

Narrative research is used with particular enthusiasm in nursing research (Launer 2002). This may be indicative of the oral traditions in nursing, in which much communication is communicated verbally (Frost and Cliff 2004). Meaning is rooted within the narrative and will vary depending upon who is telling the story, to whom, where, when and by the themes or categories produced when analysing and evaluating narrative data, (Ville and Khlal 2007). It has been used as a method to gain insight about and describe a diverse range of health-related topics, for example, how people feel about a treatment (Overcash 2003), the course of a disease to provide insights in how to offer support (Hardy et al 2009) and to inform policy and staff development (Asselin 2003). It was initially believed that the telephone interviews would elicit participants' narratives of their experience of error in the simulation and any subsequent impact on clinical practice in the intervening two years between the simulation experience and evaluation stage and the telephone interview.

Thematic analysis was ultimately selected as the method to collect and analyse the interview data. This was because the medication administration error literature highlighted that data would potentially be excluded if the interviews focused on a purely narrative angle. For example, the potential impact of making a medication administration area on future clinical practice, emotions and attitudes to error, and perceived systemic causes of medication administration error. In addition, it was uncertain before the interviews whether participants would answer the questions within a narrative structure. Thematic analysis was therefore selected because it has the flexibility to capture all aspects of the interview data which do not directly attach themselves to a narrative.

Thematic analysis is a widely used qualitative analytic method embedded within many qualitative approaches, for example, grounded theory. It is more often considered a tool and not a methodological approach (Ryan and Bernard 2000). Thematic analysis was selected for this research based on Braun and Clarke (2006) who argued it is a 'foundational method for qualitative analysis' p 4, to identify, organise, analyse, and report themes or patterns from interview data and a methodological approach in its own right. It is suitable across different theoretical approaches and the freedom and flexibility of thematic analysis enables a rich and complex analysis of data and can answer a specific research question. Braun and Clarke (2006) provide guidance on how to complete thematic analysis in a manner that is methodologically sound. The following analysis and report of the data elicited in the study is based on Braun and Clarke's (2006) guidance on thematic analysis.

8.4.1 Theme Specification Overview

The initial task was to identify what counted as a theme. A theme captures an important aspect of the interview data in relation to the research question. It can also encompass some element of a patterned response or meaning. Within this, the researcher determined what counts as a theme and whether it should be completed across the whole or part of the interview dataset. Analysis of the full data set can result in some data loss due to volume, but can provide a rich and detailed overall description of predominant themes. This study aimed to acquire a rich analysis of the participants' experience, to be extrapolated onto a specifically defined, pre-registration nursing population. Braun and Clarke assert that examining a full dataset is particularly useful for under-researched or new topic areas, which is consistent with this study. Analysis across the whole interview dataset was selected. Unlike in quantitative analysis, the frequency of a theme does not automatically correlate with how important it is to the research question. A crucial theme can occur infrequently across the dataset. Therefore, this analysis will include themes that encapsulate an important aspect of the experience, and not just those that occur frequently.

The next element of thematic analysis determined whether themes should be analysed from a deductive, theoretical, top-down approach (Hayes 1997, Frith and Gleeson, 2004) or from an inductive, bottom-up approach. A 'deductive' thematic analysis is more theoretically dictated and correlates more closely upon the research question, aims and objectives. Within the inductive approach, themes are 'data-driven' and discovered from within the data. Themes are not implicitly connected to research questions nor categorised according to preconceived themes. An example from this study is the theme of emotion. This is explicitly deductive driven as it forms part of the theoretical underpinnings of the study. However, the different types of emotion that may be produced from the experience of error have not been explicitly theorised and therefore lean to an inductive or participant driven approach. This study completed both an inductive and theoretically driven analysis. Completing the simulation within an education context is a new and novel research area and using a mixture of both approaches enabled all relevant themes to be identified.

The next stage identified whether themes should be determined at a semantic or latent level. The semantic approach focuses on the semantics, or surface meanings of the data. In contrast, latent analysis requires a deeper exploration into the meaning of the interview data goes beyond the meaning of the words used. It identifies and examines underlying ideas, assumptions, and conceptualisations that shape the semantic content. Assumptions and/or meanings are theorised as underpinning what is actually articulated semantically in the data. This analysis focused on

latent analysis, but also included some semantic analysis to enable as wide and comprehensive range of themes to identified, to facilitate an extensive analysis of this unresearched area. One example, from the interview data is the comment 'this is relevant'. The semantic approach refers to the literal view that the simulation was 'relevant' to them. Within latent analysis, 'this is relevant' would expand and explore, for example, what is relevant, why it is relevant, why is relevance important, what type of education have they previously experienced and provides insight into the participants learning needs and methods of learning.

The next element refers to the epistemological approach to the analysis and whether it should take an essentialist/realist, constructionist or contextualist approach. The essentialist/ realist approach reports experiences and meanings of the individual, and similarly to narrative analysis, is interpretive (Boyatzis 1998). In contrast, in a constructionist approach, meaning and experience are 'socially produced' and reproduced, rather than being inherent within individuals (Burr 1995). The constructionist framework focuses upon 'structural conditions' and 'contexts' and not individuals, their motivations and psychology. The contextualist approach is in between and is characterised by critical realism. This study employed the constructionist framework as it is researching the participant's responses to the simulation, which formed an educational experience that was imposed on them.

It was important that the data was properly analysed so that the analysis did not purely paraphrase data extracts used to support the researcher's aims and objectives. It was also important to avoid using the interview questions to form the basis of the themes. Although the interview schedule helped to elicit themes, it was important that the analytical claims were substantiated by the data.

8.4.2 Analysis Procedure

Phase One - Transcription of Data

The interview data was transcribed verbatim and entered onto Microsoft Word located in Appendix O. It was punctuated so that the meaning of the data was retained (Poland 2002). Each interview was allocated a number and cassette tapes were constantly rechecked for accuracy.

Phase Two – Generating Initial Codes

The researcher familiarised themselves with the dataset. This enabled the researcher to gain a provisional understanding of the breadth and depth of the data and any patterns within it. Initial codes were generated through a systematic reading of the entire dataset, identifying any semantic or latent areas of interest. All relevant data extracts were coded and linked to the original interview. Coding of the data was driven by both the theoretical underpinnings of the study and by what emerged within the data. The dataset was coded as comprehensively as possible. Individual extracts were allotted multiple codes where relevant and some surrounding data around the item was retained so that context could be established.

Phase Three - Searching for Themes

The coded data extracts were sorted and grouped together into potential themes, sub-themes and links between themes. This provided an initial notion of the significance and importance of themes and sub-themes which were reassessed in subsequent phases.

Phase Four- Reviewing Themes

Themes, sub-themes and links were reassessed and reorganised. Some themes were merged and divided whilst others were discarded from the analysis. All identified themes were reanalysed to determine if they formed a coherent pattern, were sufficiently distinct from one another and collectively reflected the whole interview dataset. When a theme did not provide a coherent pattern, the theme was re-examined to see if it should be removed or merged into another theme. This process was repeated three times until additional analysis did not add anything substantial. The theme map before the final analysis is displayed in figure 15.

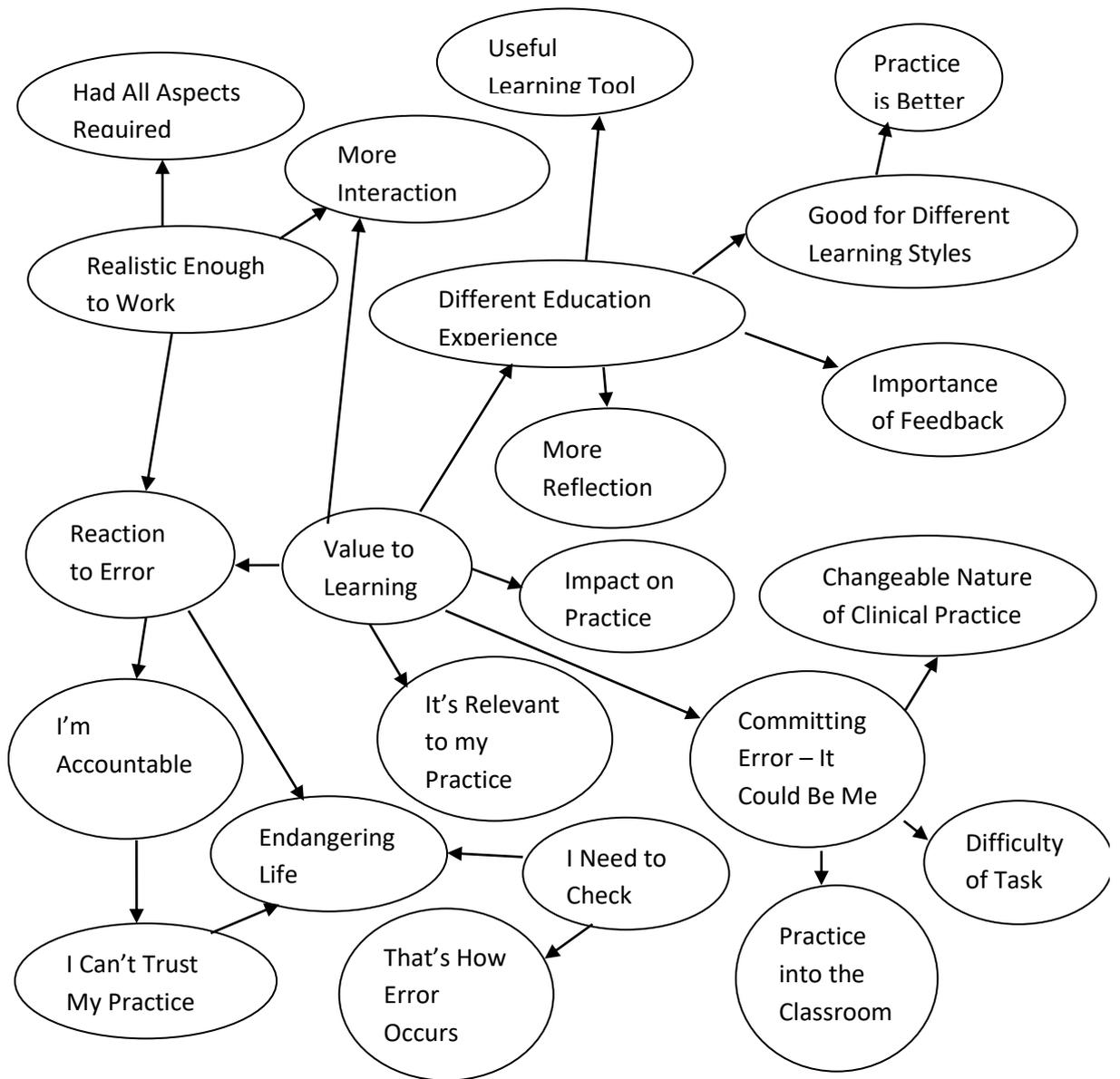


Figure 15. Preliminary Theme Map

Phase Five – Defining and Naming Themes

The next phase was to define and name the themes so that they encapsulated the essence of the theme. Essence refers to what aspect of the data is captured by the theme and what is not. The researcher examined the data extracts for the theme to generate names for the themes. The themes were allotted a name which gave a sense of what the theme and are located in Appendix P.

Phase Six – Producing the Report

The final phase was writing up the report with an analysis which goes beyond just describing the interview data and supports original the research question that the interviews sought to answer. Extracts of the interview data were embedded into the following section to illustrate, justify and support the analysis.

8.5 Interview Results

8.5.1 Overview

All but one interview lasted over thirty minutes and the majority of participants were able to discuss the simulation and provide insights into their experiences, their responses to it and the impact of the simulation on their learning in depth.

All participants remembered completing the simulation two years later but recalled different aspects. Many were able to recall completing the simulation clearly and were able to provide accurate descriptions. However, some participants recalled completing the simulation, but were inaccurate in some aspects of how they described it. A minority of participants stated they could not remember specific details of the simulation, or remembered it 'vaguely', but were able to provide brief summaries. One participant recalled that they did not make a medication error, one participant believed, but could not guarantee they made an error and all others recalled making an error. Five participants specifically recalled making the designed right-drug wrong-patient. An overview of the final themes is displayed in Figure 16:

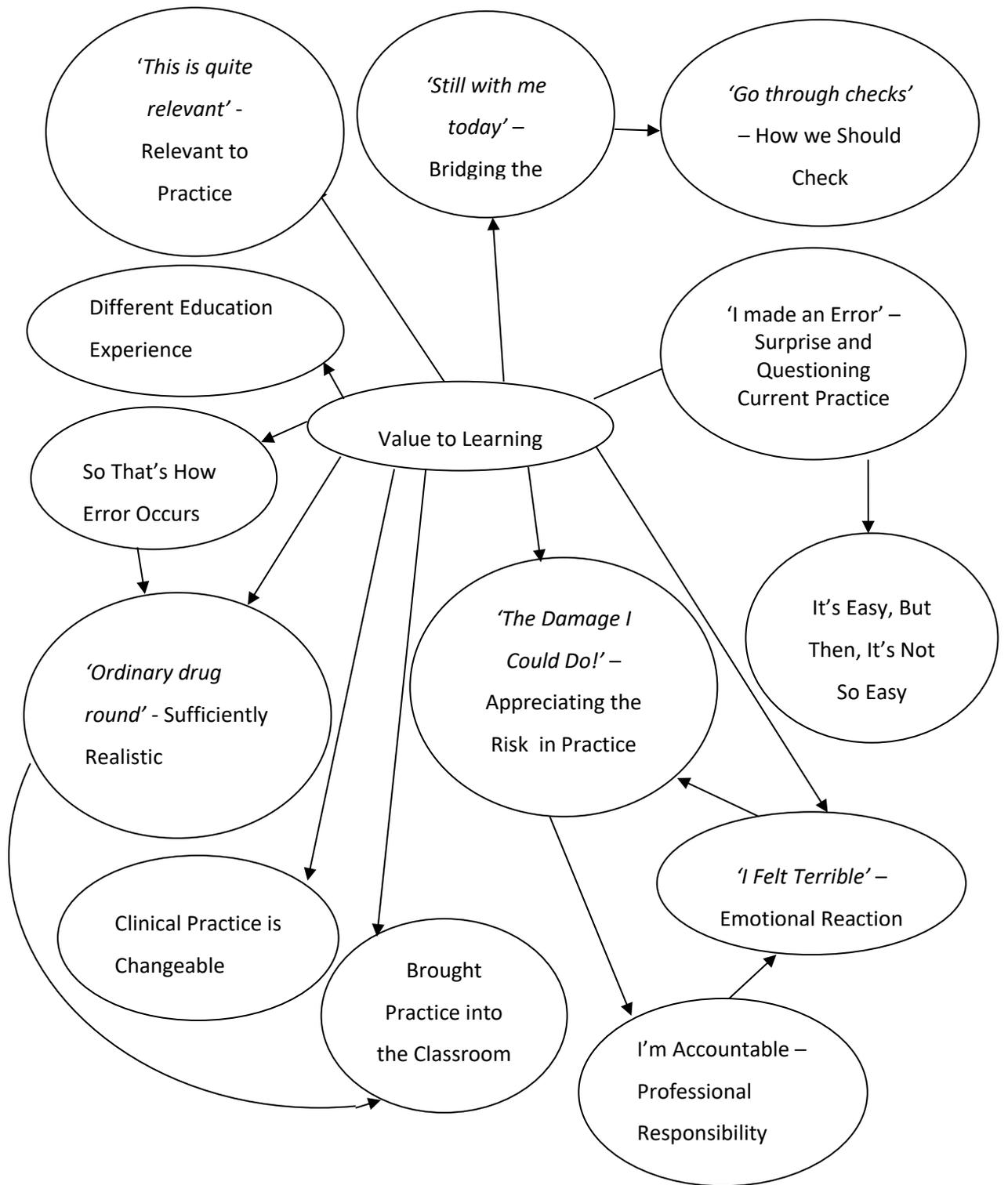


Figure 16- Overview of Final Themes

8.5.2 Value to Learning

The overall theme derived from the interviews was the perceived value and contribution of the simulation to the participants' medication administration education. This theme formed the foundation of the learning experience and coloured how participants viewed all other elicited themes. It encapsulated both the participants' views of the simulation and the consistency of those views. Eleven participants considered the simulation to be valuable, for example:

"I think a simulation is great for adding on and solidifying the knowledge that we are given through other bases". (Participant 1)

"It developed my knowledge and from that I learnt". (Participant 4)

In contrast, one participant related the value of the simulation in terms of learning from error. They acknowledged the role of experiencing error in learning, but did not believe that the simulation was valuable to them. For example;

"Even though I know I did make errors and I can see the importance (for) of learning. But not due to the simulation is why I would be more careful". (Participant 10)

This illustrates how although the participant did make an error and accepted the underlying theory of the simulation, they denied it had any impact upon their clinical practice. Three participants were inconsistent in how they viewed their simulation experience. For example, although they considered completing the simulation valuable, they equally denied that it had any effect upon clinical practice. For example;

"So, knowing I need to check that the patient's right and the tablet is right erm arose from those mistakes made (in the simulation). Erm and if I hadn't made them and hadn't known why it was important ... then I wouldn't know to change my practice". (Participant 5)

In contrast, the participant also stated;

"Now I always do check my patient's name band and that kinda thing before I give the drugs but I wouldn't have attributed it to the skills session itself, the simulation thing". (Participant 5)

8.5.3 *'This is quite relevant'* - Relevant to Practice

One important aspect related to the value of the simulation was its perceived impact on clinical practice. 11 participants considered it to be actively relevant to them and their practice, including the one participant who did not make an error. For example;

'was actually very good because of course everyone thinks they are doing everything perfectly all of the time, and of course you get to the end and it would show you have made two or three drug error... it was actually quite an eye opener to see that actually'. (Participant 2)

"I remember thinking actually this is quite relevant". (Participant 4)

Interestingly, despite this, participants were unable to provide specific examples where they recalled the simulation whilst in clinical practice. Instead, participants highlighted that the simulation helped to consolidate a culture of safe medication administration practice, expanded their knowledge and understanding of theory and reinforced the need to complete the five rights. For example;

"It just made me much more aware how to be safe ... it is just really confirmed how important safety is. You have to do everything you possibly can to ensure your practice is safe... it is something that I kinda like took away from that and you know still practice, is still with me today". (Participant 4)

A minority of participants contradicted how relevant the simulation was to their practice. For example;

"I did learn something [from the simulation]... I suppose we can all learn something from mistakes". (Participant 6)

But conversely, they also stated;

"I mean it is good to have that, like as a taster, [the simulation, but] I don't see how it would be beneficial". (Participant 6)

These statements highlight how some participants held incongruent views of the simulation and its impact on practice. This stemmed from participants identifying that the simulation did impact upon their theoretical learning and why their practice had to change, but did not relate that

explicitly to clinical practice. These participants suggested completing the simulation had no impact upon their clinical practice. One participant stated the simulation did not have an impact on their education or on clinical practice at all, for example;

"It hasn't had much of an impact". (Participant 10)

8.5.4 'Still With Me Today' – Bridging the Practice-Theory Gap

11 participants discussed how the simulation and specifically making an error reinforced the importance of the five rights in clinical practice. For example;

"I kind've obviously hadn't realised how erm important some of the theory is, obviously about identification and things. We had always been told, but obviously the simulation brought it to my attention just that much more". (Participant 7)

"It is really, really important. It is the easiest way not to make a mistake if you use it correctly".
(Participant 8)

"You have to do everything you possibly can to ensure your practice is safe... it is something that I took away from that and still practice, is still with me today". (Participant 4)

The error helped participants to bridge the practice-theory gap and understand that they must administer medications in-line with evidenced based practice. For some participants, the experience of error helped form their understanding the importance of the five rights. For example,

"I think that is when I really started checking and double checking I suppose". (Participant 2)

"So, knowing I need to check that the patient's right and the tablet is right erm arose from those mistakes made. Erm and if I hadn't made them (I wouldn't) and hadn't known why it was important". (Participant 5)

In contrast one participant did not feel the simulation reinforced the importance of the five rights although they did understand the importance of appropriate checking. They considered other methods of learning to be more appropriate;

"I think other things have had more of an impact than the simulation". (Participant 10)

A participant who did not make an error also stated that being aware of the possibility of error was sufficient to learn from the simulation.

8.5.5 'Go Through checks' - How We Should Check

11 participants stated that the experience illustrated why the five rights and checking procedures were important to clinical practice, and how they should be implemented using a systematic and non-complacent approach.

"That you always have to go through the checks all of the time and rather than you have done them once, to go onto auto pilot". (Participant 9)

"Well it made you think you definitely have to double check and triple check everything". (Participant 3)

8.5.6 'I Made an Error' – Surprise and Questioning Current Practice

All participants were surprised to realise that they had made an error in the simulation. Making an error was something participants had not previously considered and this realisation forced the participants to question their current practice. Feedback within the simulation was central to this. It was also important that participants took responsibility for the error which was no longer just a vague theoretical possibility discussed in terms of other nurses, but intrinsic to them, their patients and their clinical practice. This stemmed from the notion 'it could be me' to make an error if they do not apply the five rights. This new perceived vulnerability reinforced the importance of checking procedures as a means to prevent future medication errors. For example;

"I thought I definitely got them all right and was a bit shocked when I realised that I didn't get them all right". (Participant 3)

Participants highlighted that to learn from error, it was important that they were informed that they had made an error. For example;

"Thinking something was correct but later on when it gives you the result you find out actually it is wrong and you know you are like oh my god I didn't know I did anything wrong and it made me, you know rethink you know my practice". (Participant 11)

Participants were also able to link the feedback received to clinical practice where such feedback is rarely forthcoming. A minority of participants expanded this to express concern that they may have made errors in clinical practice that they were unaware of. Feedback was seen as an integral component to the simulation which enabled the extent of learning to manifest.

8.5.7 It's Easy, But Then, It Is Not So Easy

11 participants described how the simulation highlighted the ease to which errors can occur. This includes participants who did not make an error. During the simulation, participants believed they were administering medications appropriately, and despite efforts made, still made an error. The ease of error surprised participants and reinforced their vulnerability to making an error. Making an error was not previously considered by participants nor acknowledged in university or clinical placement. In addition, the simulation demonstrated the inherent complexity of safe medication administration in context. Many thought the task was easy to complete. However, the simulation demonstrated the correct medication administration is a complex, multi-dimensional task. It does not solely incorporate the five rights, but extends to the consideration of contextual issues. This not only compounds the ease in which errors occur, but underpins the need for vigilant checking during every medication administration.

"Yes absolutely. It made you think more about things that could go wrong and maybe not only see things as numbers but consider them more as a holistic approach". (Participant 1)

"I am thinking no I am always meticulous and would never make a mistake like that but then obviously in the simulation, it proven that it is quite easy to make a mistake. Knowing how easy it is to make a mistake, I think, it means then you don't then become complacent". (Participant 8)

"It was really certainly very good to see all the simple small things that can go wrong, no things that you don't even expect. So it is really very important". (Participant 11)

8.5.8 'I Felt Terrible'– Emotional Reaction

All participants experienced an emotional reaction when they realised they made an error and found it difficult to reconcile their pre simulation assumption that they would safe medication administrators. Participants expressed numerous emotional reactions to this including guilt, shock and feeling sick, scared and stupid. The emotional reaction provided an added dimension to their learning and made the simulation highly salient. The participants used very emotive terms to describe their reactions to the simulation and the experience of error;

"I felt terrible". (Participant 2)

"Yeah I think it scared me... I think I felt very disappointed in myself ... I kind of berated myself and thought why did I make a mistake". (Participant 7)

Interestingly, one of a minority of participants who did not support the simulation also experienced a negative emotional reaction to making an error, which underlines the potential emotional impact of error;

"Gutted, you just kinda go ahhhh oh no!! It felt awful". (Participant 10)

Conversely, a minority of participants expressed relief that having made an error, at least it was the simulation, and not clinical practice. Experiencing these emotional reactions surprised participants. Despite the errors not being real, the emotional reactions expressed were similar to emotions expressed by nurses who made real medication errors (Mayo and Duncan 2004, Gladstone 1995, Santos et al 2007). This is indicative of the salience, psychological realism and effectiveness of the simulation as a learning experience as such responses are rarely generated within a classroom setting.

8.5.9 'The Damage I Could Do!' – Appreciating Risk in Clinical Practice

10 participants recognised and feared that if they make an error in a simulation, they could make an error in clinical practice where they could potentially harm patients. Participants were able to extrapolate the importance of the five rights more widely outside the narrow confines of the specific type of error they made. Completing the simulation and making an error may have greater resonance beyond their individual experience. Although errors made in the simulation would not have resulted in an adverse outcome, many participants extrapolated the error to other types of error and in terms of the worst-case scenario of killing the patient;

"That was a shock, the damage I could do". (Participant 4)

"Yes, because you could have potentially killed a patient! ... that's a thought that went through my mind that I have potentially harmed someone". (Participant 6)

"It made me feel, oh my god, how many patients might I have killed?" (Participant 11)

The participants acknowledged that the fear of harming patients was a constant concern which informed and supported the use of the five rights. This demonstrates that it is not the consequences, but the fear of potential, imagined consequences that stimulates the response.

8.5.10 'I'm Accountable!' – Professional Responsibility

10 participants indicated that the simulation and error reminded and gave a deeper understanding of the concept of professional responsibility;

“So I think it highlights that I am accountable at the end of the day”. (Participant 1)

“Incredibly important, really important, because you cannot as a nurse, bearing in mind the professional code of practice you operate under, you sign up for, you have to, that has to be a given, you have to make sure your practice is safe”. (Participant 4)

Making an error emphasised to participants that the prime concern of a nurse is the welfare of their patient and underlined the importance and responsibility of the nurse's role to safeguard this. Making an error undermined the participants' belief in their ability to provide this. Participants they were also fearful of the consequences of error for their nursing career and their own desire to be, and regarded as, competent nurses. This was encapsulated by one participant who acknowledged they would find it difficult to report making an error. Participants understand their future responsibilities and this both scared and motivated them to be accurate nurses and to complete checking procedures and is inextricably linked to the previous two themes. For example;

“When you think about it in a real life scenario then obviously you are in a lot more trouble”.
(Participant 12)

8.5.11 'Ordinary Drug Round' – Sufficiently Realistic

9 participants considered the low-fidelity design of the simulation to be a realistic representation of clinical practice. They were positive about the simulation and believed it effectively incorporated key cognitive and theoretical elements of the task and reflected clinical practice;

“I think it did it really well. I wouldn't know how to improve it as a computer simulation in itself..., all the points of the theory, i.e. the right drug, right dose etc, were covered”. (Participant 5)

“You could see it was just an ordinary drug round”. (Participant 6)

A minority of participants felt that the simulation lacked the interactivity necessary to replicate the communication between nurses and patients, for example, identifying if the patient needed analgesia or if they had an empty stomach. Despite this, the participants still considered the simulation to be a useful learning experience. Two participants stated that to learn from the simulation, assumptions about how realistic the simulation experience was needed to be made. For example;

“Learning in college as a half way measure is, yeah, as long as students are willing to accept that it is a half way kind of thing and kind of get on with it, I think actually, yeah, it worked for me”.

(Participant 2)

This is substantiated by another participant who stated that whilst there was some lack of realism, it still provided a valuable learning experience:

“In my head I was thinking it was not quite realistic, er it kind of reminded me that no, I do need to take it seriously no matter what happens”. (Participant 7)

For the majority of participants, the simulation was sufficiently realistic to be a useful learning tool. One participant categorically refuted the use of an online simulation to represent medication administration. They disagreed with the concept, representation and accuracy of the simulation as an education method and believed only practical experience is the appropriate education method;

“Well, I did think it wasn’t particularly accurate or that helpful to do it on the computer”.

(Participant 10)

There were two themes that contributed to how realistic the simulation was perceived to be. The simulation highlighted both the changeable nature of clinical practice, and underlined how error occurs, both of which contributed to the perceived realism of the simulation. In turn, the realism fed into a third theme of bringing practice into the classroom. All three will be discussed below.

8.5.12 Watch Out – Clinical Practice Is Changeable

10 participants stated that the simulation highlighted and reflected the changeable nature of clinical practice and helped transform the simulation into a realistic and authentic learning experience;

“Knowing how easy it is to make a mistake I think, it means then you don’t then become complacent, ignoring clinical things like for instance, if you go to the drugs cupboard three times a day and make sure that the drugs that you pick up are in date, because you used the same drug that morning and not assuming that is the same box you pick up in the evening”. (Participant 8)

“I guess it sort of makes you think that you shouldn’t just rely on things staying the same, like you just... Things can change all the time so not to rely on that the patient is, you forget the medications so not to give it to them without really checking. Erm, it just helps you keep on your toes sort of thing”. (Participant 9)

Participants noted change was a direct source of error in the simulation and extrapolated this to their own experience of clinical practice. Understanding the changeable nature of clinical practice helped guard against complacency and informed how error can occur. This was partially extended to how change can be a source of cognitive load and underlined the need to be vigilant administering medications. This validated the use of change and cognitive load as causes of error in the simulation and demonstrated how participants were able to link the designed method to generate error to their clinical practice. However, one participant stated that although the simulation did highlight the changeable nature of clinical practice, they also thought the patients changing position was a computer error.

8.5.13 So That’s How Error Occurs!

11 participants highlighted how the simulation contributed to learning because it demonstrated how error occurs, an issue participants had not previously considered. Error was the starting point to learning and facilitated participants to reflect upon the causes and mechanism of medication administration error. This was contrasted to university teaching, where medication administration is often taught in a more sanitised, regulated and didactic manner, in which error is not experienced. In the simulation, errors are made real and personal to participants as future practitioners;

“It made you think more about things that could go wrong”. (Participant 1)

“It was really certainly very good to see all the simple small things that can go wrong, no things that you don’t even expect. So it is really very important”. (Participant 11)

One participant who stated that the simulation did highlight how error occurs, also partly put this down to a computer error;

"I think names got muddled up." (Participant 6)

8.5.14 Brought Practice into the Classroom

11 participants suggested the simulation helped bring clinical practice into the classroom.

"It was definitely a positive experience for me because it did bring practice into the classroom".
(Participant 3)

"It kind've fuses what we needed to know theoretically and what we are going to be doing practically...it kinda gave me that extra dimension". (Participant 4)

"Yes, because it was like a simulation of the real thing, like the real thing, being on the ward and doing it for real". (Participant 6)

This subverts the norm of nurse education where the education journey is traditionally from classroom to clinical practice. The participants were engaged in a practical and active process administering medications, identifying patients, opening medication cards, selecting medications and administering them. This enabled participants to link learning to clinical practice and underscored the importance of classroom-based theory. In contrast, the same minority of participants who did not consider the simulation to be valuable and failed to provide a realistic representation of practice also felt it did not translate clinical practice into the classroom;

"But maybe not so useful as to what it is like when maybe you are in that situation, when you are on a busy ward and being face to face with patients and looking at their symptoms and actually looking at the patient". (Participant 9)

8.5.15 Different Education Experience

11 participants thought the simulation provided an added dimension to their learning experience. Participants considered the simulation and error to be a more visual, authentic, active and interactive method of learning. This alternative approach made the simulation distinctive and innovative.

"I think being challenged in that way within the practical aspects... would be a good way of changing things around". (Participant 1)

“Actually because of the pictures, because I like learning through pictures and that’s the thing you know, it sticks in my head you know and then I am able to learn”. (Participant 11)

Participants thought these elements would help cater for different learning styles and requirements, not necessarily catered for by traditional learning methods.

“You are looking at things in a different way so I guess for people with different learning styles...So I think the wider variety you have of ways of learning, I think the more likely the more likely you are to capture something useful”. (Participant 8)

All participants believed a combination of education approaches was important, however a minority of participants considered practice as the only place where medication administration learning can properly take place.

“I don’t think anything can prepare you for the real thing when you are actually doing it”. (Participant 6)

The belief that one can only learn in practice includes participants who stated they learnt from making an error. This is an interesting paradox as it is inherently impossible to implement learning through error as an active strategy within clinical practice. It is unethical to specifically organise error in clinical practice and simulations provide a safe alternative. In addition, participants valued learning in practice because it is an active experience, which is similar to the simulation.

8.6 Long-term Qualitative Interview Phase Summary

Most participants reported making a medication administration error in the simulation. The majority of participants considered the simulation to be a realistic, authentic useful learning tool and that making an error was pivotal to this. This included the one participant who did not make an error, who stated that being aware of the possibility of error was important to their learning experience. Despite clear differences between an online simulation and the hospital ward, many participants believed the simulation comprised all salient cognitive and theoretical components of medication administration and was sufficiently similar to the 8am medication round. The combination of the simulation and error as an active learning strategy, served to underline the importance of the five rights within clinical practice. The awareness of error supported participants to have the robustness to administer medications within the complex environment in clinical practice. This is supported by the themes elicited in the study which reflect the general medication administration literature, for example, causes of error, responses to error, need for

vigilance and importance of checking. Although participants did not provide explicit examples of using the simulation in clinical practice, participants frequently extrapolated their experience to the importance of the five rights and linked it to clinical experience. The majority of participants were able to reflect and provide rich descriptions of their experiences of the simulation in depth. The low-fidelity design provided a sufficiently realistic representation of clinical practice to provide a salient, insightful, comprehensive and useful learning experience for the majority of participants. This was demonstrated by the participants' realistic emotional response to error. The simulation which generated error provided a salient learning experience over the long-term.

Chapter 9: Discussion

9.1 Introduction

The central aim of this study was to design a low-fidelity medication administration simulation that generates error as a salient learning experience for first year nursing students over the long-term. The simulation was evaluated during phase three, the comparative study, in which the simulation was compared to two other more traditional teaching sessions, and in phase four, the long-term qualitative interview study, in which the simulation was evaluated two years later. This chapter provides a discussion for all four phases of this study. Section 9.2 details an overview of the study results. Section 9.3 provides a discussion of the study results in relation to the study's aims and objectives with reference to the background literature. Section 9.4 details the methodological limitations of the study and section 9.5 provides the overall study conclusions.

9.2 Overview of the Study Results

9.2.1 Simulation Design

The study achieved its objective to design a low-fidelity medication administration simulation which generated a medication administration error. The simulation also successfully incorporated all cognitive and theoretical elements to enable participants to administer medications safely and accurately using the five rights. The simulation provided a realistic and authentic representation of clinical practice and medication administration error.

9.2.2 Comparative Study

17 (35%) of participants in the simulation session made the target right drug, wrong patient error. Participants also made an additional 24 (6.28%) wrong dose errors. There was a difference between teaching sessions in whether their experience would reduce the likelihood that they would make a medication administration error in clinical practice. Simulation session participants were more likely compared to other participants to state this, however, there was no corresponding difference between teaching sessions in the predicted number of medication administration errors made during the first year of clinical practice. There was a difference between teaching sessions in how frequent medication administration errors were perceived to be. Simulation session participants were less likely to perceive medication administration errors to be a frequent occurrence in comparison to participants from the other two teaching sessions.

In addition, there was a difference between teaching sessions in whether their teaching session helped them with learning about medication administration error. Participants from the specific knowledge teaching session were more likely to state that their session would help them compared to simulation and theory only session participants.

There was no difference between teaching sessions in the type and extent of emotional reaction to either making or knowing about medication administration errors made in the simulation. Similarly, there was no difference between teaching sessions in how participants rated the importance of the causes of error, including cognitive load, which was the principle cause of error in the teaching sessions. There was also no difference between teaching sessions in how important the topic of medication administration was perceived to be to clinical practice, the likelihood that participants will make a medication administration error compared to nurses of simulation education and experience, or how serious medication administration error was perceived to be.

9.2.3 Long-term Qualitative Interview Study

10 (91.67%) of the participants reported that they made an error in the simulation. The vast majority of participants remembered the simulation two years later. Most of the participants perceived the simulation to be a salient and effective part of their medication administration education. The simulation was realistic to participants and achieved high levels psychological fidelity. The experience of error underlined the complexity of medication administration, the importance of the five rights and the risk of error if they were not applied. This strengthened participants' knowledge and understanding of the theory and process of safe medication administration practice. The simulation was highly available to most participants who were able to discuss their experiences in depth. Making an error elicited multiple emotional responses. Participants were shocked that they made an error and experienced difficulty reconciling this with their pre simulation assumption that would administer the medications safely. Participants' emotional reactions provided an added dimension to their learning and made the simulation more available and salient over the long-term. In addition, understanding the risk and making an error made participants reflect upon themselves as safe, question their clinical practice, and most importantly, consider how to minimise future medication administration error. The learning from error was not restricted to the individual error made, but was generalised to encompass all medication administration errors and the most severe potential consequences. This simulation was internally and externally salient in terms of availability and affect over the long-term and helped support participants to have the robustness to guard against error.

9.3 Discussion of the Results

9.3.1 Importance of Error to Learning

The central aim of this study was to design a low-fidelity medication administration simulation that generates error as a salient learning experience for first year nursing students over the long-term. To that extent, the study was successful. The results of the long-term qualitative interview study indicate that overall, the simulation did provide a salient learning experience. This included level of realism achieved and level of affect. In contrast, the results of the comparative study highlight that overall, the simulation session did not provide a distinctly salient learning experience compared to the specific knowledge and theory only sessions. This included the degree to which the simulation generated affect.

This discrepancy in results reflects the proportion of participants in the two studies who made, or reported that they made an error in the simulation. In the comparative study, only a third of participants made the target right drug, wrong patient error, whilst in the long-term qualitative interview study, over 80% of participants reported that they made an error. If error was so central to the learning experience, as identified in the long-term qualitative study, this difference in error rates may account for the inconsistent results.

In addition, if error was as central for learning, a second reason for the discrepancy in results is that participants in the specific knowledge and theory only sessions in the comparative study were also likely to have experienced error. Participants in the two sessions were presented with the same change blindness scenario from Simons and Chabris (1999) and Levin and Simons (1997). In Simons and Chabris study, up to 75% of 192 participants failed to detect changes to the visual scene and were subject to the change blindness phenomenon. In addition, in the Levin and Simons study, 74% of 40 participants did not notice the change of actor in the telephone scenario and in the café scenario, only an average of 2 of 9 changes were identified by 10 participants when they were informed of the changes. If these results are extrapolated to the two teaching sessions, it is likely that majority of participants also experienced making an error. This means that a higher proportion of participants in these two sessions experienced some form of error compared to simulation session participants. This may have had an impact on the learning experience and provided a more equitable error related active learning experience across the three teaching sessions.

This assertion is supported by multiple studies. For example, Levin et al (2000) discussed four separate change blindness scenarios: change of colour of props within four picture stills, a video in which a large colourful scarf worn by an actor disappeared and reappeared across shots, a video in which a change of actor occurred during a change in camera position, and a scenario in which an actor changed position with another during a conversation with a member of the public whilst they were momentarily obscured from each other. A mean of 89% of participants were subject to change blindness across the four scenarios. In addition, Davies and Hine (2007) explored connections between change blindness and accuracy of eyewitness testimony. 80 participants reviewed a two-minute video of a burglary in which halfway through, an actor playing the burglar changed with a second actor. Although both actors were dressed in dark clothing, they differed in height, build, face shape and clothing type. Despite these differences, 61% of participants did not notice the change. In addition, the specific knowledge and theory only teaching sessions also actively linked the change blindness error to medication administration error. This combination may have produced an error generating learning experience more akin to the simulation session, and therefore may account for the predominant lack of significant difference in results in the comparative study.

The importance of learning through error as provided in all three teaching sessions is supported by multiple researchers, for example, King et al (2013) and Kneebone et al (2007) who encouraged integrating error in low risk settings such as simulation because it allows better foresight to manage the situation in clinical practice. Kneebone et al (2007) state that “the apparently routine nature of much clinical practice may lull practitioners into a false sense of security, concealing complexity, hiding latent dangers and dulling awareness of liminal zones of risk” p 811. The use of error in the teaching sessions altered the nature of medication administration from one which was routine and easy, to one which complex and difficult and posed a risk for patients and nurses alike.

Fischer et al (2006) interviewed 29 medical and surgical residents enrolled at a university in the United States about their experiences of error within clinical practice. Participants considered error to be both ‘inevitable’ and a ‘part of the practice of medicine’. The authors conclude that error should be used to support learning in clinical practice. The study also provides insight on how to best incorporate error into the curriculum. Participants reported that reflecting on their own errors as opposed to near misses was most effective, predominantly because of the increased emotional impact of error. However, they also acknowledged that discussing the errors of others would also be of benefit. This might partially account for why the specific knowledge and theory only teaching sessions overall provided an equivalent learning experience to the

simulation session. Participants in these sessions were more likely to make an error external to the simulation and were also taught about the errors of others, which also encapsulated the key or salient components of the important of the theory of the five rights to clinical practice.

9.3.2 Importance of Active Learning to Simulation Education

This study incorporated simulation and error as a deliberate and active learning strategy to enhance the low-fidelity design. It utilised both experiential and constructionist learning theory to formulate new understanding about the importance of the five rights and ease in which error occurs if they are not applied. The results of the study underscore the importance of active learning. All three teaching sessions in the comparative study were bespoke and part of the student nurse curriculum, and therefore integrated the same learning components to help students minimise future medication administration error. All used the active experience of error, either directly in the simulation session or indirectly in the other two sessions.

Participants in the simulation session learnt through error and became active contributors to their own learning and discovery (Jeffries 2005, 2007 and Juhary 2006). This supports studies which demonstrate that students become more engaged in a topic when they have the opportunity to participate (Stevenson and Gordon 2014). The participants in the two other teaching sessions were also able to learn from an active learning strategy. The experience of error was actively linked to medication administration error. In that respect, the specific knowledge and theory only sessions provided a simulation 'light' scenario which underlined the importance of the five rights. They also had the opportunity to learn by doing, in which the meaning of what was taught was captured through the experience of error (Hope et al 2011).

The experience of error also helped participants to construct new learning models and deepen their understanding of theory (Powell and Kalina 2009). This supports Parker and Myrick (2009) who highlight that knowledge transmission is created by individual learners processing their experiences and interacting with their environment. Talbot (2013) agrees and states that the quality of a simulation-based training experience depends on successful engagement with the learner, which includes a sense of immersion and good narrative. This was achieved in the simulation because the core features of the five rights of medication administration was intrinsically salient to participants (Alinier et al 2004), and this was sufficient to provide an effective educational experience (Kneebone 2010). In addition, within the comparative study, all participants had the opportunity to consider that they could make an error, which in itself

underlined the importance of the five rights. Therefore, the active nature of learning through error was helpful to all participants, irrespective of teaching session.

The importance of using an active learning strategy is supported by a number of studies. Shin et al (2015) assessed the impact of an active learning strategy to teach clinical performance and competency in evidence-based care. In a randomised control trial, 147 final-year nursing students received teaching in an active learning program or traditional learning format. The active learning program incorporated high-fidelity simulation, situation-based case studies, standardized patients, audio video playback and reflective activities. Participants were evaluated using 5 domains: human understanding and communication, professional attitude, critical-thinking and evaluation, general nursing performance, and special nursing performance competency. All participants completed post learning questionnaires with three outcome measures: self-assessment of learning, levels of satisfaction and core nursing competency. Nursing competency scores were significantly higher in the active learning group across all 5 domains compared to the traditional learning group ($p = <0.001$). There was a statistical difference between groups on levels of satisfaction ($p = 0.002$), however, no statistical difference between groups in professional attitude competency. In Mills et al (2014), 47 first-year nursing students participated in four, six-hour case study simulation sessions. Participants gave the sessions an average of 4.3 out of 5 in level of active learning and reported an average of 4.5 out of 5 in how important the active strategy was to their learning.

Scherer et al (2007) compared learning outcomes from a 60-minute slide presentation, a video-recorded 20-minute simulation scenario task followed by debriefing, and a case study / care plan teaching session. Both groups completed knowledge and confidence assessments pre simulation and one week and one-month post simulation. There was no significant difference between the groups for knowledge and confidence scores. Although the techniques used in the two teaching approaches differed, both groups experienced an active learning strategy using group discussion, collaborative problem-solving task formulating care plans and had access to academic leadership.

Hoke and Robbins (2005) used a bespoke 'holistic, active cooperative' learning strategy, which used emotional connections to teach critical-thinking skills to nursing students. Methods included role modelling, communication activities, interactive student and group learning/testing. 23 nursing students who completed the course were tested on their critical-thinking skills and their results were compared with 25 student nurses who were taught using a more didactic traditional teaching approach. The mean critical-thinking score for the active learning strategy was 87.03 and the traditional learning group was 84.19. Students who underwent the active learning instruction

reported higher levels of enjoyment and reduced levels of stress. The authors argue that although the difference in scores between groups was not significant, they believe it was due to inherent differences between the groups and state that the use of an active cooperative teaching approach helps students to transfer and apply knowledge to the clinical setting. The authors conclude that holistic, cooperative, active learning incorporates various ways of learning which facilitate the learner to internalise content, form new learning strategies and develop critical-thinking skills to improve educational outcomes. They state that although incorporating an active learning strategy into the curriculum requires additional resources, effectively designed simulations can improve learning.

These studies and the results of this study underline the importance of simulation as an active learning strategy. In addition, this study incorporated error as a deliberate learning strategy to enhance a low-fidelity simulation and utilised both experiential and construct learning theory. This underlines the need for nurse educators to understand the underlying pedagogy of simulation education before integrating it into the nursing curriculum. McGaghie et al (2010) argues that effective use of medical simulation depends on a close match of education goals with simulation tools. The study underlines that whichever level of fidelity is selected, the selection must be based on a clear understanding of the underlying pedagogy that the simulation is to support and that the extra resources required for effective simulation education can be justified.

9.3.3 Impact of Error on Perceived Importance of Theory to Clinical Practice

The experience of error in the low-fidelity simulation made salient the importance of the five rights to clinical practice. The key cognitive and theoretical elements of medication administration practice were integrated into the simulation and underlined by the experience of error. Participants in the long-term qualitative interview study reported that making an error in the simulation, or recognising the potential for error, was central to their learning experience. It underlined to participants that medication administration occurs within the systemic complexity of clinical practice and that there are numerous contextual causes of medication administration error. It helped them understand the importance of the five rights and how to apply them in clinical practice.

This central finding supports the literature, for example, Ziv et al (2005), De Swardt et al (2012), Kneebone et al (2007) and Butler et al (2009) who argued that learning from mistakes in simulation can facilitate clinical skill acquisition and support safe clinical practice. It also supports learning theorists, for example, Lipshitz et al (2002) and Homsma et al (2009) who argue that the

experience of error activates the learning process. Participants reported that the experience of error activated awareness of and supported the use of applying the five rights in clinical practice. The experience of error emphasised the use of the five rights because it reinforced the potential consequences to patients if they are not applied. This supports the literature, for example, Kuehster and Hall (2010) state learning from error within a safe environment provides a valuable lesson to learn and the experience of error reduces the likelihood that such errors will be repeated in clinical practice.

The results of the long-term qualitative study mirror the findings of Crigger and Meek (2007) who conducted 10 qualitative interviews with nurses who described 17 in-hospital mistakes that they made. The authors analysed the interviews using grounded-theory and produced the “Self-reconciliation after making mistakes in hospital practice” process which incorporated four distinct categories: reality hitting, weighing in, acting, and reconciling. Reality hitting refers to the realisation that an error has occurred. Weighing in refers to deciding whether the mistake should be disclosed. Acting refers to the actions of the nurse after they either disclose or fail to disclose the error, for example, seeking emotional support if they disclose the error, or if they choose not to disclose, watching to determine if the error should be disclosed in the future. Reconciliation refers to determining the level of harm of the error and where appropriate, moving on. In this stage, participants identified that they were at increased vulnerability to making an error and discussed error preventing strategies, for example, ‘I double check, triple check sometimes’. This is reflected in results of the long-term qualitative interview study in which participants’ responses to making an error were framed in terms of strategies to minimise future error, such as using theory and applying the five rights. This is similar to McCaughey and Traynor (2010) who highlight that 97.8% of participants agreed that they learned from the mistakes they made during simulation and that the experience of error helped them to formulate new more safe practices.

One of the key aspects identified by the study is from learning from error to occur, individuals must notice the error, reflect upon it and take responsibility for it. The long-term qualitative study highlighted that taking responsibility for the error was pivotal to identifying the need to instigate corrective behaviours and apply theory, such as the five rights. This supports the literature which states individuals must acknowledge their role in error in order to instigate changes, such as the application of theory, to improve practice (Crigger and Meek 2007). Karga et al (2011) investigated the emotional responses and error-coping strategies of nurses who made an error and whether they were associated with constructive or defensive changes in nursing practice. 536 nurses from various hospital departments from 5 hospitals in Greece completed a questionnaire. Participants were asked to report the most serious error they felt responsible for

and: identify the causes and severity of the error, describe the consequences for the patient, detail the error coping strategies used and changes to practice in response to the error. Participants were also asked to report using a four-point Likert scale, their emotional responses to the error and whether they were internally or externally focused, for example, angry at self or angry at others. Participant responses were described as positive, for example, having a discussion about how to prevent future errors and negative, for example, taking disproportional measures to mitigate further error compared with the severity of the error. There were further subscales which investigated, for example, accepting responsibility, planful problem-solving and seeking social support.

Nurses were significantly more likely to make constructive changes in practice if they accepted responsibility for the error ($p = 0.031$). For those who accepted responsibility for the error, 81.2% of participants reported using at least one constructive change. For example, 59.6% identified that they used planful problem-solving, 68.5% reported paying more attention to detail and 38.5% sought advice. Meurier et al (1997) highlight that acceptance of the error and planful problem-solving can lead to positive changes to clinical practice which demonstrates how making an error can link theory to clinical practice. This is important because as Karga et al acknowledge, the need to accept responsibility for the error has to occur within the systemic context, which requires a balance between individual and system responsibility. This supports the premise of this study that clinical practice is a complex and error prone environment. Error can never be fully irradiated and nurses must be supported within this context to be aware of their role to safely administer medications.

The importance of making an error, reflecting upon the error and recognising one's role in the error supports Kneebone et al (2007)'s simulation-error learning framework. The framework involves four stages: identification and acknowledgement of mistakes performed by individuals or teams, root-cause analysis of errors at an individual, team and systemic level, identification and internalisation of changes to reduce error, and the implementation of the lessons learned. The responses of the majority of participants in the long-term interview study reflected all of these stages. Participants recognised that they had made an error, identified the systemic cause of the error, internalised the error and identified the importance of theory to their clinical practice to reduce future error. It was at this stage that the transfer of theory to clinical practice occurred. This is similar to reflection post simulation experience as defined in experiential and constructionist learning theory. Particularly Kolb (1984) proposition of an iterative cycle of concrete experience, reflective observation, abstract conceptualization of the significance of the experience and active experimentation with new corrective strategies. The experience of error

altered the simulation from an activity in which participants practised medication administration to one which altered their perceptions about themselves as nurses. It informed participants' perceptions of being nurse and the responsibility endowed on them to be accountable and safe practitioners for their patients. This supported Ziv et al (2005) who state that error can enhance professions competency and foster a correct attitude.

9.3.4 Salience, Availability and Affect Generated by Error in the Simulation

The results of the long-term qualitative study highlight the importance of salience to simulation education. The majority of participants were able to reflect upon their experiences in depth over two years later and indicated that the experience of error was pivotal. This supports the theoretical underpinning of this study that the active experience of error would make the simulation salient through the heuristics of availability and affect over the long-term (Tversky and Kahneman 1974). The results of the study are in line the salience and error model of simulation learning (Figure 2, Section 3.6) which underlines the importance of simulation to be both internally and externally salient.

The majority of participants highlighted that the simulation incorporated the key cognitive and theoretical elements of medication administration, reinforced by the experience of error. The simulation incorporated all salient aspects of the task and was therefore internally salient. Error generated affect which made salient and available over the long-term the importance of the five rights to support safe medication administration practice. This also underlined the risk of error if the five rights were not applied. This was externally salient over the long-term to enable students to recall the learning and therefore make it available to apply in clinical practice over the long-term. It supports the literature, for example, Da Rosa and Durand (2007) and Fischhoff et al (2005) who state that a salient event is memorable over the long-term.

The results of the long-term qualitative interview study support the premise that perception of risk and heuristics of availability and affect can be exploited to affect behavioural change (Lockton 2012). The result supports the literature, for example, Jackson (1981), Argris and Schön (1996) and Zaleskiewicz et al (2002) who state that a negative event, such as error, increases the perceived risk of the event, which supports the use of measures such as theory to prevent or reduce a reoccurrence. For example, in the context of flooding, Gallagher (2014) analysed the insurance purchase patterns of neighbouring communities who either experienced or did not experience a flood. There was no particular trend to purchase insurance before a flood, however, there was a two thirds increase in the purchase of insurance in flood hit communities compared

to neighbouring non flood hit communities immediately after. The uptake of insurance remained statistically significant for nine years post flood. This demonstrates how the experience of a negative event, such as flood can increase the perceived risk of the event reoccurring and can help guide behavioural change over the long-term. Although long-term quality interview study participants were not able to provide specific examples of when their simulation experience helped them in clinical practice, they stated that what they learnt infused into their clinical practice. Participants highlighted that experience of error developed and deepened knowledge and understanding of safe medication administration practice.

The study also highlighted the importance of affect as a mechanism to make the simulation available and salient. Peters et al (2006) assert that the availability of an event is influenced by the degree to which information is emotionally compelling and vivid. More weight is attached to affective testimonials compared to statistical summaries, and as a consequence, easier to recall. This assertion is exemplified in the long-term qualitative interview study in which the participants' emotional reaction was pivotal to their ability to recall over the long-term. The simulation successfully manipulated availability and affect as a mental shortcut to make salient the importance of the five rights and the potential consequences if they were not applied.

The importance of affect in this study is supported by Kinatader et al (2015) who state that information or experiences need to convey emotions in order to become meaningful. Kousky and Shabman (2015) states the emotional evaluation of risk can more effectively support behavioural change compared to cognitive evaluation and lead to different conclusions (Loewenstein et al 2001). Fear of error amplifies perceptions of risk (Slovic and Peters 2006) and can completely dominate an individual's risk analysis. The power of affect can be so pronounced, that when considering risk reduction and management, individuals sometimes neglect the probability of an event and focus entirely on the consequences (Sunstein 2002). This was exemplified in the long-term qualitative interview study whereby participants extrapolated their error to the worst-case scenario in which they could have 'killed' a patient. The use of emotion in education is supported by Fischer et al (2006) who states learning should focus on emotionally charged situations. Whilst this can be initially distressing, internal emotional responses are prerequisite for coping with and learning from error. This is particularly important for nurse education as nurses commonly encounter error in clinical practice.

In contrast, the results of the comparative study highlight that the simulation session provided a more equitable learning experience compared to the other two teaching sessions. The literature suggests that the more available an event is, the more frequent it is perceived to occur (Tversky

and Kahneman 1982 and Zaleskiewicz et al 2002). However, there was a difference between teaching sessions in whether participants considered medication administration errors to be a frequent occurrence. Simulation session participants were less likely to report medication administration errors to be a frequent occurrence compared to participants from the other two sessions. In addition, there was no difference between teaching sessions in how likely participants considered themselves to make an error compared to nurses of similar education and experience. In terms of affect, participants in the three teaching sessions were asked two different questions; to rate their emotional reaction to their own error in the simulation or rate their emotional reaction to others making an error. There was no difference between sessions in how participants rated their emotional reaction. This was an unexpected finding as the underlying premise of this study was that making an error in the simulation would provide a more affective learning experience. It also contrasts with the results of the long-term qualitative interview study. There are three potential explanations for why teaching sessions in the comparative study provided an equitable teaching experience despite the long-term qualitative interview study participants highlighting that the simulation session provided a salient learning experience.

Firstly, only a third of simulation session participants made an error in the simulation and a higher proportion of participants answered the question in relation to others making an error than was expected. Secondly, the long-term qualitative interview study highlighted that the simulation provided an effective learning experience for one participant who did not make an error. The participant described how knowing about the possibility of error was sufficient for learning and reinforced the importance of safe medication practice. Awareness of the possibility of error, without actually making an error, was sufficient to provide an effective learning experience. The participant was able to link and extrapolate their learning to other closely related circumstances. Making an association with the possibility of risk without direct experience is supported by the literature. For example, Keller et al (2006) completed a randomised control trial in which 170 psychology students were asked to imagine that they were buying a house. They were provided with different formats of flood risk probabilities attached to the house. The risk of flood was the same but described in four different timeframes: "On an average, there is a flood every hundred years," "Each year, there is a 1% probability of flood." "Within 40 years, there is a 33% probability of flood" and "Within 80 years there is a 55% probability of flood." Although these risk estimates were statistically identical, the group receiving the probability information for one year showed significantly lower risk ratings than the other three groups ($F(3,173) = 7.73, p < 0.01$). This demonstrates that how the risk of an undesired event is communicated can dramatically alter perceptions of risk, even when an individual does not directly experience the risk.

In a sub-study which specifically manipulated levels of affect, Keller et al randomly allocated 92 participants to look at two photographs of houses experiencing or not experiencing flood. Participants looked at the photographs for about 30 seconds. They were asked to imagine that they were planning to buy the house and provided with the probability of flood. The scenario emphasised that “this flood causes severe damage, which is only partly covered by insurance.” Half of the participants received the risk information based on one year; the other half received the risk information for a time period of 30 years. Participants were asked to state using a scale of 1-6 the risk of living in a place similar to house in the photo. There was a significant difference for the manipulation of affect ($F(1,88) = 5.50, p = 0.02$). This study highlights that exposure to the possibility of a negative event, such as flooding or making an error, even without directly experience of the event, may therefore also have been sufficient to generate an affective learning experience.

Third, the similarity of responses participants in the comparative study may have been influence by the availability-by-recall heuristic. This is a subset of the availability heuristic in which recall of an event is based upon the individual’s experience of occurrences of the event in their social network. This is similar to vicarious learning, in which the experience of others directly influenced the learning, behaviour and attitudes of others (O’Regan et al 2016), although they were not direct observers. Pachur et al (2012) specifically gauged how individuals use availability-by-recall and affect in determining risk in 24 forms of cancers. 33 students from a Swiss university were asked to estimate: risk of diagnosis, annual national mortality rates, cost of treatment, and the maximum annual spend of treatment to reduce mortality per individual patient. The researchers also asked participants to rate for the 24 forms of cancer and 12 risk characteristics feelings of dread. In a final recall task, participants were asked to recall how many deaths they could recall from their social network for each form of cancer. The median across participants estimated frequency for a risk was strongly related to the mean number of recalled instances, ($r = 0.62, p < 0.001$). Available risks, which included instances from social networks, were estimated to be more frequent in the population than less available risks. When judging relative mortality frequencies (which of two cancers claims more lives?) and absolute frequencies (what is the annual death toll of a cancer?), participants also appeared to primarily rely on the number of recalled instances from their social network.

This is supported by McDowell et al (2013) who completed a qualitative interview study with 239 men with a first-degree history of prostate cancer and 207 men without. They examined perceptions of prostate cancer risk, testing behaviours and perceived similarity to the stereotypical man diagnosed with prostate cancer. Participants with a family history of prostate

cancer reported a greater risk perception and a higher rate of testing. In the non-family history group, risk perception and testing rates increased significantly when the analysis widened to include friends and acquaintances. In this study, the family history combined with the individuals' broader social environment to influence risk perceptions and screening behaviour and demonstrates how the experiences of others can alter risk perception. This may account for the similarity in results across the comparative study, because participants in the specific knowledge and theory only sessions observed participants in their teaching session make an error in the change blindness scenario and were informed of medication administration error rates in the simulation and clinical practice. This may have contributed to their understanding of the risk and frequency of medication administration error.

9.3.5 Designing the Simulation to be a Realistic Representation of Clinical Practice

The use of error transformed the low-fidelity simulation into one that had high psychological fidelity and was realistic to participants. The simulation supports a subset of the literature, for example, Carrera (2013), Sharpnack and Madigan (2012), Tun et al (2015) and Talbot (2013) who state that low-fidelity simulation can provide an effective and realistic learning experience. It confirms Beaubien and Baker (2004) that psychological fidelity is paramount in simulation over and above environmental and engineering fidelity. The usability engineering design methods used ensured that the simulation was internally salient and accurately captured all of the theoretical and practical elements necessary to administer medications according to best practice and the five rights. This ensured that the simulation was an appropriate educational tool. The simulation scenario, pages and layout closely replicated real life medication administration and as a consequence, the simulation was intrinsically recognisable to participants.

The levels of realism achieved is demonstrated by the response of participants in the long-term qualitative interview study when they stated that the simulation represented clinical practice. This was exemplified by the participants' emotional responses to making a medication administration error. The emotional responses of participants were highly similar to nurses who make real life errors, for example guilt, anger, upset, concern and terror plus a loss of confidence in their clinical abilities (Mayo and Duncan, 2004, Jones and Trieber 2010, Gladstone, 1995 and Santos et al 2007). The emotional reaction experienced by the participants provided an added dimension to their learning, made the simulation easier to recall and more salient. Such an emotional response is not usually elicited within the classroom setting and this made the simulation particularly distinctive. It enabled participants to learn, at a more profound and deeper level, conceptual knowledge about medication administration in a manner which reflected the

reality of clinical practice (Herrington and Herrington 2006). This made learning about the importance of the five rights more pertinent and relevant. Studies such as Mayo and Duncan (2004) and Jones and Treiber (2010) underscore that affect is an integral and realistic part of nursing practice. Affective should be proactively incorporated into nurse education so that student nurses are prepared and supported for this core component of clinical practice.

This underlines the importance of authenticity and realism to effective simulation education and the ability to learn conceptual knowledge (Gaba 2004, Kardong-Edgren et al 2007, Garrett et al 2011, Kneebone et al 2004, McCaughey and Traynor 2010, Reilly and Spratt 2007, Bland et al 2011 and Herrington and Herrington 2006). The simulation, including the error generated, was realistic to participants, partly because it provided an authentic representation of the changeable nature of clinical practice. This demonstrates to theorists, for example, Rafferty et al (1996) and Yassin (1994) that university education can incorporate the realities of clinical practice (Corlett 2000). In the simulation, the error occurred into a perceptively low-risk, commonly occurring situation which was highly recognisable to participants. The majority of qualitative interview participants recognised that patient change was integral to the simulation design and that the right drug wrong patient error was an error that they could easily encounter in clinical practice. This was essential in the context of the simulation as the level of risk in the simulation was realistic because it reflected the level of skill and responsibility of participants (Kneebone et al 2007). Although in the simulation, participants administered oral medications, in clinical practice, first-year nursing students are not allowed to administer medications without the supervision of a qualified nurse. However, student nurses are taught to administer medications safely in preparation for professional practice (NMC 2015b), and therefore the task did reflect the goals and purpose of medication administration education.

The results of this study support the literature which indicates that contextualised, authentic and realistic simulations can be achieved through innovative low cost or low-fidelity design. For example, Fickley (2014) designed a low-fidelity simulation of post-partum haemorrhage using role-play, static mannequin arms and out of date blood units. Participants achieved an average improvement of 10 points in post simulation scores and were satisfied with their teaching experience. Participants considered the simulation to be so realistic that it generated affect, similar to how they would feel in a real emergency situation. In another example, Sadideen et al (2014) developed a low cost, high-fidelity, portable, immersive simulation environment which incorporated the principles of Advanced Trauma and Life Support and Emergency Management of Severe Burns. The simulation was designed similarly to the simulation development design process of this study in that it integrated current education theory and was refined using task

analysis and expert opinion. Qualitative data analysis revealed that participants felt the experience was 'real', they were 'able to behave as if in a real resuscitation environment' and the simulation addressed additional skills, including nontechnical skills. The authors state recreating challenges within the clinical context, such as error, is crucial to optimise simulation training. In another example, Tosterud et al (2013) examined the perceptions of nursing students to various levels of simulation and whether their level of education influenced this. 86 baccalaureate nursing students were randomly allocated to complete either high-fidelity patient simulator, a static mannequin or a paper/pencil case study. Participants were asked whether the teaching methods used were helpful and effective. Using a five-point Likert scale in which five was strongly agree and one was do not agree, participants mean scores in the high-fidelity, static mannequin and case study groups were 3.83, 4.21 and 4.50 respectively. Participants in the case study group were significantly more likely to state that they were most satisfied with their education experience ($\chi^2 = 8.301$, $p = < 0.001$). The level of education of participants did not influence the results. The study highlights very low-fidelity simulation can provide a more satisfying learning experience over simulation with higher levels of fidelity.

These results highlight that the selection of simulation fidelity should be based on fitness for purpose, and suitably designed lower-fidelity simulations should be considered when they can achieve sufficient levels of realism for learning to occur. The simulation was not high-fidelity but was sufficiently realistic to provide an effective learning experience (Kneebone et al 2010, Kneebone 2010). The effectiveness of the simulation highlights that if the simulation is suitably designed, engineering fidelity becomes less important (Beaubien and Baker 2004). This is supported by multiple authors for example, Kneebone et al (2007), Parker and Myrick (2009) who recommend that selection of fidelity should be based on maximising education outcomes with the minimum cost. This study successfully transformed the low-fidelity simulation to provide a sufficiently realistic simulation to improve learning outcomes (Kneebone 2010). The results corroborate Kardong-Edgren et al's (2007) assertion that if it can be demonstrated if significant knowledge can be achieved through the application of low-fidelity methods, lower-fidelity methods should be used. The effectiveness of low-fidelity, low cost simulation has major implications for simulation education, particularly during increasing financial austerity.

9.3.6 Importance of Evaluating Simulations Over the Long-term

The importance of evaluating simulation over the long-term is clearly illustrated within this study. The results of the long-term qualitative interview study had a profound retrospect impact on the conclusions of the comparative study. The results of the comparative study highlighted that the

three teaching sessions provided a predominantly comparable education experience and the simulation session did not appear to be salient. However, the long-term qualitative interview study highlighted that the simulation session provided a highly salient and realistic learning experience for nursing students over the long-term. This in turn provided new insights into the results of the comparative study and the effectiveness of all three teaching sessions. The combination of both studies enabled a more comprehensive understanding of the effectiveness of the simulation, the importance active learning and the role of the 'simulation light' scenario.

The study underlines the need for simulation education to be salient and evaluated over the long-term. Simulation is primarily used to teach skills and competencies for future clinical practice and it is essential that methods used to evaluate simulation education reflect this long-term goal. Simulation education is null and void if what is taught is not consolidated and used over the long-term. The literature for example, Kinney and Henderson (2008) and Levett-Jones et al (2011) suggests that educational improvements evident immediately after simulation experience are not always retained over the long-term. In addition, the literature suggests that the long-term saliency of an event, such as error may diminish over time (Michel-Kerjan et al 2012 and Gallagher 2014). This underlines the need for simulation education to be evaluated over the long-term.

This study investigated perceived simulation learning outcomes over the long-term. Although research, for example, Fritz et al (2008) suggests that the gold standard to evaluate simulation effectiveness is to determine its impact on patient care, this was unfeasible and outside the scope and resources of this study. However, the participants in the long-term qualitative interview study were able to recall and reflect upon their simulation experience and discuss how it underlined the importance of the five rights to subsequent clinical practice. This enabled more comprehensive insights into the long-term salience of the simulation and its potential impact on their clinical practice. This goes to the essence of nursing education in that what is taught is to be applied over the long-term (NMC 2010) to support patient outcomes. The literature highlights that there is a gap in knowledge as to whether these learning outcomes from simulation education are transferred to clinical practice over the long-term, for example, Norman (2012). The study demonstrates that is possible to determine if simulation learning outcomes are recalled over the long-term, which in turn is more likely to be transferred to clinical practice. The method used in the long-term evaluation study is a feasible method to help close this gap.

9.3.7 Future Changes to the Simulation Session

Each of the three sessions comprised the same learning components but differed in their presentation format. The learning components were; the simulation, the experience of error through change blindness, causes of medication administration error and the importance of the five rights. The objective was to identify what teaching session provided the most effective learning experience.

The results of this study suggest a number of changes to the simulation session to improve education outcomes. The results of the comparative study highlight that the specific knowledge session participants were significantly more likely to state that the session helped with their learning about medication administration. Therefore, a teaching session which combines the simulation and the specific knowledge session may provide the most comprehensive learning experience. This will provide students who did not make an error in the simulation the opportunity to learn from error in the 'simulation light' change blindness scenarios which are then linked to error. Students will also benefit from the bespoke teaching session designed specifically to teach about the causes and prevention of medication administration error. This is supported by the literature, for example, Siddiqui et al (2014) who suggest that low-fidelity simulation improves the learning process when used in addition to more conventional teaching.

This study evaluated the simulation within a research format and therefore the questionnaire aimed to gauge the immediate responses of participants about their experiences of the simulation. It was important that the simulation session was conducted without a debriefing session, so that the impact of the simulation on participants learning could be measured in isolation. In addition, the time available to conduct the comparative study teaching sessions did not enable a debriefing session to be conducted. However, much of the simulation literature discusses the importance of debrief for effective simulation education.

For example, Jeffries (2005) produced a simulation model framework of nursing practice which identifies five major integral components that are needed for successful learning from simulation. Each component has associated variables which can be included or excluded depending on the individual aims and requirements of each simulation. The components are interactive and impact upon each other, so that they collectively achieve a successful learning experience. The components are teacher, student, educational practices, outcomes and simulation design characteristics. Included in the simulation design characteristics components is debrief. Jeffries describes debriefing as an essential part in simulation education (Jeffries 2005, Jeffries 2007 and

Waxman 2010) and should ideally be completed in conjunction with both the teacher and the student, at the end of the simulation experience. A debrief is a collective examination of the simulation experience. In the debriefing session, the teachers encourage critical-thinking and reflective practice to support and reinforce the learning objectives of the simulation experience and actively link them to clinical practice (Groom et al 2014). The teacher also uses the debriefing to assess the student's performance and corrects or discusses any inappropriate actions that occur during the simulation. The debriefing session helps students to solidify their learning, facilitates self-correction (Fanning and Gaba 2007) and verbalise their actions (Lasater 2007). While many researchers support the use of debriefing, research into debriefing is limited (Neill and Wotton 2011).

Levett-Jones and Lapkin (2014) support the use of debrief in simulation education. They completed a systematic review of the effectiveness of simulation debriefing in health profession education between January 2000 and September 2011 and analysed 10 studies of randomised control trials. Studies involved teaching a range of skills including vital signs assessment, psychomotor skills and team working and reported a significant improvement in pre-test and post-test scores. Multiple methods were employed, including post simulation debriefing, in-simulation debriefing, instructor facilitated debriefing and video-assisted instructor debriefing. They were unable to complete a meta-analysis into the role of debrief because of differences in outcome measurements, control groups and interventions. Despite this, the authors conclude that regardless of the type of debriefing conducted, it is an important component of simulation education and is an integral component of all simulation-based learning experiences. This is supported by Cant and Cooper (2010) who state that debriefing is a core component in successful simulation, but that practices can vary according to the context of the scenario. Therefore, a teaching session which combines the simulation and the specific knowledge sessions and debrief may provide the most optimal student experience. Further research is needed on the most appropriate form of debrief suitable for the simulation.

9.4 Methodological Limitations

There are a number of methodological limitations in this study. The comparative study sample size was limited to nursing students available in the first-year nursing programme. As a consequence, the comparative study could have been insufficiently powered and other interesting differences between groups could not be clearly attributed to differences in teaching session. Further research is also required to design the simulation so the majority of students make a medication administration error.

The long-term qualitative study did not include sufficient number of participants who did not make an error in the simulation session. The focus of the study was to identify the learning outcomes of error, and participants stated the experience of error was central to their learning experience. Identifying the education impact of the simulation without making an error would provide a more comprehensive understanding of the potential for error on learning outcomes. Due to time constraints, the study did not investigate the long-term learning outcomes of participants in the specific knowledge and theory only sessions. Therefore, the long-term learning outcomes derived from these sessions cannot be established, nor compared to the simulation session.

The study was completed at one institution and with one student cohort. This reduces the generalisability of the study results. However, the uniformity of participant responses in the long-term follow-up study relating to the importance of error in the simulation and the impact of making an error to their learning suggests that the results can be extrapolated more widely. The study could be repeated on other first year nursing cohorts and at different institutions, particularly where they do not use high-fidelity simulations to teach medication administration.

9.5 Conclusion

The results of the study demonstrate that there is a distinct role for simulation education in the student nurse medication administration curriculum. Simulation and the experience of error can provide a powerful and insightful learning experience which goes beyond the traditional didactic learning approach. The use of error and the integration of change and cognitive load into the simulation demonstrate simulation can provide a realistic learning experience of clinical practice which cannot be generated in clinical practice as part of the student nurse curriculum.

Participants considered the simulation to be a valued addition to their learning which supported them in clinical practice.

This study integrated adult learning theory, change blindness, theory of risk, salience, heuristics and error to design the simulation to provide a salient learning experience over the long-term. This is a novel combination of various psychological theories to enable participants to directly experience and internalise the importance of theory to clinical practice and requires further research. The study highlights how each of these elements has a role in simulation education to support nurses in clinical practice. Error transformed the learning experience into one that made salient the theoretical components of safe medication practice within the clinical environment over the long-term. It enabled participants to appreciate the risks involved in medication

administration and their responsibility as qualified nurses to safeguard patients. This made the simulation internally and externally salient and supported participants to have the robustness to guard against error. The heuristics of availability and affect are key learning components that can be manipulated to support the salience of simulation learning to clinical practice over the long-term. Affect in particular, is a central and profound component to learning in the simulation. It is an underused but integral part of effective learning and appropriately designed programmes which generate affect should be more routinely integrated into the student nurse curriculum. Heuristics, error and salience can all be manipulated to enhance learning outcomes of simulation education.

This study underscores the importance of active learning in simulation education irrespective of fidelity. The active learning component goes to the very heart of the effectiveness of simulation education and how it can be best integrated into the nursing curriculum should be a core consideration for nurse educators. The importance of active learning highlights the need for nurse educators to take into account learning theory when selecting simulation design, target student group, fidelity, learning goals and evaluation methods. Simulation needs to be evaluated over the long-term to identify links between theory and implementation in clinical practice.

This study highlights that innovatively designed lower-fidelity simulations can be sufficiently realistic and provide an effective learning experience that is salient over the long-term. The medication administration and the error generating scenario helped transform the simulation into one which was authentic, had high levels of psychological fidelity and was realistic to participants. This reinforces the importance of psychological fidelity is the cornerstone of effective simulation education over and above engineering and environmental fidelity, and can be provided using a low-fidelity design. The use of cognitive load and change to generate error demonstrates that the systemic complexity of clinical practice can be integrated into lower-fidelity simulation to provide an effective learning experience. There may be other elements in addition to error that can potentially transform lower-fidelity simulations into ones with high levels of psychological realism, and is an area of further research.

Educational outcomes achieved in this study highlight that the cost benefit derived using low-fidelity simulation is highly advantageous, particularly when taking account of the current financial constraints facing universities and should be considered before integrating a new simulation programme into the nursing curriculum. This study illustrates that low-fidelity online simulation has a place in 21st century nursing education. The low-fidelity medication administration simulation is easy to use, cost-effective and can easily be incorporated into the

first-year nursing curriculum to provide an effective and salient learning experience over the long-term. Error was central to the salience of theory and realism of the simulation over the long-term. Error should be transformed from a useful by-product of simulation education into an active learning strategy.

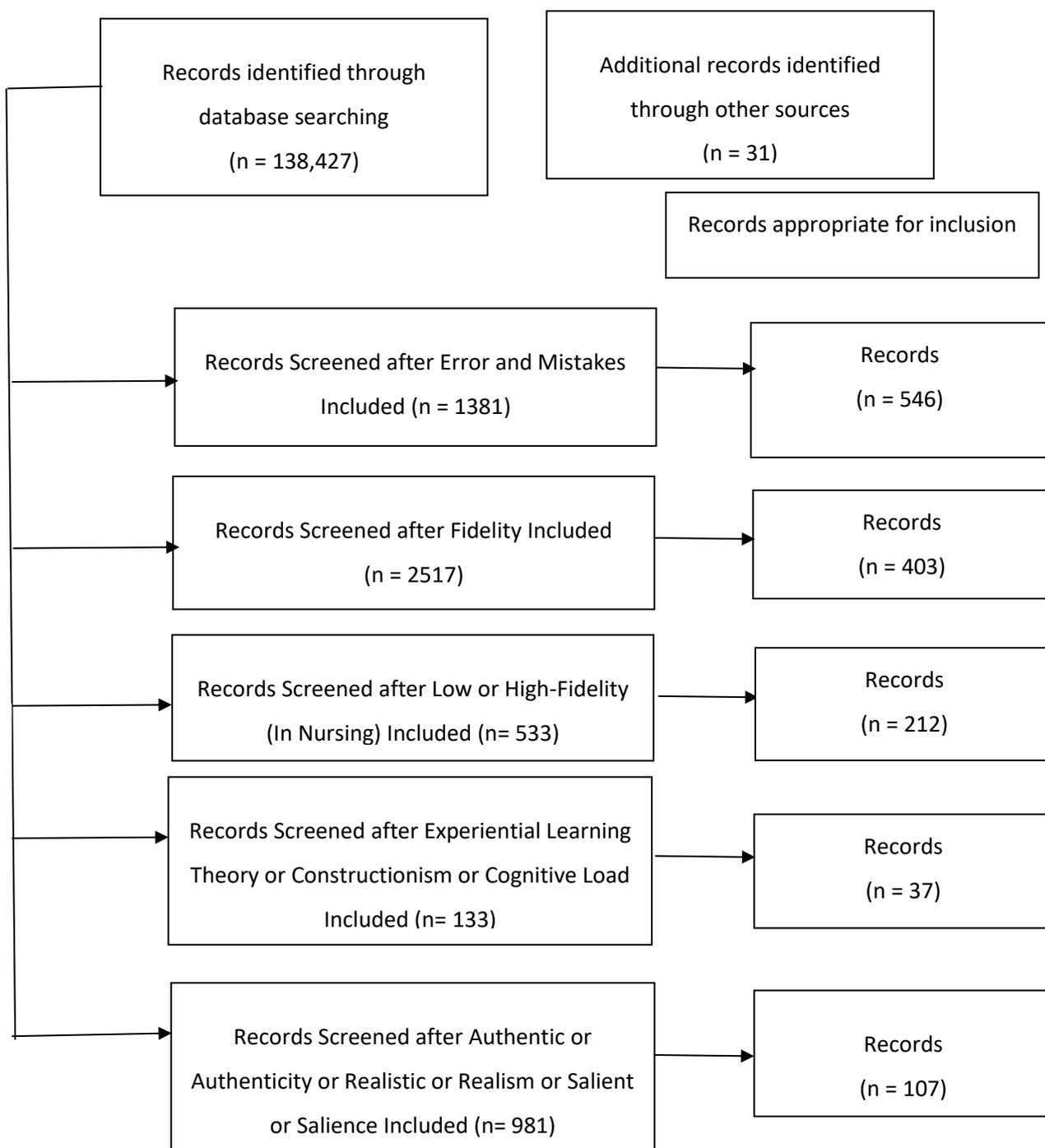
Appendices

Appendix A Literature Search

Literature Search Flow Diagram

Simulation (Abs) – CINAHL and Medline until March 2017.

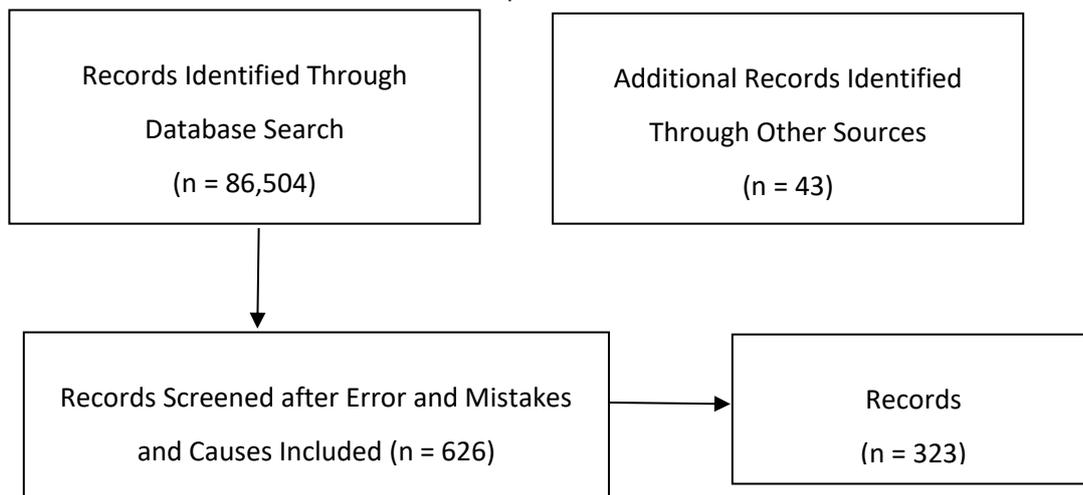
Records were suitable for inclusion if they related to education.



Literature Search Flow Diagram

Medication Administration – CINAHL and Medline until March 2017.

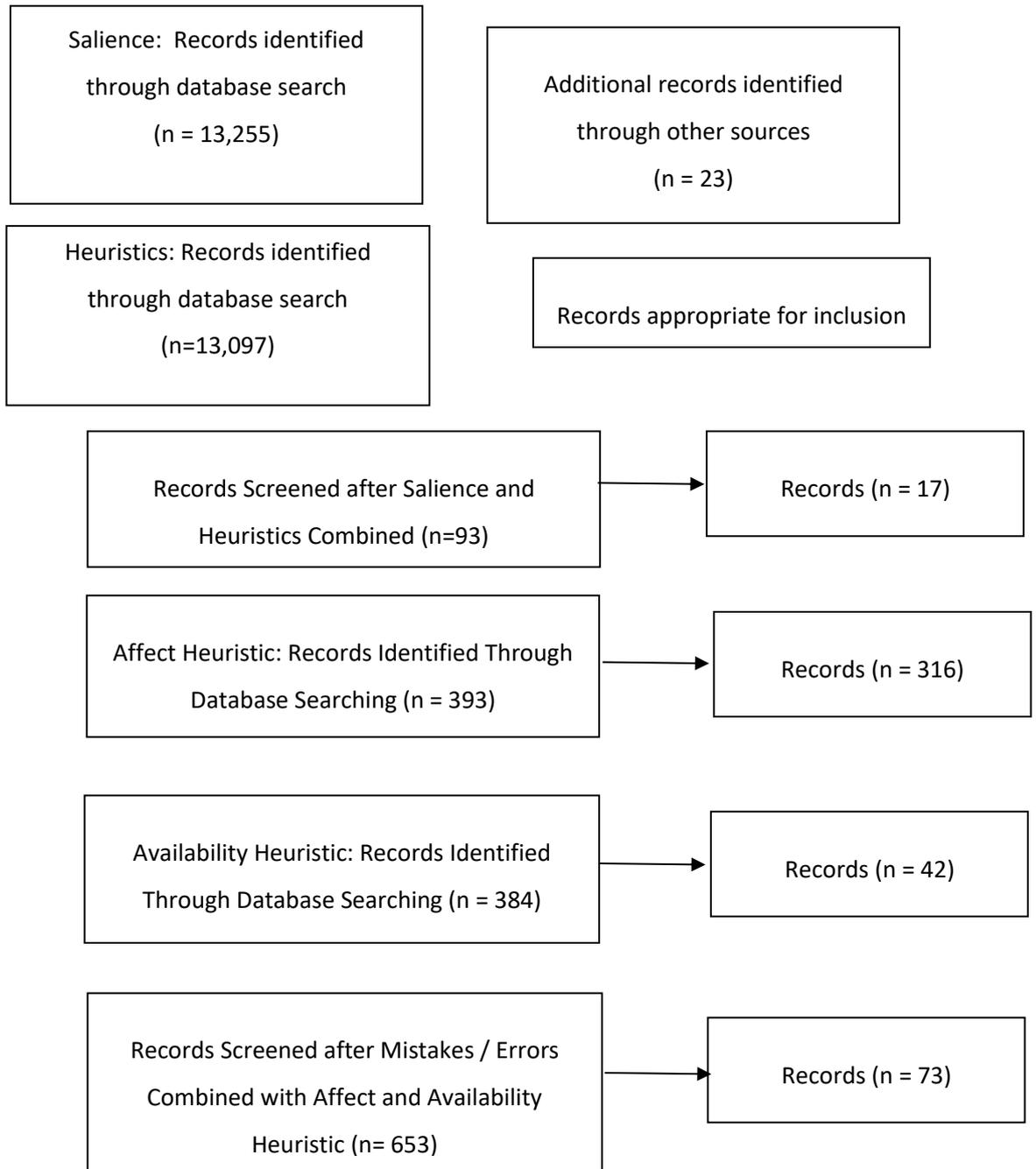
Records were excluded if they were a case-study, out of hospital or related to a particular device, medication or patient condition.



Literature Search Flow Diagram

Psychological Phenomenon – PsychINFO until March 2017.

Records were appropriate for inclusion if they related to potential participant behaviour and not to artificial constructs.



Appendix B Ethical Approvals

Professor Peter Griffiths
Room 4.29b
James Clerk Maxwell Building
Waterloo Road
London SE1 8WA
Friday 15th June 2007

Dear Professor Griffiths

CREC/06/07-174 Simulated drug administration errors as a learning experience - development of a theory based low-fidelity simulation model to generate salient learning experiences for healthcare students.

Thank you for sending in the amendments requested to the above project. I am pleased to inform you that these meet the CREC's requirements and therefore that full approval is now granted. Please read the enclosed Notes for Investigators of Approved Projects and the College guidelines on record management. These can be found by accessing the KCL website at <http://www.kcl.ac.uk/depsta/iss/archives/recman/toolkit0.html> and reading Fact Sheet 15 'How to manage academic research records'.

For your information ethical approval is granted for a period of two year, after which point you will be reminded to apply for an extension of approval (please note however that a full re-application will not be necessary unless the protocol has changed).

Please would you also note that we may, for the purposes of audit, contact you from time to time to ascertain the status of your research.

We wish you every success with this work.

With best wishes

Yours sincerely

Rowena Lamb Research Ethics Officer

Sinead Helyar
The Flat
Poundisford Lodge
Poundisford Taunton
TA3 7AE
06 October 2009
Dear Sinead Helyar

PNM/08/09-129 Simulated drug administration errors as a learning experience - Does a theory base low-fidelity simulation model generate a salient and long lasting learning experiences for healthcare students?

Thank you for sending in the amendments requested to the above project. I am pleased to inform you that these meet the requirements of the PNM and therefore that full approval is now granted.

Please ensure that you follow all relevant guidance as laid out in the King's College London Guidelines on Good Practice in Academic Research (http://www.kcl.ac.uk/college/policyzone/attachments/good_practice_May_08_FINAL.pdf).

For your information ethical approval is granted until 06/10/2012. If you need approval beyond this point you will need to apply for an extension to approval at least two weeks prior to this explaining why the extension is needed, (please note however that a full re-application will not be necessary unless the protocol has changed). You should also note that if your approval is for one year, you will not be sent a reminder when it is due to lapse.

If you do not start the project within three months of this letter please contact the Research Ethics Office. Should you need to modify the project or request an extension to approval you will need approval for this and should follow the guidance relating to modifying approved applications: <http://www.kcl.ac.uk/research/ethics/applicants/modifications.html>

Any unforeseen ethical problems arising during the course of the project should be reported to the approving committee/panel. In the event of an untoward event or an adverse reaction a full report must be made to the Chairman of the approving committee/review panel within one week

of the incident.

Please would you also note that we may, for the purposes of audit, contact you from time to time to ascertain the status of your research.

If you have any query about any aspect of this ethical approval, please contact your panel/committee administrator in the first instance (<http://www.kcl.ac.uk/research/ethics/contacts.html>). We wish you every success with this work.

With best wishes

Yours sincerely

Riina Heinonen
Senior Research Ethics Officer
c.c.
Professor Peter Griffiths

Appendix C Nurse Simulation User Testing

Nurse response: Contextual Analysis

Nurse 1.

“Today I know all my patients from yesterday which is a good start. Sometimes I check who the patient is first and sometimes I look at the drug chart first, especially if the patient is asleep. It really depends.

I have the drug trolley and when I approach the bed I get the drug chart, check the chart is for the patient I think it is. If I know them I won't check name band etc but will say hello George, how are you etc, how are you feeling to day etc? Like now, how are you George?’ (Not real name)

‘Fine thanks.’

Gets out drug chart and opens it.

“If there was a new patient, I would check properly.

I will check his drug chart to see what has been given and what is now due. I normally start getting out the meds. The ones I check for are digoxin - so I check the heart rate, but I can't think what else.”

Checks drug chart, gets out drugs, checking right drug, checking doses and expiry dates.

“I check the drug packs and dose - particularly here like in warfarin. Lots of different tablets you could give. Oh I forgot - I also check the once only doses to see if anything has been given drugs more recently. - Its easy to miss that bit. expiry dates and put all the tablets in the cup.

So I put everything in the cup, I usually sign as I go along.

I go through the chart just to check I haven't missed anything and then give the drugs to George. . If there isn't a drug that I need, I can see from the lack of signature and will go and get it and return at the end. Also, I come back after with SC and IV meds etc that I haven't previously given.”

Gives medications to patient and water. She also puts water in the aspirin cup

“Just to check George - have you eaten breakfast, as you need your aspirin? I always check this before that have gastric irritant drugs.”

George takes medication

'Yep - so now I know George has the drugs I have signed and then I go off to the next patient.'

George asks nurse to complete some tasks around the bedside area.

"Now I would go to the next patient and go through the same process and do the other drugs afterwards (SC etc)"

Nurse 2.

"We only have two drug trolleys for three nurses so I always try and get it first - otherwise you have done a time error before you have even started. I always check the nameband in the morning as it sets you up for the day and I always ask about allergy status as part of my introduction as it is something to say to interact with the patient. Then I have done it for the rest of the day. If I know the patient, I don't check their details (after), although if I have loads of drug charts with me, I may do a quick check...don't want to get it wrong!. I always ask if they are allergic to anything when I introduce myself to the patient. I do it now as a small task, for something to say. It is an easy way of checking without having to think about it.

Morning Ann (not real name), how are you?"

'Fine thank you.'

"I am checking the nameband to check she is who she is and cross check with the drug chart. I have got the drug chart mixed up before.

I check the chart, look at all the details, check what is to be given and check obs etc and check that the patient can take it (the medication) as prescribed before I start.

I go to the drug trolley, get the cup and go through the drug chart and see what is to be given. I get the tablets and check I have the right number and put it in one at a time. and then I give it to the patient".

Nurse prepares medications, checks name, dose and route and gives drugs to patient.

"If the patient is prescribed paracetamol etc, I tend to give it without asking, but I have to say I often forget to look at PRN stuff, so I need to be more aware. But I usually wait to see if the patient complains of pain for example or if they are nauseous, itching, SOB. Actually if salbutamol etc is PRN I am usually more proactive with that.

I get the patient some water for the medications and check that they have taken it and then sign. But then have to remember what I have given etc. Sometime I don't have all the drugs which is a complete irritation and you have to go and write it in the book and order it for later and then give it at a later drug round. You then have to sign for it so it is much more time consuming, Often there isn't the subcut meds - but here I have the clexane so that is ok. I always do the IV drugs after. If I have time and I know I have IVs, I try and prepare them before hand, just in case you run out of the drugs, Actually, that is the most irritating aspect, not having what you need and taking ages to sort it out. I would also keep the drug chart if I needed to order more drugs and keep in pharmacy book".

Nurse 3.

"Well how you administer medications is check the patient ' name band, drug, dose, route and time. I try and make sure the right time is completed but often it is really difficult to accomplish this.

I check the patient's nameband to check that they are who they say they are and cross check that with the drug chart and check what drugs need to be given. Also with the drugs its good cause you can work out what is wrong with the patient and what they are suffering with.

I check the name band and get the drug chart and make sure they are the same. I then do to the drug trolley and go through the drug chart, check the drugs, dose, and put it in the cup. I then when finished give to the patient and give them the cup. I always watch the patient taking the medications, some patients can be confused etc, so that can be a bit of a problem. Once I have seen that I sign. I should say that this patient has a red nameband and so has an allergy. I know what the patient allergy is already so that is fine, perhaps I should have checked it now with you here, but that is really important so I do do that!"

Checks nameband, gets drugs, counts out tablets, gives cup to patient and gives water to patient.

"Antibiotics, I haven't given this one - Its IV and they were given it quite recently, so I am crossing that out and signing to state that is the case, otherwise they can have an overdose. But it saves me time now, so that's ok'. Now I have finished, I will then go on to the next patient",

Task Analysis Assessment

Responses from three nurses

“Yes it’s fine, I can’t think of anything else to add. I would take away wash hands and give water etc, I don’t know how you would add that in.”

“Are we checking pharmacology knowledge or just the process of drug administration? What about the BNF, I think that needs to be kept in if students are working out what to actually give.”

“As long as they know they should give it, you probably don’t need the BNF. Will they have the time to check the BNF in the timeframe of the simulation? I think you need to be clear.”

“What about food - do they give food with the drug- aspirin? - You could give it as an instruction?”

“Are you programming wash hands and give water into the simulation? Not sure how that will work.”

“That seems fine. Not sure what else is there. Do the students check the bnf. Are you giving them copies or a link to it? I think if they aren’t being assessed on the actual drug doses, just put an instruction saying all drugs are appropriate to give.”

“Just looking at the structure, yes that seems ok. Yep. Think everything is there.”

“I like the structure, it is really clear - I hadn’t realised how complicated it is!”

“My key concerns are the BNF - what happens with that? Wash hands and give water to swallow the drugs. I am not sure if it necessarily needs to be included. It would be good, but how to you put it in?”

“So this is from our training records and the Royal Marsden? Well if that is correct then it has everything that you need”.

Template Screen Shots

Nurse 1

“I think having three pictures is a good idea, as it is like when you go into a bay and youve not met the pa-tients before. Three is probably ok, four would be too much, but with the switch around you want, two might be too easy.

Easy name band. Easy patient info, I know where to click that is fine. I think it has all the information. Would be good to get background details, obs etc as there are some meds you wouldn't give. I need to know what the obs are. So yes, make sure they are all ok. Patient details - allergy status - ensure that is compatible. Patient bed side number is a good idea to specify that - perhaps when they change the bed number stays the same. Sometimes patients have names above them clearly displayed to nurses, but this might not be kept up to date so I think it is good to have to check the name band.

Medication chart - I really like that its clear - all the patients details need to be clearly displayed on the medication chart as well to check. Can all the boxes open and close 'oh that is good. And it opens up well - so it opens over the faces, ok that works. I like the trolley aspect. Make it clear what has been clicked on and the dose. Needs to be taken in and out.

Need guidance about how to get in.

The one thing is, I don't know the difference between the name band and patient details - is that my handover sheet? I think that could be a source of confusion. Could it be amalgamated into something else together.

The name band should swap with the patient, but then I might check the patient details and think that is the same thing if that makes sense. Also, student needs to know patient has been given the drugs and to sign the drug chart.

The click and drag yeah, I think that can work. You need to be able to take drugs out of the cup before giving to the patient. Clear feedback at all times in what you have done.

Liked it - makes sense, all info is there, but I could mix up the nameband and patient details.

Also, I think it should be clear all along who the patient to give drugs are, pt name, hosp number and bed number".

Nurse 2.

"Yes, that is a good patient screen, need instructions on who to give patient to. I think clicking on different areas and opening and closing is really helpful - on ward I think staff check in a different order. Bed numbers needed as it helps work out zone of patient.

How do I identify the patient? I would probably click on both as I would expect them to have the same sort of info. I need to know patients presenting complaint to see if what I am giving is appropriate. That is an important part of medication which I still think should be there - obs,

pmh, also drug expiry date. I can't see that. That needs to be checked for each drug - perhaps a box. Always to be in date for easy.

What about name band - red or white if allergic - that is what happens in hospital - can we do that or would that make it more obvious of who the patient is. All of them could be NKDA? That would sort that out. It might be easier and then that is something the students don't need to think about it.

Medication chart, patient details and name band - what is the difference between them all. Might be confusing. Which changes with the patient we don't want to different pieces of information giving info about two different patients when they swap.

The drug chart is fine - needs to be clear which line is what medication - prescription, any extra info, dr prescription, and signature, times of giving drug, any info about how to take drug - aspirin here - dissolve in water and after food. The valid period needs completing. Otherwise you wouldn't actually give it. Need to be able to put in and out of drug chart. Also empty drug cup and to know how to scroll up and down. Also, I think you need to make it clear where you go through the chart etc. Patient details to be clear on drug chart for the whole time with pt name allergy status etc.

I want to see the drugs go into the cup when I add to cup and can take them out whenever. Also I think the drag aspect will work and feedback to show patient has got it, you don't need to just hover over it".

Nurse 3.

"I would want to start with who am I supposed to give the medications to and where they are so and so in bed x for which drug round - who where and when.

I am confused, is the patient name band the same as the patient details? I would look at both? You need to be clear what stays with the patient and what doesn't make it clearly encapsulated together. I am just going through how I think it will work.... Make it clear that everything should be given and is suitable.

I would click here, that is fine, and go through to the medication chart - that is fine and make sense. I would like to go back and forth to check. Also, all the patient details need to be clearly displayed at all times, that seems fine.

You could put the drugs actually in the cup. And then you need to be able to take them out".

Final Simulation Evaluation

Nurse 1.

“The task is clear, I know what to do and that makes sense.

I like being able to flit from drug chart to patient details and the chart is like the one at work. I know where the patient is, who to give the drugs to and I know what would need to be checked to id the patient and what I would expect to be swapped. Yes, I can see how to give the drugs – scroll bar etc, that seems fine. I can put them in and out and in again – close drug chart and give to patient. Yes that seems fine”.

Nurse 2.

“Ok, I start here, check the task – The clock is good – I know what the time in and yes its the 8 am medication round and then I check who to give it to – look here in bed 22, yes that is clear. GO all the info I think – I now click on the drug chart. That is ok, I can move them around which is good. I can see which drugs need to be give. Click here and then it comes up in the cup. I can scroll down to see if anything else is necessary. Finished, yes I see it closed and now I administer it”.

Nurse 3.

“Administer drugs – there is the bed space, I check the nameband, this has all the information that I need. I like the background info re diagnosis, observations etc. The medication chart, yes that has everything, I can see how to select and dispense the medications. Yes, everything I need , clicking and adding, scrolling down. I like being able to see the drugs in the cups easily. I closet the chart and drag it to the patient. I check the patient – who has moved, yes that Works. I have the med chart and the name band and check that they have changed position, I can see how it Works and then give to the wrong patient”.

Nurse 4.

“I know what I am supposed to do and do the 8 am drug round. There is the patient I ahve checked - nameband has more information than I need. I can keep it open or closed. I open the medication chart and see what I need to give. I looks like a complete drug chart. Patient details, allergy, correct clear prescription, what I am to give now. It deosn't have the signature bit. I can see how to give the medications, I click here, select this and scroll diwn till I am finished. I click here. Am ready to give. I see the patients have swapped round. I could check again and give drug cup – here I drag it over and yes that have taken it and I sign”.

Appendix D Photo Consent Form



For office use	Date of photoshoot:
Location:	Staffed by (photographer and King's staff member):

King's College London would like to use [a photographic image/photographic images] of you. We would like to publish [this image/these images] in perpetuity in all media now known and hereinafter devised throughout the World.

Please note that your name [will/will not be] published with the image[s]. Before [taking/using] any photographs of you we need your permission. Please complete this form, then sign and date the form where indicated.

Your personal details	
Surname.....	May we use your photographic image in perpetuity in all media now known and hereinafter devised throughout the World? (please circle the appropriate response)
Forname(s).....	
Address.....	
.....	
.....	
.....	
Contact telephone number:.....	YES NO
Declaration I agree to King's College London using my photographic image in perpetuity in all media now known and hereinafter devised throughout the World.	
Signature	Date

Please note that King's College London will process the personal information provided in this form in accordance with the Data Protection Act 1998 and will use it in the management of its photographic

Appendix E Titration Phase Consent Form / Information Sheet

Titration phase: this information will be sent initially by email and will be repeated on the 'login' screen of the simulation where consent will be recorded. REC Protocol Number CREC/06/07-174

YOU WILL BE GIVEN A COPY OF THIS INFORMATION SHEET

Development of a drug administration simulation

We would like to invite you to participate in this project that is being conducted by a research group within the School of Nursing at King's College. You should only participate if you want to; choosing not to take part will not disadvantage you in any way. Before you decide whether you want to take part, it is important for you to understand why the project is being done and what your participation will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information.

This study aims to look at the performance of health care practitioners or students on a computer based simulation that involves checking a prescription and giving the correct drug(s) to one or more 'hospital patients'. We wish to do this so that we can develop a simulation package to support students in learning this task. At the moment we are trying to determine how people perform on the task and what factors affect that performance in order to develop a full simulation. Experience of using simulations such as this may help students to improve their clinical practice. At the moment this is unknown.

If you take part we will ask you to undertake a simulated drug administration task that is completed on a personal computer. The system will collect information about how you perform and will, at the end, give you individual feedback. You will be given some time to practice using the simulation before the task proper begins. We do not anticipate that the entire study will take more than 20-30 minutes and for some people it could be considerably shorter. As we do not want prior knowledge of the factors that we are investigating to influence your performance we will provide you with the opportunity (at the end of the simulation) to give us your email address so that we can send you more details about this at a later date if you wish. We may also ask you to complete an anonymous questionnaire about your experience.

In order to take part you should have a relevant professional healthcare background for the task. This would include all student doctors, nurses and pharmacists even if very junior. If you are uncertain about your suitability you should ask. Qualified practitioners are also eligible.

We cannot foresee any risks or discomforts other than those encountered in every day life although if your performance in the task causes you any concerns you are free to raise this with us and discuss it with us. You should be reassured that this is a simulation and at the moment we are not aware of any link between performance on the simulation and actual performance in practice.

Nobody other than investigators will have access to the information we collect and all information will be stored in an anonymised form. Your individual performance is completely confidential and there are no circumstances in which this would be reported to anyone else. Although computer files will exist which link your performance to a code that could be used to identify you, decoding would only take place at your request. Data extracted for analysis will not contain this information.

It is up to you to decide whether or not to take part. If you do decide to take part you will be given a copy of this information sheet to keep and be asked to indicate your consent as you commence the simulation. If you decide to take part you are still free to withdraw at any time and without giving a reason.

In the event of you suffering any adverse effects as a consequence of your participation in this study, you will be compensated through King's College London's 'No Fault Compensation Scheme'.

For further information contact Sinead Helyar or Peter Griffiths on 0207 848 3057

(sinead.helyar@kcl.ac.uk, peter.griffiths@kcl.ac.uk)

Appendix F Titration Phase Results

ID	T	Change	Similarities	Calculation	Number	Visibility	Sim	LevelofCalc	Number2	
1	1	hidden	dissimilar	Easy	Many	1	2	1	2	correct
1	2	hidden	dissimilar	Hard	Few	1	2	2	1	correct
2	1	obvious	Similar	Easy	Few	3	1	1	1	correct
2	2	obvious	dissimilar	Hard	Many	3	2	2	2	correct
3	1	hidden	dissimilar	Hard	Few	1	2	2	2	correct
3	2	obvious	Similar	Easy	Few	3	1	1	2	correct
4	1	obvious	dissimilar	Hard	Many	3	2	2	2	correct
4	2	hidden	Similar	Hard	Few	1	1	2	1	correct
5	1	hidden	Similar	Hard	Many	1	1	2	2	correct
5	2	subtle	Similar	Easy	Few	2	1	1	2	correct
6	1	hidden	dissimilar	Hard	Many	1	2	2	2	correct
6	2	subtle	dissimilar	Hard	Many	2	2	2	2	Correct
7	1	obvious	similar	Easy	Many	3	1	1	2	Correct
7	2	none	similar	Easy	Few		1	1	2	Correct
8	1	subtle	dissimilar	Hard	Many	2	2	2	2	Error
8	2	subtle	similar	Easy	Many	2	1	1	2	Correct
9	1	obvious	dissimilar	Easy	Few	3	2	1	1	Correct
9	2	hidden	dissimilar	Easy	Many	1	2	1	2	Correct
10	1	hidden	dissimilar	Hard	Few	1	2	2	2	Correct
10	2	obvious	similar	Easy	Few	3	1	1	2	Correct
11	1	subtle	similar	Hard	Few	2	1	2	1	Error
11	2	hidden	dissimilar	Hard	Many	1	2	2	2	Error
12	1	obvious	dissimilar	Hard	Many	3	2	2	2	Correct
12	2	hidden	similar	Easy	Few	1	1	1	2	Correct
13	1	hidden	dissimilar	Easy	Few	1	2	1	2	Error
13	2	hidden	similar	Hard	Many	1	1	2	2	Error
14	1	subtle	similar	Easy	Few	2	1	1	2	Correct
14	2	obvious	similar	Hard	Many	3	1	2	2	Error
15	1	hidden	similar	Easy	Many	1	1	1	2	correct
15	2	hidden	similar	Hard	Few	1	1	2	2	Correct

16	1	Hidden	dissimilar	Hard	many	1	2	2	2	correct
16	2	Subtle	dissimilar	Hard	many	2	2	2	2	Correct
17	1	Obvious	dissimilar	Easy	many	3	2	1	2	Error
17	2	Hidden	dissimilar	Hard	Few	1	2	2	1	Correct
18	1	Hidden	similar	Easy	many	1	1	1	2	Error
18	2	Hidden	similar	Hard	Few	1	1	2	2	Correct
19	1	Subtle	dissimilar	Easy	Few	2	2	1	1	Correct
19	2	Subtle	similar	Hard	many	2	1	2	2	Correct
20	1	Obvious	similar	Easy	Few	3	1	1	1	Correct
20	2	Obvious	dissimilar	Hard	many	3	2	2	2	Correct
21	1	Hidden	similar	Easy	many	1	1	1	2	Error
21	2	Hidden	similar	Hard	Few	1	1	2	2	Error
22	1	Subtle	similar	Easy	many	2	1	1	2	Correct
22	2	Obvious	dissimilar	Easy	many	3	2	1	2	Correct
23	1	Obvious	similar	Hard	many	3	1	2	2	Error
23	2	Hidden	similar	Easy	many	1	1	1	2	Correct
24	1	Subtle	similar	Hard	Few	2	1	2	2	Error
24	2	Hidden	dissimilar	Hard	many	1	2	2	2	Error
25	1	Subtle	similar	Hard	Few	2	1	2	1	Correct
25	2	Hidden	dissimilar	Hard	many	1	2	2	2	Error
26	1	Subtle	similar	Easy	many	2	1	1	2	Error
26	2	Obvious	dissimilar	Easy	many	3	2	1	2	Error
27	1	Hidden	similar	Easy	Few	1	1	1	1	Error
27	2	Subtle	similar	Hard	Few	2	1	2	1	Error
28	1	Subtle	similar	Easy	Few	2	1	1	2	Correct
28	2	Obvious	similar	Hard	many	3	1	2	2	Correct
29	1	Obvious	dissimilar	Hard	Few	3	2	2	1	Error
29	2	Obvious	similar	Easy	many	3	1	1	2	Correct
30	1	Obvious	dissimilar	Easy	many	3	2	1	2	Correct
30	2	Hidden	dissimilar	Easy	Few	1	2	1	2	Correct
31	1	Subtle	Dissimilar	Hard	many	2	2	2	2	correct
31	2	Subtle	Similar	Easy	many	2	1	1	2	Correct
32	1	Hidden	Dissimilar	Hard	many	1	2	2	2	Correct

32	2	subtle	Dissimilar	Hard	Many	2	2	2	2	Correct
33	1	obvious	Similar	Easy	Many	3	1	1	2	Correct
33	2	none	Similar	Easy	Few		1	1	1	Correct
34	1	subtle	Dissimilar	Easy	Many	2	2	1	2	Correct
34	2	obvious	Dissimilar	Easy	Few	3	2	1	1	Correct
35	1	subtle	Dissimilar	Easy	Many	2	2	1	2	Correct
35	2	obvious	Dissimilar	Easy	Few	3	2	1	2	Correct
36	1	obvious	Dissimilar	Hard	Few	3	2	2	2	Correct
36	2	obvious	Similar	Easy	Many	3	1	1	2	Correct
37	1	obvious	Similar	Easy	Many	3	1	1	2	Correct
37	2	none	Similar	Easy	Few		1	1	1	Correct
38	1	subtle	Dissimilar	Easy	Many	2	2	1	2	Correct
38	2	obvious	Dissimilar	Easy	Few	3	2	1	1	Correct
39	1	hidden	Dissimilar	Hard	Few	1	2	2	2	Correct
39	2	obvious	Similar	Easy	Few	3	1	1	2	Correct
40	1	obvious	Similar	Hard	Many	3	1	2	2	Error
40	2	hidden	Similar	Easy	Many	1	1	1	2	Error
41	1	subtle	Similar	Hard	Few	2	1	2	2	Correct
41	2	hidden	Dissimilar	Hard	Many	1	2	2	2	Correct
42	1	subtle	Dissimilar	Hard	Few	2	2	2	2	Correct
42	2	obvious	Similar	Hard	Few	3	1	2	2	Correct
43	1	subtle	Similar	Hard	Many	2	1	2	2	Error
43	2	subtle	Dissimilar	Hard	Few	2	2	2	1	Error
44	1	Obvious	Dissimilar	Hard	Many	3	2	2	2	Correct
44	2	Hidden	Similar	Easy	Few	1	1	1	2	Correct
45	1	Subtle	Similar	Hard	Many	2	1	2	2	Correct
45	2	Subtle	Dissimilar	Hard	Few	2	2	2	1	Error

46	1	Subtle	dissimilar	Easy	many	2	2	1	2	Correct
46	2	None	similar	Easy	few		1	1	1	Correct

47	1	Hidden	similar	Hard	many	1	1	2	2	Correct
47	2	Subtle	similar	Easy	few	2	1	1	2	Correct
48	1	Obvious	similar	Hard	few	3	1	2	2	Correct
48	2	Obvious	dissimilar	Hard	few	3	2	2	2	Correct
49	1	Subtle	similar	Easy	few	2	1	1	2	Correct
49	2	Obvious	similar	Hard	many	3	1	2	2	Correct
50	1	Obvious	similar	Hard	few	3	1	2	1	Correct
50	2	Obvious	dissimilar	Hard	few	3	2	2	2	Correct
51	1	Hidden	similar	Easy	few	1	1	1	1	Correct
51	2	Subtle	similar	Hard	few	2	1	2	2	Correct
52	1	Obvious	similar	Easy	many	3	1	1	2	Correct
52	2	undefined	undefined	undefined	undefined					Correct
53	1	Hidden	similar	Hard	many	1	1	2	2	Error
53	2	Subtle	similar	Easy	few	2	1	1	1	Correct
54	1	Obvious	dissimilar	Easy	few	3	2	1	1	Correct
54	2	Hidden	dissimilar	Easy	many	1	2	1	2	Error
55	1	Hidden	similar	Hard	few	1	1	2	2	Error
55	2	Subtle	dissimilar	Hard	few	2	2	2	1	Correct
56	1	Hidden	similar	Easy	many	1	1	1	2	Error
56	2	Hidden	similar	Hard	few	1	1	2	2	Error
57	1	Subtle	dissimilar	Easy	many	2	2	1	2	Correct
57	2	Obvious	dissimilar	Easy	few	3	2	1	1	Correct
58	1	Hidden	similar	Hard	few	1	1	2	1	Correct
58	2	Subtle	dissimilar	Easy	few	2	2	1	1	Correct
59	1	Subtle	dissimilar	Easy	many	2	2	1	2	Correct
59	2	Obvious	dissimilar	Easy	few	3	2	1	1	Correct
60	1	Hidden	similar	Hard	many	1	1	2	2	Error
60	2	Subtle	similar	Hard	few	2	1	2	2	Error

61	1	Hidden	Dissimilar	Hard	Few	1	2	2	2	Correct
61	2	hidden	Similar	Hard	many	1	1	2	2	Correct
62	1	obvious	Dissimilar	Easy	Few	3	2	1	1	Correct
62	2	hidden	Dissimilar	Easy	many	1	2	1	2	Correct
63	1	obvious	Dissimilar	Hard	many	3	2	2	2	Correct
63	2	hidden	Similar	Easy	Few	1	1	1	2	Correct
64	1	subtle	Dissimilar	Hard	many	2	2	2	2	Correct
64	2	subtle	Similar	Easy	many	2	1	1	2	Correct
65	1	hidden	Dissimilar	Easy	many	1	2	1	2	Correct
65	2	hidden	Dissimilar	Hard	Few	1	2	2	1	Correct
66	1	obvious	Dissimilar	Easy	many	3	2	1	2	Correct
66	2	hidden	Dissimilar	Easy	Few	1	2	1	2	Correct
67	1	hidden	Dissimilar	Easy	many	1	2	1	2	Error
67	2	hidden	Dissimilar	Hard	Few	1	2	2	2	Error
68	1	obvious	Similar	Easy	Few	3	1	1	1	Error
68	2	obvious	Dissimilar	Hard	many	3	2	2	2	Error
69	1	hidden	Similar	hard	Few	1	1	2	2	Error
69	2	subtle	Dissimilar	easy	Few	2	2	1	1	Correct
70	1	hidden	Dissimilar	hard	many	1	2	2	2	Error
70	2	subtle	Dissimilar	hard	many	2	2	2	2	Error
71	1	subtle	Similar	easy	Few	2	2	1	2	Correct
71	2	subtle	Dissimilar	easy	many	3	2	1	1	Correct
72	1	hidden	Dissimilar	easy	Few	1	2	1	2	Correct
72	2	hidden	Similar	hard	many	1	1	2	2	Correct
73	1	subtle	Similar	easy	many	2	1	1	2	Correct
73	2	obvious	Dissimilar	easy	many	3	2	1	2	Correct
74	1	obvious	Dissimilar	hard	Few	3	2	2	2	Correct
74	2	obvious	Similar	easy	many	3	1	1	2	Correct
75	1	subtle	Similar	easy	Few	2	1	1	2	Correct
75	2	obvious	Similar	hard	many	3	1	2	2	Correct

76	1	Hidden	dissimilar	Hard	few	1	2	2	1	Error
76	2	Obvious	similar	Easy	few	3	1	1	2	Error
77	1	Subtle	similar	Hard	many	2	1	2	2	Correct
77	2	Subtle	dissimilar	Hard	few	2	2	2	2	Correct
78	1	Subtle	dissimilar	Easy	few	2	2	1	1	Error
78	2	Subtle	similar	Hard	many	2	1	2	2	Error
79	1	Obvious	similar	Hard	few	3	1	2	2	Error
79	2	Obvious	dissimilar	Hard	few	3	2	2	2	Correct
80	1	Hidden	similar	Easy	few	1	1	1	2	Error
80	2	Subtle	similar	Hard	few	2	1	2	2	Error
81	1	Subtle	dissimilar	Hard	few	2	2	2	2	Correct
81	2	Obvious	similar	Hard	few	3	1	2	1	Correct
82	1	Subtle	similar	Hard	many	2	1	2	2	Error
82	2	Subtle	dissimilar	Hard	few	2	2	2	2	Correct
83	1	Subtle	dissimilar	Easy	few	2	2	1	1	Correct
83	2	Subtle	similar	Hard	many	2	1	2	2	Correct
84	1	Obvious	dissimilar	Easy	many	3	2	1	2	Correct
84	2	Hidden	dissimilar	Easy	few	1	2	1	1	Correct
85	1	Subtle	dissimilar	Easy	many	2	2	1	2	Correct
85	2	Obvious	dissimilar	Easy	few	3	2	1	1	Correct
86	1	Hidden	similar	Hard	few	1	1	2	1	Correct
86	2	Subtle	dissimilar	Easy	few	2	2	1	1	Correct
87	1	Obvious	similar	Easy	few	3	1	1	2	Correct
87	2	Obvious	dissimilar	Hard	many	3	2	2	2	Correct
88	1	Obvious	similar	Hard	many	3	1	2	2	Correct
88	2	Hidden	similar	Easy	many	1	1	1	2	Correct
89	1	Subtle	dissimilar	Hard	many	2	2	2	2	Correct
89	2	Subtle	similar	Easy	many	2	1	1	2	Correct

90	1	obvious	Dissimilar	easy	few	3	2	1	1	Correct
90	2	hidden	Dissimilar	easy	many	1	2	1	2	Correct
91	1	hidden	Dissimilar	easy	many	1	2	1	2	Correct
91	2	hidden	Dissimilar	hard	few	1	2	2	2	Correct
92	1	hidden	Similar	hard	few	1	1	2	1	Correct
92	2	subtle	Similar	hard	few	2	1	2	1	Correct
93	1	obvious	Similar	hard	many	3	1	2	2	Correct
93	2	hidden	Similar	easy	many	1	1	1	2	Correct
94	1	subtle	Dissimilar	hard	few	2	2	2	2	Correct
94	2	obvious	Similar	hard	few	3	1	2	2	Correct
95	2	obvious	Similar	hard	few	3	1	2	1	Error
95	1	subtle	Dissimilar	hard	few	2	2	2	1	Correct
96	1	hidden	Dissimilar	easy	few	1	2	1	1	Correct
96	2	hidden	Similar	hard	many	1	1	2	2	Correct

Appendix G Titration Phase Results: Statistical Output

Visibility of Patient Change

Crosstab

			CorrectCode		Total
			1	2	1
Howchangeocode	1	Count	42	22	64
		% within howchangeocode	65.6%	34.4%	100.0%
	2	Count	47	14	61
		% within howchangeocode	77.0%	23.0%	100.0%
	3	Count	52	10	62
		% within howchangeocode	83.9%	16.1%	100.0%
Total	Count	141	46	187	
	% within howchangeocode	75.4%	24.6%	100.0%	

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.785(a)	2	.055
Likelihood Ratio	5.780	2	.056
Linear-by-Linear Association	5.637	1	.018
N of Valid Cases	187		

a 0 cells (.0%) have expected count less than 5.

The minimum expected count is 15.01.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.176	.055
	Cramer's V	.176	.055
N of Valid Cases		187	

a Not assuming the null hypothesis.

b Using the asymptotic standard error assuming the null hypothesis.

Similarity of Patients' Physical Characteristics

Crosstab

			CorrectCode		Total
			1	2	1
PtSimCode	1	Count	63	29	92
		% within PtSimCode	68.5%	31.5%	100.0%
	2	Count	78	17	95
		% within PtSimCode	82.1%	17.9%	100.0%
Total		Count	141	46	187
		% within PtSimCode	75.4%	24.6%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4.679(b)	1	.031		
Continuity Correction(a)	3.973	1	.046		
Likelihood Ratio	4.718	1	.030		
Fisher's Exact Test				.041	.023
Linear-by-Linear Association	4.654	1	.031		
N of Valid Cases	187				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 22.63.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	-.158	.031
	Cramer's V	.158	.031
N of Valid Cases		187	

a Not assuming the null hypothesis.

b Using the asymptotic standard error assuming the null hypothesis.

Number of Medications on the Chart

Crosstab

			CorrectCode		Total
			1	2	1
NumDrugsCode	1	Count	74	21	95
		% within NumDrugsCode	77.9%	22.1%	100.0%
	2	Count	67	25	92
		% within NumDrugsCode	72.8%	27.2%	100.0%
Total		Count	141	46	187
		% within NumDrugsCode	75.4%	24.6%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.647(b)	1	.421		
Continuity Correction(a)	.403	1	.526		
Likelihood Ratio	.648	1	.421		
Fisher's Exact Test				.498	.263
Linear-by-Linear Association	.644	1	.422		
N of Valid Cases	187				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 22.63.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.053	.465
	Cramer's V	.053	.465
	Contingency Coefficient	.053	.465
N of Valid Cases		187	

a Not assuming the null hypothesis.

b Using the asymptotic standard error assuming the null hypothesis.

Complexity of Calculation

Crosstab

			CorrectCode		Total
			1	2	1
LevleofCalcCode	1	Count	74	15	89
		% within LevleofCalcCode	83.1%	16.9%	100.0%
	2	Count	67	31	98
		% within LevleofCalcCode	68.4%	31.6%	100.0%
Total		Count	141	46	187
		% within LevleofCalcCode	75.4%	24.6%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	5.492(b)	1	.019		
Continuity Correction(a)	4.724	1	.030		
Likelihood Ratio	5.598	1	.018		
Fisher's Exact Test				.027	.014
Linear-by-Linear Association	5.463	1	.019		
N of Valid Cases	187				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 21.89.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.171	.019
	Cramer's V	.171	.019
N of Valid Cases		187	

a Not assuming the null hypothesis.

b Using the asymptotic standard error assuming the null hypothesis.

Administration Time

Crosstab

			CorrectCode		Total
			1	2	1
Time	1	Count	71	25	96
		% within Time	74.0%	26.0%	100.0%
	2	Count	71	21	92
		% within Time	77.2%	22.8%	100.0%
Total	Count		142	46	188
	% within Time		75.5%	24.5%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.263(b)	1	.608		
Continuity Correction(a)	.118	1	.732		
Likelihood Ratio	.263	1	.608		
Fisher's Exact Test				.616	.366
N of Valid Cases	188				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 22.51.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	-.037	.608
	Cramer's V	.037	.608
N of Valid Cases		188	

a Not assuming the null hypothesis.

b Using the asymptotic standard error assuming the null hypothesis

GEE Analysis

Model Information

Dependent Variable	CorrectCode(a)
Probability Distribution	Binomial
Link Function	Logit
Subject Effect 1	ID
Within-Subject Effect 1	Time
Working Correlation Matrix Structure	Unstructured

a The procedure models 1 as the response, treating 2 as the reference category.

Case Processing Summary

	N	Percent
Included	187	97.4%
Excluded	5	2.6%
Total	192	100.0%

Correlated Data Summary

Number of Levels	Subject Effect	ID	96
	Within-Subject Effect	Time	2
Number of Subjects			96
Number of Measurements per Subject	Minimum		1
	Maximum		2
Correlation Matrix Dimension			2

Categorical Variable Information

			N	Percent	
Dependent Variable	CorrectCode	1	141	75.4%	
		2	46	24.6%	
		Total	187	100.0%	
Factor	Time	1	96	51.3%	
		2	91	48.7%	
		Total	187	100.0%	
	howchangeCode	1	64	34.2%	
		2	61	32.6%	
		3	62	33.2%	
		Total	187	100.0%	
		PtSimCode	1	92	49.2%
			2	95	50.8%
	Total		187	100.0%	
	LevleofCalcCode	1	89	47.6%	
		2	98	52.4%	
Total		187	100.0%		
NumDrugsCode	1	95	50.8%		
	2	92	49.2%		
	Total	187	100.0%		

Goodness of Fit(a)

	Value
Quasi Likelihood under Independence Model Criterion (QIC)	206.316
Corrected Quasi Likelihood under Independence Model Criterion (QICC)	210.675

Tests of Model Effects

Source	Type III		
	Wald Chi-Square	df	Sig.
(Intercept)	30.640	1	.000
Time	1.234	1	.267
HowchangeCode	4.849	2	.089
PtSimCode	2.494	1	.114
LevleofCalcCode	4.351	1	.037
NumDrugsCode	1.572	1	.210

Dependent Variable: CorrectCode

Model: (Intercept), Time, howchangeCode, PtSimCode, LevleofCalcCode, NumDrugsCode

Parameter Estimates

Parameter	B		Std. Error		95% Wald Confidence Interval		Hypothesis Test	
	Lower	Upper	Wald Chi-Square	df	Sig.	Lower	Upper	
(Intercept)	1.147	.3532	.455	1.839	10.543	1	.001	
[Time=1]	-.252	.2271	-.697	.193	1.234	1	.267	
[Time=2]	0(a)	.	.	.	.	.	.
[howchangeCode=1]	-.338	.3395	-1.003	.328	.989	1	.320	
[howchangeCode=2]	.376	.3439	-.298	1.050	1.193	1	.275	
[howchangeCode=3]	0(a)	.	.	.	.	.	.
[PtSimCode=1]	-.470	.2975	-1.053	.113	2.494	1	.114	
[PtSimCode=2]	0(a)	.	.	.	.	.	.
[LevleofCalcCode=1]	.542	.2600	.033	1.052	4.351	1	.037	
[LevleofCalcCode=2]	0(a)	.	.	.	.	.	.
[NumDrugsCode=1]	.333	.2659	-.188	.855	1.572	1	.210	
[NumDrugsCode=2]	0(a)	.	.	.	.	.	.
(Scale)	1							

Dependent Variable: CorrectCode Model: (Intercept), Time, howchangeCode, PtSimCode, LevleofCalcCode, NumDrugsCode a Set to zero because this parameter is redundant.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Time *	188	97.9%	4	2.1%	192	100.0%
CorrectCode howchange code *	187	97.4%	5	2.6%	192	100.0%
CorrectCode PtSimCode *	187	97.4%	5	2.6%	192	100.0%
CorrectCode LevleofCalc Code *	187	97.4%	5	2.6%	192	100.0%
CorrectCode NumDrugs Code *	187	97.4%	5	2.6%	192	100.0%
CorrectCode						

How Patients' Change – Without Subtle

howPatientsChange * CorrectCode Crosstabulation

			CorrectCode		Total
			1	2	
howPatientsChange	Hidden	Count	42	22	64
		% within howPatients Change	65.6%	34.4%	100.0%
		% within CorrectCode	45.2%	68.8%	51.2%
		% of Total	33.6%	17.6%	51.2%
	Obvious	Count	51	10	61
		% within howPatients Change	83.6%	16.4%	100.0%
		% within CorrectCode	54.8%	31.3%	48.8%
% of Total		40.8%	8.0%	48.8%	
Total	Count	93	32	125	
	% within howPatients Change	74.4%	25.6%	100.0%	
	% within CorrectCode	100.0%	100.0%	100.0%	
	% of Total	74.4%	25.6%	100.0%	

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	5.302 ^a	1	.021		
Continuity Correction ^b	4.400	1	.036		
Likelihood Ratio	5.412	1	.020		
Fisher's Exact Test				.025	.017
N of Valid Cases	125				

- a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 15.62.
- b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	-.206	.021
	Cramer's V	.206	.021
	Contingency Coefficient	.202	.021
N of Valid Cases		125	

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
NoDrugsDef2 * CorrectCode	125	100.0%	0	0.0%	125	100.0%

Number of Medications – Definition Two

NoDrugsDef2 * CorrectCode Crosstabulation

			CorrectCode		Total
			1	2	
NoDrugsDef2	1	Count	24	4	28
		% within NoDrugsDef2	85.7%	14.3%	100.0%
		% within CorrectCode	25.8%	12.5%	22.4%
		% of Total	19.2%	3.2%	22.4%
2	2	Count	69	28	97
		% within NoDrugsDef2	71.1%	28.9%	100.0%
		% within CorrectCode	74.2%	87.5%	77.6%
		% of Total	55.2%	22.4%	77.6%
Total		Count	93	32	125
		% within NoDrugsDef2	74.4%	25.6%	100.0%
		% within CorrectCode	100.0%	100.0%	100.0%
		% of Total	74.4%	25.6%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.425 ^a	1	.119		
Continuity Correction ^b	1.720	1	.190		
Likelihood Ratio	2.658	1	.103		
Fisher's Exact Test				.045	.078
Linear-by-Linear Association	2.406	1	.121		
N of Valid Cases	125				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 7.17.

b. Computed only for a 2x2 table

Final GEE Analysis

				95% Wald Confidence Interval				
	Parameter	B	Std. Error	Lower	Upper	Df	Wald Chi-Square	P
Complexity of Calculation								
0	Easy	0.242	0.278	-0.304	0.788	1	0.752	0.386
1	Hard	0						
Number of Medications on the Chart								
0	Few	1.220	0.498	0.244	2.195	1	6.009	0.014*
1	Many	0						
Visibility of Patient Change								
0	Hidden	-0.560	0.3267	-1.220	0.100	1	2.768	0.096
1	Obvious	0						
Similarity of Patient's Physical Characteristics								
0	Similar	-0.661	0.310	-1.270	-0.053	1	4.541	0.033*
1	Dissimilar	0						
Administration Time								
0	First	-0.718	0.282	-1.271	-0.166	1	6.507	0.011*
1	Second	0						

Titration Phase Participants Questionnaire Comments

A good extra tool

Being and with the five rights system. Just by checking and checking again

Highlighting possible mistakes

Reminds you to check and check again

Being more careful and precise

It is more practical practice and a reminder of everything that needs to be considering when administering meds

It'll make me pay more attention even towards the end of the task

Thinking about drug doses and how many tables to give, also checking the patient correctly.

Ensures administrator checks all aspects of drug dose etc

Shows errors can occur

Pay more attention to dose

I thought I was being careful but still made mistakes

I think the patient replacement (changing bed) was a very useful exercise as you would have to double check everything

Double check everything

It definitely made me more aware of the need not to follow instructions blindly It was not that similar to real life but was a good taster

Awareness of procedure involved

Once you have got it wrong you can't get it back

Be more careful

Its important to check namebands and dob

I was so distracted by the bed swapping and became focussed on right patient rather than other elements such as time prescribed. This has made me more aware for practice

Got me thinking about mistakes that can easily occur

It will make me aware

Makes people more aware of patient identification

To be more careful and pay attention to detail

Provides a realistic opportunity to consider the skill as if qualified and provides a good basis on which to reflect

Drawing attention to process

Checking and double checking again

Need to continue to be careful at all times

It has reinforced that I needed to be aware of the right patient, right drug, right time right route.

Important to look at faces not just bed numbers

Shows importance of checking pt before getting drugs and giving them

Yes it helps you think but it is not really a brilliant substitute for the real thing More practice is needed

Double check each dosage before administering

I think practice will reduce the chance of making an error

Double check patient id

Help me develop a system for checking

This helped in trying to get a standard operating procedure of checking drugs against the drug chart

I will pay more attention to detail

More practice

Good practice with dealing with looking and using a drug chart and useful practice calculating doses

More thoughts to medication giving

I will need to read the prescription more carefully

Checking right patient

Make sure you know what you are doing

It could make a difference because patient can be moved with a bay or side rooms after and before preparing the medication still confirm the name and date of birth before administering the medicine

Must be more meticulous

Reminde to concentrate correct drug / dose by correct route by correct patient

Even with careful checking errors can sill be made. The simulation doesn't have anyone to double check the dispensed product

Highlights the process of checking the patient, always

More likely to take my time when administering and rechecking correct patient administ

Gets ou used to seeing te doses of drugs and used to knowing their names and what doses they come in

It will make a difference because it will make me double to check the drug to be administered before giving the drug to the patient. Also it will help me double check the right person is recieveing the medication

So it important to check namebands / identification

Drug Errors

Impact of irrelevant information

Prevalence of drug errors in clinical practice

- Mayo and Duncan (2004) estimate that 1.9 medication errors occur per patient per day.
- Scott (2002) – 1200 people died in England and Wales due to drug errors in 2001. An increase of 500% from the previous decade.
- 10 to 18% of all reported hospital injuries have been attributed to medication errors, (Stetler et al 2000).

Failure to recognise environmental influences on error

Aviation

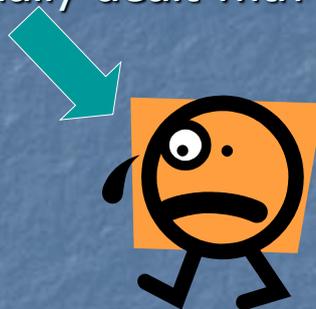
- Preventable disasters- I.e. Tenerife 1974. loss of 583 lives (Galvin and Maran 2003).
 - Identified communication, workplace stress and workload management as environmental issues.
 - Initiated anonymous reporting for potential error generating problems.
 - No blame culture.

Other industries – Nuclear.

Healthcare. Health Protection Agency. Only founded in 2001.

How errors were traditionally dealt with

- Assigning individual blame (e.g. Wolfe 1989)
- Scapegoats
- Abdicating managerial responsibility
- Poor professional support and understanding



Failure to recognise environmental influences on error

Aviation

- Preventable disasters- I.e. Tenerife 1974. loss of 583 lives (Galvin and Maran 2003).
 - Identified communication, workplace stress and workload management as environmental issues.
 - Initiated anonymous reporting for potential error generating problems.
 - No blame culture.

Other industries – Nuclear.

Healthcare. Health Protection Agency. Only founded in 2001.

What causes errors

Systems or individuals?

Human error!

Individuals

- Poor practice – Need to be accountable (Wolfe 1989)
- Complacency (Preston 2004)

Systems contribute to

- High work load
- Distraction
- Fatigue (O'Shea 2003, Reason 2000)

Unknown

- Unexpected drug reactions

Sources of Drug Error

- Conflict with prescriber
- Illegible writing
- PRN prescriptions
- Telephone orders
- Patients metabolic status may change

- Can you think of others?

Feedback

- Gorilla Basketball 1
 - 50% of participants missed the Gorilla. Was on screen for nine seconds.
- Gorilla Basketball3
 - Tested object rather than location. Items attending the same space. Participants were less likely to notice.
- Surprise party / Zoo
 - Did you notice all the changes???
- Telephone Movie
 - 70% of participants did not notice the change in actor.
 - More notice if they know a change will occur!

Distraction and perception

- Being aware of our background. Did we perceive the changes?
- Conscious perception and implicit perception - Mack and Rock (1998)
 - Conscious when they have a conscious experience of an object or an event.
 - Implicit is when observers do not perceive an object, but it still may have an implicit influence on their subsequent decisions and performance.
- Which one is related to the movies?

Distraction and visual awareness

- Levin and Simon (1997) – We think we will notice, but often we don't!
- Conscious perception requires attention
- Can we do this all day on a busy ward?
- When attention is diverted to another task or object, we fail to perceive something that changes.
- Can fail to notice large alterations.
 - This can lead to different errors.

What does this tell us about our nursing practice?

- Distraction has been identified as one of the main causes of drug errors. (Mayo and Duncan 2004).
- We are always accountable as practitioners and we can all be affected by distraction.
- Identify times of distraction in practice.
- Identify where these can lead to errors.
- Do we believe ourselves to be more vulnerable to distraction after seeing the clips?
- What can we do to help ourselves and our patients?

Results of Drug Simulation

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Change Blindness Scenarios

Gorilla Link <https://www.youtube.com/watch?v=vJG698U2Mvo>

Telephone Link <https://www.youtube.com/watch?v=wBoMjORwA-4>

Cafe Conversation Link https://www.youtube.com/watch?v=6JONMYxaZ_s

Appendix I Comparative Study Questionnaire

Q1. Have you ever made a medication administration error whilst in practice?

Yes

No

Q2. Have you ever observed a medication administration error whilst in practice?

Yes

No

Q3. The topic of medication administration is very important.

5	4	3	2	1
Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree

Q4. Participating / Knowing about the medication administration simulation has helped me with my learning about medication administration

5	4	3	2	1
Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree

Q5. What I have learned about medication administration errors in the simulation is likely to reduce the chances that I will make a drug error in the future

5	4	3	2	1
Very Likely	Somewhat Likely	Undecided	Not Very Likely	Very Unlikely

How do you think it will make a difference? If so why, if not, why not?

Q6. Medication administration errors are a frequent occurrence

5	4	3	2	1
Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree

Q7. Medication administration errors are rarely serious.

5	4	3	2	1
Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree

Q8. What I have learnt in recent sessions in college about medication administration error will reduce the chance that I will make a medication administration error in practice.

5	4	3	2	1
Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree

Q9. Compared to other nurses of similar training and experience I am less likely to make a medication administration error.

5	4	3	2	1
Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree

Please explain why?

Q10I will make medication administration errors on a regular basis when I first qualify as a nurse

5	4	3	2	1
Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree

Please state if you aim to work in a ward, in out patients or in the community.

Q11. How many medication administration errors do you think you will make in your first year as a qualified nurse?

0-1

2-3

4+

Q12. Scenario: A nurse has committed a medication administration error. Please rank factors that contribute to such an error. 1 is most important. 2 second most important etc.

Distraction _____

Lack of knowledge _____

Incompetence _____

High workload / Time pressure _____

Illegible prescription _____

Other(s): Please state and rank _____

Q13. People experience different feelings when they make a medication administration error.

What did you feel when you realised you made a medication error in the simulation / heard that others made medication errors in the simulation? Please rate...

Anxious

Very anxious

Not anxious

1 2 3 4 5 6 7 8 9 10

Angry

Very angry

Not angry

1 2 3 4 5 6 7 8 9 10

Embarrassed

Very embarrassed

Not embarrassed

1 2 3 4 5 6 7 8 9 10

Fear

Very fearful

Not fearful

1 2 3 4 5 6 7 8 9 10

Happy

Very happy

Not happy

1 2 3 4 5 6 7 8 9 10

Did you have any other feelings?

If so, please state what that feeling is / was and rate as above.

Other feeling

Very

Not ...

1 2 3 4 5 6 7 8 9 10

Anything else you would like to add?

Appendix J Comparative Study Simulation Results

Participant	Presentation	Correct Choice	Extras	Administration
125	0	1	similar => dissimilar	1
125	1	1		2
125	2	1		3
125	3	1		4
126	0	2		2
126	1	2	Overadministered: Warfarin 8mg	1
126	2	2		3
126	3	2		4
128	0	1		2
128	1	1		1
128	2	1		3
128	3	1		4
130	0	1		1
130	1	1		2
130	2	1		3
130	3	1		4
131	0	1		2
131	1	2		1
131	2	1		3
131	3	1	Overadministered: Isoniazid 100mg	4
134	0	1		2
134	1	1	Overadministered: Warfarin 3mg	1
134	2	1		3
134	3	1		4
135	0	1	Overadministered: Simvastatin 40mg	2
135	1	1		1
135	2	1		3
135	3	1		4
136	0	2		1
136	1	1		2
136	2	1		3
136	3	1		4
137	0	2		1
137	1	1	similar => dissimilar	2
137	2	1		3
137	3	1		4
138	0	1		2
138	1	2		1
138	2	2	easy => hard;	3

138	3	1		4
139	0	1	easy => hard;	2
139	1	1		1
139	2	1	Overadministered: Bendrofluazide 2.5mg	3
139	3	1		4
140	0	1		2
140	1	1		1
140	2	1		3
140	3	1		4
141	0	1		1
141	1	1		2
141	2	1		3
141	3	1		4
142	0	2		1
142	1	1		2
142	2	1		3
142	3	1		4
143	0	1		1
143	1	1		2
143	2	1		3
143	3	1		4
144	0	1		2
144	1	1		1
144	2	1		3
144	3	1		4
145	0	1		2
145	1	2		1
146	0	2		1
146	1	1	Overadministered: Simvastatin 40mg	2
146	2	2		3
146	3	2		4
147	0	1	easy => hard;	2
147	1	1		1
147	2	1		3
147	3	1		4
148	0	1		2
148	1	1		1
148	2	1		3
148	3	1		4
150	0	1		2
150	1	1		1
150	2	1		3
150	3	1		4
151	0	2		1

151	1	1		2
151	2	2	Overadministered: Warfarin 4mg	3
151	3	1	Overadministered: Simvastatin 40mg	4
152	0	1		2
152	1	1		1
152	2	1		3
152	3	1		4
153	0	1		2
153	1	2	similar => dissimilar	1
153	2	1		3
153	3	1	Overadministered: Simvastatin 40mg	4
155	0	1		2
155	1	2		1
155	2	2		3
155	3	2		4
156	0	1		1
156	1	1		2
156	2	1		3
156	3	1		4
157	0	2		1
157	1	1		2
157	2	1		3
157	3	1		4
159	0	2		1
159	1	1		2
159	2	1		3
159	3	1	easy => hard;	4
160	0	1		2
160	1	2		1
160	2	1		3
160	3	1		4
161	0	1	Overadministered: Warfarin 3mg	1
161	1	1		2
161	2	1		3
161	3	1		4
162	0	1	similar => dissimilar	1
162	1	1		2
162	2	1		3
162	3	1		4
163	0	1		1
163	1	1	Overadministered: Simvastatin 40mg	2
163	2	1		3
163	3	1		4

164	0	1		2
164	1	1		1
165	0	1		1
165	1	2		2
165	2	2		3
165	3	1		4
166	0	1		1
166	1	1		2
166	2	1		3
166	3	1	easy => hard;	4
167	0	1		2
167	1	1		1
167	2	1		3
167	3	1	easy => hard;	4
168	0	1	Overadministered: Furosemide 120mg	1
168	1	1		2
168	2	1		3
168	3	1		4
169	0	1		2
169	1	1		1
169	2	1		3
169	3	1		4
170	0	1		2
170	1	2		1
170	2	2		3
170	3	1		4
171	0	1		1
171	1	1		2
171	2	1		3
171	3	1		4
172	0	1	Overadministered: Simvastatin 40mg	1
172	1	1		2
172	2	1		3
172	3	1		4
173	0	2		2
173	1	1		1
173	2	2		3
173	3	1		4
174	0	1		1
174	1	1		2
174	2	1		3
174	3	1		4
175	0	1	easy => hard; Overadministered: Simvastatin 40mg	2

175	1	1	Overadministered: Simvastatin 40mg	1
176	0	1		1
176	1	1		2
176	2	1		3
176	3	1		4
177	0	1		1
177	1	1		2
177	2	1	Overadministered: Simvastatin 40mg	3
177	3	1		4
178	0	1		2
178	1	1		1
178	2	1		3
178	3	1		4
179	0	1		2
179	1	2		1
179	2	1		3
179	3	1		4
182	0	1		2
182	1	1		1
182	2	1		3
182	3	1		4

Appendix K Comparative Study Questionnaire Results

Specific Control

Participant	Condition	Q1. Made an error	Q2. Witnessed error	Q3.Importance-Topic of med admin	Q4.Med sim helped with learning	Q5.Med sim reducing future errors
Specific Control						
SC1	1	1	2	1	1	2
SC2	1	1	2	2	2	2
SC3	1	1	1	2	2	3
SC4	1	1	1	1	3	2
SC5	1	1	1	1	2	3
SC6	1	1	1	1	2	1
SC7	1	1	1	1	2	1
SC8	1	1	1	1	2	2
SC9	1	1	1	1	1	1
SC10	1	1	2	1	2	2
SC11	1	1	1	1	3	3
SC12	1	1	1	2	3	2
SC13	1	1	1	1	2	2
SC14	1	1	2	1	2	1
SC15	1	1	2	1	2	2
SC16	1	1	2	1	2	2
SC17	1	1	2	2	3	3
SC18	1	1	1	1	2	2
SC19	1	1	1	1	2	3
SC20	1	1	1	2	2	3
SC21	1	1	1	1	1	2
SC22	1	1	1	1	1	2
SC23	1	1	2	1	1	1
SC24	1	1	1	1	5	1
SC25	1	1	2	2	2	2
SC26	1	1	1	1	1	2
SC27	1	1	1	2	2	3
SC28	1	1	2	1	2	2
SC29	1	1	1	1	2	2
SC30	1	1	1	1	2	2
SC31	1	1	2	1	2	2
SC32	1	1	2	2	3	3
SC33	1	1	1	1	3	2
SC34	1	1	1	1	2	2
SC35	1	1	1	1	2	2
SC36	1	2	2	1	2	2
SC37	1	1	2	1	3	2

	Q6.Freq of med errors	Q7. Seriousness of med errors	Q8.Learning in college - reduce future errors	Q9.Comparing ability to other nurses	Q10.Regularity of future med errors
SC1	2	1	2	4	4
SC2	2	2	2	4	3
SC3	4	3	1	3	5
SC4	1	2	2	3	3
SC5	1	2	3	3	4
SC6	2	2	2	4	4
SC7	3	1	2	4	5
SC8	2	3	3	3	3
SC9	2	2	2	4	4
SC10	2	1	2	3	4
SC11	2	5	3	3	4
SC12	3	3	2	4	4
SC13	2	2	2	2	4
SC14	2	3	2	4	4
SC15	3	2	2	4	4
SC16	4	2	2	4	2
SC17	2	1	3	3	3
SC18	2	2	1	3	4
SC19	2	2	1	4	5
SC20	3	2	2	4	4
SC21	2	2	2		4
SC22	2	2	2	3	5
SC23	2	1	2	4	2
SC24	2	2	1	4	5
SC25	2	2	2	4	5
SC26	2	2	2	4	5
SC27	3	3	2	2	4
SC28	2	3	2	2	5
SC29	2	3	2	2	4
SC30	1	1	3	2	2
SC31	2	2	3	3	4
SC32	2	3	4	3	4
SC33	2	2	2	3	2
SC34	1	3	2	2	3
SC35	2	2	2	4	4
SC36	2	2	3	3	4
SC37	1	1	2	2	3

	Q.11 No. errors when qualified	Q12. Factors causing error					
		Distraction	Lack of Knowledge	Incompetence	High workload/ Time pressure	Illegible	Other
SC1	3	1	5	4	2	3	
SC2	2	1	5	4	3	2	
SC3	3	1	1	1	1	2	1
SC4	3	1	1	1	1	1	
SC5	3	4	2	1	5	3	
SC6	3	3	5	4	2	1	1
SC7	3	1	1	1	2	2	
SC8	1	1	2	2	1	1	
SC9		2	4	3	1	5	
SC10	3	3	5	4	2	1	
SC11	2	4	3	2	5	1	
SC12		3	1	2	5	4	
SC13	3	1			2	3	
SC14	3						
SC15	3	3	4	5	1	2	
SC16	3	1	1	1	2	2	
SC17	1	2	3	1	4	5	
SC18	2	5	2	4	1	3	
SC19	3	1	3	4	2	5	
SC20	3	2	4	5	1	3	
SC21		1	4	5	2	3	
SC22		2	4	5	1	3	
SC23	3	1	1	1	1	1	
SC24	3	4	1	2	3	5	
SC25	3	1	5	3	2	4	
SC26	3	2	4	5	1	3	
SC27	3	5	3	1	4	3	
SC28	3	2	1	1	5	4	
SC29	3	5	4	2	3	4	
SC30	1	1	4	5	2	3	
SC31	3	2	3	5	1	3	
SC32	2	2	3	4	1	5	
SC33	1	1	1	5	2	4	
SC34	1	1	4	1	1	2	
SC35	3	1	5	2	3	5	
SC36	1	1	4	4	3	2	
SC37	1	2		5	1	3	

	Comment and which question they relate to
SC1	5. More alert and more thorough at checking. 9. Learning about drug administration has brought an awareness
SC2	5.Ensure concentrate 100% of time less likely because of the emphasis of error in education
SC3	9. Believes with training and practice errors can be eliminated
SC5	9. to know the competence of other nurses. Everyone is different. 12 Errors due to incompetence and lack of knowledge distressing. However ones due to distraction and workload pressures are ones we are all susceptible to
SC6	9.Been responsible for drug administration in another career. Knows the importance of it. 13A;ways aware of their responsibility how easily mistakes occur. Believes people become blase and complacent about drug administration
SC7	5It will help the nurse remember what happened,
SC8	5 Just remembering what not to do. If I think something is wrong I should stop what I am doing, look at things carefully and necessary get a colleague involved to make sure it is right. 9. You never know what might happen at that precise moment
SC9	5. I will take a lot more care. Even when distracted I'll try my best to concentrate. 9. Because it has been drummed into me more aware.
SC10	5. Ensure that all details are thoroughly checked before administering any medication. 9. In the process of learning at the combined with both practice and what I have learned will enable / help me to identify and recognised drug administration this will help me in not making errors.
SC11	5. The topic frightens me, but it is good to be reminded how important it is, but how easy it is to make mistakes. 9. Although session was interesting, I think any mistakes I make will happen regardless of a session to tell me how important drug rounds I know this already.11. Sm,all ones hopefully.
SC12	5. Because I will remember how easily distraction can cause error. 9. Because i.m still a student with constant reinforcement help when giving drugs and a personal mentor to oversee the chart.
SC13	5. It has made me more aware of how easy it is to make a medicine administration error. 9. Everyone makes mistakes. If we have the same training then we may have the same chance. Being aware of mistakes is very important
SC14	9. I;m smart and accurate
SC15	5. It will help me to be more vigilant while administering medication
SC19	9. Because I would do everything in my ability not to make an error
SC20	End.Double check and sometimes the patient's themselves are not helpful and will allow you to make an error in order for them to gain compensation if they survive of course
SC22	10.I aim to work in a critical care ward so drug errors cannot occur
SC24	Because it makes aware of incidents that are occurring either due to negligence or other stress
SC25	5. More aware errors made by patient changing bed etc. Not to be distracted by other things when doing med round. 9. Been made aware that drug errors occur and to be vigilant when doing drug rounds
SC26	5.I will be more vigilant / checking namebands / drug charts etc. 9. i have had more in depth training
SC27	9. Because other nurses maybe much more aware of drug administration errors.Everyone is different.
SC28	9. Everyone is different
SC29	5. It will help as it will make me double check patient id etc. 9. Because everyone is different and experiences different situations and stressors
SC30	5. Being more aware of common distractions. 9. Human error seems across the board.
SC32	9. Is supposed to be the best kcl for nursing but everyone is individual. 13 Quite a complicated way of getting the message
SC33	9. I have always been checked by my mentor therefore have not yet made an error. 13 I've not taken part in the simulation I don't know anyone who has.
SC34	5. I have a better understanding of how easy it can be to make potentially life-threatening mistakes. 9. I feel I am just as likely with this learning due to other factors. Eg. Workload.
SC35	5. Check nameband immediately before giving meds. 9 More aware
SC36	5. Be more aware of the type of errors that are likely to occur and surrounding factors that contribute to them

Simulation Session

Participant	Condition	Q1. Made an error	Q2. Witnessed error	Q3.Importance-Topic of med admin	Q4.Med sim helped with learning	Q5.Med sim reducing future errors
I1	2	1	2	1	3	3
I2	2	1	2	1	4	2
I3	2	1	1	1	1	1
I4	2	1	1	1	1	2
I5	2	1	1	1	1	3
I6	2	1	2	1	5	2
I7	2	1	1	1	1	3
I8	2	1	1	1	5	1
I9	2	1	1	1	2	2
I10	2	1	1	1	1	1
I11	2	1	2	1	2	3
I12	2	1	1	1	2	2
I13	2	1	2	1	1	2
I14	2	1	1	1	1	1
I15	2	1	1	5	1	2
I16	2	1	2	1	5	1
I17	2	1	1	1	5	2
I18	2	1	1	1	5	1
I19	2	1	1	1	3	2
I20	2	1	1	1	2	1
I21	2	1	2	1	5	1
I22	2	1	1	1	1	1
I23	2	1	1	1	5	1
I24	2	1	2	1	5	1
I25	2	1	2	1	1	1
I26	2	1	1	1	1	1
I27	2	1	2	1	2	2
I28	2	1	1	1	5	1
I29	2	1	2	1	5	1
I30	2	1	1	1	2	2
I31	2	1	2	1	5	2
I32	2	1	2	1	5	2
I33	2	1	1	1	2	4
I34	2	1	1	1	2	2
I35	2	1	1	1	2	2
I36	2	1	1	1	2	2
I37	2	1	1	1	2	2
I38	2	1	1	1	2	2
I39	2	1	1	1	5	2

I40	2	1	1	5	2	2
I41	2	1	1	1	1	2
I42	2	1	1	1	5	1
I43	2	1	2	1	5	2
I44	2	1	2	1	1	2
I45	2	1	1	1	2	2
I46	2	2	2	5		5

	Q6.Freq of med errors	Q7. Seriousness of med errors	Q8.Learning in college - reduce future errors	Q9.Comparing ability to other nurses	Q10.Regularity of future med errors
I1	2	2	2	2	4
I2	1	3	3	4	4
I3	4	1	1	5	5
I4	3	1	2	2	4
I5	3	2	4	3	3
I6	2	3	2	3	5
I7	2	1	3	3	3
I8	2	1	2		
I9	2	1	1	3	1
I10	3	2	2	5	5
I11	4	4	2	3	5
I12	2	2	2	3	2
I13	3	2	2	3	3
I14	2	3	1	2	2
I15	4	3	2	2	4
I16	3	2	2	2	5
I17	1	2	2	3	4
I18	2	2	1	4	5
I19	2	2	2	3	2
I20	3	2	2		4
I21	2	2	2	3	2
I22	1		1	5	5
I23	4	4	2	4	5
I24	1	1	2	3	5
I25	3	2	2	3	3
I26	1	1	2	4	4
I27	1	4	2	4	5
I28	1	1	1	5	2
I29	2	3	2	2	4
I30	2	1	2	3	5
I31	2	3	1	3	4
I32	2	2	2	3	2
I33	2	2	2	2	4

I34	3	2	2	2	5
I35	3	4	3	3	3
I36	2	3	2	4	3
I37	2	2	2	3	5
I38	2	3	2	3	4
I39	2	3	2	4	5
I40	4	2	2	3	4
I41	3	4	2	3	4
I42	1	1	1	4	4
I43	1	2	2	3	5
I44	3	2	3	3	4
I45	4	2	2	3	4
I46	3	2	1	5	1

Part	Q11. No Errors Qual	Q12. Factors Causing Error					
		Distraction	Lack of Knowledge	Incompetence	workload Time	Illegible Prescription	Other
I1	3	2	4	5	1	3	
I2	3	1	2	3	5	4	
I3	3	1	1	1	2	1	
I4		2	1	1	2	1	
I5	3	1	5	4	2	3	
I6	3	2	4	1	5	3	
I7							
I8							
I9	3	1	5	5	1	1	
I10	1	3	5	4	1	2	
I11	3	1	4	5	3	2	
I12		1	4	5	2	3	
I13	2	1	2	5	3	4	
I14	2	2	4	5	1	3	
I15	3	1	5	5	2	3	4
I16	3	1	3	4	2	5	
I17	3	1	4	5	3	2	
I18	2	5	1	4	2	3	
I19	2	1	4	4	1	2	
I20	3	1	3	4	2	1	
I21		1	3			2	
I22	1	1	2	1	1	1	
I23	3	1	1	1	2	2	
I24	3	1					
I25		4	2	1	5	3	

I26	3	2	5	4	1	3	
I27	3	1	4	5	2	3	
I28	2	2	1	1	2	2	
I29	3	4	2	1	3	5	
I30	1	1			2		
I31	2	1	4	5	2	3	
I32	2	1	4	5	2	3	
I33	3	3	2	1	4	5	
I34	1	1	4	5	2	3	
I35	3	1	5	5	1	2	
I36	3	1	4	2	5	3	
I37	2	3	3	4	1	2	
I38		3	4	5	2	1	
I39	1	2	1	3	4	5	
I40	2	5	1	5	1	2	
I41	2	3	5	4	2	1	
I42	1	2	1	1	2	2	
I43	3	1	2	2	1	1	
I44	3	2	4	5	1	3	
I45	3	2	3	4	1	5	
I46	3	1	5	4	2	3	

Part	Anxious	Angry	Embarrassed	Fear	Happy	
I1	9	9	9	9	5	
I2	7	5	10	10	1	
I3						
I4	3	5	5	3	1	Surprised
I5	3	4	3	2	2	Concerned
I6	3	4	3	2	2	
I7	3	10	2	3	1	Stupid
I8	3	1	1	2	1	?
I9	1	8	6	1	1	Worried
I10	1	1	1	1	1	
I11	2	5	1	1	1	I Just Killed a patient
I12	4	4	5	4	1	Questioning
I13	2	2	6	3	2	
I14	4	4	3	2	3	
I15						more attention
I16	1	5	1	1	1	
I17	3	10	1	1	1	Worried
I18	4	5	4	6	2	
I19	7	7	7	8	8	
I20	1	1	1	1	1	
I21						

I22						
I23						
I24	2	8	9	2	1	
I25	3.5	3.5	5	3.5	1	
I26						
I27	7	3	3	8	1	
I28	1	1	1	1	10	
I29	1	1	1	1	1	
I30	2	10	9	6	1	
I31	5	7	4	4	1	Annoyed
I32	1	5	10	5	1	
I33	5	9	9	5	1	
I34	3	5	4	1	1	Confused
I35	2	2	1	4	1	Confused
I36	3	4	2	3	1	Scared
I37	3	4	3	4	3	
I38	2	3	2	1	2	
I39	1	4	5	1	1	
I40						
I41						
I42	2	1	2	4	1	
I43	6	5	5	5	5	
I44	3	2	2	1	3	
I45	5	9	6	5	1	Worried
I46	5	1	1	1	1	

	Comments and Question they come from
I11	5. Not very realistic
I12	5. It wasn't accurate. Had told me I didn't select a drug when I did. 9. I feel more confident when giving out drugs and most of the time in practice I was making misconduct of drug administration known
I13	6. A lot published but not too frequent but don't want it to occur?. 10. Well informed and practised. ? Nice try. 12. Workload- no excuse. 13. anxious and shocking Very good and very important. Would like in future an advanced version with allowed BNF as exam, i.e.OSCE.
I14	9. Confidence and experience is required. I hope by then I will be competent enough not to make drug errors. 10. I just hope the NHS will have a job for me, 11. unsure anywhere!
I15	9. I am always going to be with my mentor
I16	5. Practice. And a reminder at how many factors and things to remember when administering medication. 9. Even though King's is the best uni, (obviously), I don't know of other college courses on meds administration. 11. I hope none!
I17	9. I can't predict the future. I hope it will make me less likely to make drug errors. I don't know where I will work and I still can't predict the future!. 11 unsure. 12 These are all dependent on the nurse and the individual circumstances.
I18	5. Dealing with real human beings one can't afford any error. Check, slow down and check again. 13. Such exercises should be encouraged all the time.
I110	5. Because it made me go through a logical sequence each time. Name bands are very important. 9. Because I feel it has reinforced what I already know about the importance of the five rights. 13. Good learning resource. Thank you.
I111	9. It is down to the individual to remember to be responsible and thorough in drug administration. 13. This is a good exercise. It should be used for the OSCEs.

I12	11. hopefully none but probably some
I13	5. As it helps with areas that you may continually get wrong. And help learn from mistakes without risking lives. 9. We all make mistakes unintentionally.
I14	5. Yes. It gives you the opportunity to administer lots of different drugs to different people. 9. We are all human
I16	5. Need to pay attention. 9. Anyone of any experience can make an error. We are all human! 13. A good way of testing medication. Interesting to see over half the group made an error. Should have been none!
I17	5. Pay attention to small things like patient moving from location.
I18	5. Because I always double check before giving medications
I19	13. I did not make an error
I20	5. By checking and rechecking. 13. Checking and rechecking information is essential.
I22	10. Wherever I am I am sure if not making a mistake. Really confident in my drug administration. 13. Not applicable Very interesting exercise. This should be done at most times.
I23	9. If I put what I have learned into constant practice I may? Make errors
I25	11. unsure
I26	5. Because it makes you cross check the medication and details before giving it.
I28	5. By critically taking into consideration human errors like patients mobilising about so always cross check.
I29	5. More vigilant. 9. Because everyone is different.
I30	5. I will think more carefully and double check things more carefully. 9. Everyone makes mistakes
I31	13. I believe there may be some calculation errors on the simulation as I am sure the few drug errors I made were not right.
I32	13. A couple of errors were noted with the computer system! Needs looking at.
I36	5. The charts were very clean and easy to read on the PC. I find the real ones much more difficult and confusing.
I37	5. It has showed me how easy it is to make a mistake and helped to show me a logical way of completing the task of medication administration. 13. Change the time you give the drug for. Something else to be conscious of. Check date expiry- make it necessary.
I40	5. It reassured me who to give medication to. 9. I don't think so because anyone can make a mistake.
I41	5. It will remind me to check the dose more carefully, not just the amount, but also the units. 9. Everyone can make a mistake.
I42	5. I will double check patient information and medication.
I43	5. Check patient identity thoroughly, (before and after preparation). 13. I did not make a mistake.
I44	5. Has scared me to be more aware and shown just how important it is. 13. Was some computer errors so may not have made a medication error.
I45	5. Realised how much concentration is required. 9. I don't think my medication administration skills are any better or worse than my peers. We are all at a similar level. 11. hopefully
I46	11. hopefully

Theory Only Session

Participant	Condition	Q1.Made an error	Q2. Witnessed error	Q3.Imp of medication	Q4. Medication sim helped	Q5. Med sim reduce future error
TC1	3	1	2	1	3	3
TC2	3	2	2	1	5	2
TC3	3	2	1	5	3	3
TC4	3	1	1	1	2	2
TC5	3	1	1	1	2	3
TC6	3	1	1	1	2	2
TC7	3	1	1	1	3	3
TC8	3	1	1	2	3	3
TC9	3	1	1	1	3	3
TC10	3	1	1	1	3	2
TC11	3	1	1	1	2	2
TC12	3	1	1	1	3	3
TC13	3	1	1	1	2	3
TC14	3	1	1	1	2	3
TC15	3	1	1	1	3	2
TC16	3	1	2	2	3	3
TC17	3	1	1	1	3	3
TC18	3	1	1	1	3	3
TC19	3	1	1	1	2	3
TC20	3	1	1	1	2	3
TC21	3	1	1	1		1
TC22	3	1		1	1	1
TC23	3	1	2	1	5	1
TC24	3	1	2	1	1	1
TC25	3	1	1	1		
TC26	3	1	2	1	2	2
TC27	3	2	2	1	5	2
TC28	3	1	2	1	5	
TC29	3	1	1	1		
TC30	3	1	2	1		2
TC31	3	1	1	1	1	1
TC32	3	1	1	1	5	3
TC33	3	1	1	5	2	2
TC34	3	1	2	1	3	3
TC35	3	1	1	1	1	2
TC36	3	1	1	1	3	3
TC37	3		1	1	2	1
TC38	3	1	1	1	5	1

Participant	Q6.Freq	Q7. Seriousness	Q8.Learning in college	Q9. Compared to other nurses	Q10. Regularity of error
TC1	2	3	1	3	4
TC2	2	3	2	3	4
TC3	2	2	2	1	4
TC4	2	2	2	3	4
TC5	1	1	3	3	3
TC6	1	1	1	3	1
TC7	2	2	2	3	3
TC8	3	2	2	4	4
TC9	2	2	2	3	3
TC10	2	2	2	2	2
TC11	2	2	2	2	5
TC12	2	1	2	3	3
TC13	1	1	1		
TC14	2	2	3	3	2
TC15	2	2	2	2	5
TC16	2	1	1	4	4
TC17	1	2	3	3	4
TC18	2	3	2	2	2
TC19	2	2	2	3	3
TC20	2	2	2	3	4
TC21	4	2	1	5	5
TC22	4	1	1	4	5
TC23	2	2	1	4	4
TC24	2	1	2	4	5
TC25	1	2	1	5	4
TC26	1	2	2	3	4
TC27	1	1	2	1	3
TC28		3	1	5	3
TC29	2	2	1	3	2
TC30	2	3	2	4	4
TC31	1	2	1	4	4
TC32	1	4	1	4	5
TC33	2	2	2	4	5
TC34	2	2	2	4	4
TC35	2	3	2	4	5
TC36	2	2	2	4	4
TC37	2	4	2	5	5
TC38	4	1	2	4	4

Part	Q11. No of Errors	Q12 Causes Distraction	Lack of Knowledge	Incompetence	High Workload /Time Pressure	Illegible Prescription
TC1	1	2	4	5	1	3
TC2	2	2	4	5	1	3
TC3	3	3	5	4	2	1
TC4	3	2	4	5	1	3
TC5	3	1	4	5	2	3
TC6	1	1	3	5	4	2
TC7	2	1	3	5	4	2
TC8	3	2	1	1	3	2
TC9	2	2	2	1	5	4
TC10	3	1	5	4	2	3
TC11	1	1	4	5	2	3
TC12	2	2	3	5	1	4
TC13						
TC14	3	2	4	5	3	1
TC15	3	1	4	5	2	3
TC16	1	1	3	4	5	2
TC17	3	2	1	3	4	5
TC18	3	3	4	5	1	2
TC19	2	2	5	4	1	3
TC20	3	1	4	5	2	3
TC21	3	2	5	4	1	3
TC22	3	1	2	2	1	1
TC23	3	1	1	2	1	1
TC24	3	1	5	4	3	2
TC25	3	1	2	2	1	1
TC26	3	1	4	5	2	3
TC27	1	1	3	5	2	4
TC28	3	2	1	2	1	1
TC29		2	1	1	2	1
TC30	3	2	1	2	1	1
TC31	3	1	4	2	3	5
TC32	1					1
TC33	3	1	2	1	1	1
TC34	3	2	3	5	1	4
TC35	2					
TC36	3	2	3	4	1	5
TC37	3	1	1	2	1	2
TC38	2	1	1	1	2	2

Part	Q13. Axious	Angry	Embarrassed	Fear	Happy	Other	
TC1	4	7	3	3	3	7	Surprise
TC2	4	6	4	3	6		
TC3	1	5	1	1	1		
TC4	4	6	5	6	6		
TC5	3	6	4	2	1		
TC6							
TC7	5	5	5	5	1		
TC8	5	6	9	5	1		
TC9	1	2	1	2	1		
TC10	3	5	3	5	1	4	Surprised
TC11	7	10	7	5	2		
TC12	4	3	6	4	2		
TC13							
TC14	3	7	8	4	1		
TC15	3	8	3	1	1	2	Worry/regret
TC16	5	5	5	5	5		
TC17	1	8	1	1	1		
TC18	3	8	3	6	9		
TC19							
TC20							
TC21	1	6	8	3	3	7	Emotional
TC22		4	7	6	1		
TC23	2	5	2	3	1	3	Become more alert.
TC24	4	5	4	2	1	3	Worried.
TC25	2	2	3	1	2		
TC26							
TC27							
TC28	1	10	1	10	1		
TC29							
TC30							
TC31							
TC32	1	1	1	1	1		Scared
TC33	2	2	1	1	1		
TC34	2	5	2	2	1		
TC35							
TC36	5	7	5	7	1		
TC37	1	2	1	2	1		
TC38	3	4	1	1	1	1	Surprised.

	Comments and from what question
TC2	1. It was out of date. 5. Reinforced knowledge
TC8	9. Because am learning about how to stop errors
TC10	5. Peripheral vision - not just what is in front of you as you don't always look. 9. Because I have been at the receiving end so am very aware of the effects.
TC14	9. Dependent on person, training and experience.
TC15	5. Makes me more aware, it has opened my eyes to reality - especially the video clips. 9. Everyone gets stressed and distracted. It's accidental and you don't realise until after. 11. This is a stupid, rude and discouraging question.
TC16	9. The course has highlighted the problems and what I can do
TC17	9. I'm more aware of but I could still do.
TC18	9. Because we have had a lot of teaching at the beginning of training.
TC21	5. To identify the patient and actual drug before administering. 5Rs, Pt, RT, TM, DG, SD. 9. Because I know the implications of such error, the grief to the patient and his/her family. I have to be extra careful because I like my job. 13. How they feel being in the position of having done that mistake and what caused it.
TC22	5. It makes me aware that there is the possibility of me making a drug error and so make extra effort or extra care when doing drug administration in the ward. 9. Am less likely to make error because from now on I am more likely to double check drugs with colleague before giving.
TC23	5. I will try and avoid distraction as much as possible in future. Also pay more attention to people's faces. 9. I believe I will try and read over notes and NMC code frequently. 13. It is very easy to make an error and also it is at times difficult to know / realise you made an error, especially illegible handwriting.
TC24	9. Because I was taught the 5Rs. I have also attended lectures how distraction makes things different, perceptions can lead to errors.
TC25	9. Because we have been taught the important aspect. The 5Rs.
TC27	5. Reminder to carry out 5Rs etc. Though need constant reminders.
TC28	9. Because I have some experience.
TC29	9. Know the five rights.
TC30	9. I will adopt the five rights
TC31	5. Highlights how easy it is to make a drug error, to be extra cautious. 9. More educated earlier on
TC32	9. I will be very careful. I don't want to be struck off (NMC). 13. It's not fair to introduce pharmacology in first years at the end of the day you are not allowed to do medication on preactive (ward).
TC33	5. Knowing what can lead to medication errors I have better understanding ways error can occur which can help me a lot. 9. Information given to me improve my understanding
TC37	5. As I'm now aware that drug errors exist. I will always aim to avoid making errors by checking everything before administration of any drugs. 9. Because I'm more aware now that I have received lecture about drug error.

Appendix L Comparative Study Questionnaire Results: Statistical Output

Q3. The topic of medication administration is very important.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Q3.Importance- Topic of med admin * Condition	121	96.8%	4	3.2%	125	100.0%

Q3.Importance- Topic of med admin		Condition			Total
		1	2	3	
1	Count	36	43	35	114
	% within Q3.Importance- Topic of med admin	31.6%	37.7%	30.7%	100.0%
	% within Condition	97.3%	93.5%	92.1%	94.2%
	% of Total	29.8%	35.5%	28.9%	94.2%
2	Count	1	3	3	7
	% within Q3.Importance- Topic of med admin	14.3%	42.9%	42.9%	100.0%
	% within Condition	2.7%	6.5%	7.9%	5.8%
	% of Total	0.8%	2.5%	2.5%	5.8%
Total	Count	37	46	38	121
	% within Q3.Importance- Topic of med admin	30.6%	38.0%	31.4%	100.0%
	% within Condition	100.0%	100.0%	100.0%	100.0%
	% of Total	30.6%	38.0%	31.4%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	1.001 ^a	2	.606	.706		
Likelihood Ratio	1.120	2	.571	.706		
Fisher's Exact Test	1.041			.706		
Linear-by-Linear Association	.915 ^b	1	.339	.465	.241	.126
N of Valid Cases	121					

a. 3 cells (50.0%) have expected count less than 5. The minimum expected count is 2.14.

b. The standardized statistic is .957.

Symmetric Measures

	Value	Approx. Sig.	Exact Sig.
Nominal by Nominal Phi	.091	.606	.706
Cramer's V	.091	.606	.706
N of Valid Cases	121		

Q4 Participating / Knowing about the medication administration simulation has helped me with my learning about medication administration

Condition * 4 Crosstabulation

		4		Total
		1	2	
Condition 1	Count	29	8	37
	% within Condition	78.4%	21.6%	100.0%
	% within 4	40.8%	17.8%	31.9%
	% of Total	25.0%	6.9%	31.9%
2	Count	27	18	45
	% within Condition	60.0%	40.0%	100.0%
	% within 4	38.0%	40.0%	38.8%
	% of Total	23.3%	15.5%	38.8%
3	Count	15	19	34
	% within Condition	44.1%	55.9%	100.0%
	% within 4	21.1%	42.2%	29.3%
	% of Total	12.9%	16.4%	29.3%
Total	Count	71	45	116
	% within Condition	61.2%	38.8%	100.0%
	% within 4	100.0%	100.0%	100.0%
	% of Total	61.2%	38.8%	100.0%

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.804 ^a	2	.012
Likelihood Ratio	9.066	2	.011
Linear-by-Linear Association	8.710	1	.003
N of Valid Cases	116		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 13.19

Symmetric Measures

	Value	Approx. Sig.
Nominal by Nominal Phi	.275	.012
Cramer's V	.275	.012
N of Valid Cases	116	

Q5 What I have learned about medication administration errors in the simulation is likely to reduce the chances that I will make a drug error in the future

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
	Condition * 5	118	97.5%	3	2.5%	121	100.0%

Condition * 5 Crosstabulation

		5		Total
		1	2	
Condition 1	Count	29	8	37
	% within Condition	78.4%	21.6%	100.0%
	% within 5	33.3%	25.8%	31.4%
	% of Total	24.6%	6.8%	31.4%
2	Count	40	6	46
	% within Condition	87.0%	13.0%	100.0%
	% within 5	46.0%	19.4%	39.0%
	% of Total	33.9%	5.1%	39.0%
3	Count	18	17	35
	% within Condition	51.4%	48.6%	100.0%
	% within 5	20.7%	54.8%	29.7%
	% of Total	15.3%	14.4%	29.7%
Total	Count	87	31	118
	% within Condition	73.7%	26.3%	100.0%
	% within 5	100.0%	100.0%	100.0%
	% of Total	73.7%	26.3%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	13.554 ^a	2	.001
Likelihood Ratio	13.157	2	.001
Linear-by-Linear Association	6.454	1	.011
N of Valid Cases	118		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 9.19.

Symmetric Measures

	Value	Approx. Sig.
Nominal by Nominal Phi	.339	.001
Cramer's V	.339	.001
N of Valid Cases	118	

Q6. Medication administration errors are a frequent occurrence

Condition *6 Crosstabulation

		6		Total
		1	2	
Condition 1	Count	30	7	37
	% within Condition	81.1%	18.9%	100.0%
	% within 6	33.0%	24.1%	30.8%
	% of Total	25.0%	5.8%	30.8%
2	Count	28	18	46
	% within Condition	60.9%	39.1%	100.0%
	% within 6	30.8%	62.1%	38.3%
	% of Total	23.3%	15.0%	38.3%
3	Count	32	5	37
	% within Condition	89.2%	10.8%	100.0%
	% within 6	36.3%	13.8%	30.8%
	% of Total	27.5%	3.3%	30.8%
Total	Count	90	30	120
	% within Condition	75.8%	24.2%	100.0%
	% within 6	100.0%	100.0%	100.0%
	% of Total	75.8%	24.2%	100.0%

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.778 ^a	2	.008
Likelihood Ratio	9.899	2	.007
Linear-by-Linear Association	.658	1	.417
N of Valid Cases	120		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.94.

Symmetric Measures

	Value	Approx. Sig.
Nominal by Nominal Phi	.285	.008
Cramer's V	.285	.008
N of Valid Cases	120	

Q7 Medication administration errors are rarely serious

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Condition * 7	120	99.2%	1	0.8%	121	100.0%

Condition * 7 Crosstabulation

		7		Total
		1	2	
Condition 1	Count	27	10	37
	% within Condition	73.0%	27.0%	100.0%
	% within 7	30.7%	31.3%	30.8%
	% of Total	22.5%	8.3%	30.8%
2	Count	31	14	45
	% within Condition	68.9%	31.1%	100.0%
	% within 7	35.2%	43.8%	37.5%
	% of Total	25.8%	11.7%	37.5%
3	Count	30	8	38
	% within Condition	78.9%	21.1%	100.0%
	% within 7	34.1%	25.0%	31.7%
	% of Total	25.0%	6.7%	31.7%
Total	Count	88	32	120
	% within Condition	73.3%	26.7%	100.0%
	% within 7	100.0%	100.0%	100.0%
	% of Total	73.3%	26.7%	100.0%

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.069 ^a	2	.586
Likelihood Ratio	1.086	2	.581
Linear-by-Linear Association	.347	1	.556
N of Valid Cases	120		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 9.87.

Q8 What I have learnt in recent sessions in college about medication administration error will reduce the chance that I will make a medication administration error in practice.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Condition * 8	121	100.0%	0	0.0%	121	100.0%

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.069 ^a	2	.586
Likelihood Ratio	1.086	2	.581
Linear-by-Linear Association	.347	1	.556
N of Valid Cases	120		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 9.87.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	cent	N	cent	N	cent
* 8	121	100.0%	0	0.0%	121	100.0%

Condition * 8 Crosstabulation

		8		Total
		1	2	
1	Count	29	8	37
	% within Condition	78.4%	21.6%	100.0%
	% within 8	27.6%	50.0%	30.6%
	% of Total	24.0%	6.6%	30.6%
2	Count	41	5	46
	% within Condition	89.1%	10.9%	100.0%
	% within 8	39.0%	31.3%	38.0%
	% of Total	33.9%	4.1%	38.0%
3	Count	33	5	38
	% within Condition	92.1%	7.9%	100.0%
	% within 8	33.3%	18.8%	31.4%
	% of Total	28.9%	2.5%	31.4%
Total	Count	105	16	121
	% within Condition	86.8%	13.2%	100.0%
	% within 8	100.0%	100.0%	100.0%
	|	86.8%	13.2%	100.0%

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.140 ^a	2	.219
Likelihood Ratio	3.275	2	.194
Linear-by-Linear Association	3.036	1	.081
N of Valid Cases	121		

Q9. Compared to other nurses of similar training and experience I am less likely to make a medication administration error.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Condition * 9	117	96.7%	4	3.3%	121	100.0%

Condition * 9 Crosstabulation

		9		Total
		1	2	
Condition 1	Count	20	16	36
	% within Condition	55.6%	44.4%	100.0%
	% within 9	28.2%	34.8%	30.8%
	% of Total	17.1%	13.7%	30.8%
2	Count	31	13	44
	% within Condition	70.5%	29.5%	100.0%
	% within 9	43.7%	28.3%	37.6%
	% of Total	26.5%	11.1%	37.6%
3	Count	20	17	37
	% within Condition	54.1%	45.9%	100.0%
	% within 9	28.2%	37.0%	31.6%
	% of Total	17.1%	14.5%	31.6%
Total	Count	71	46	117
	% within Condition	60.7%	39.3%	100.0%
	% within 9	100.0%	100.0%	100.0%
	% of Total	60.7%	39.3%	100.0%

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.839 ^a	2	.242
Likelihood Ratio	2.890	2	.236
Linear-by-Linear Association	.021	1	.885
N of Valid Cases	117		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 14.15.

Q10. I will make medication administration errors on a regular basis when I first qualify as a nurse

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Condition * 10	119	98.3%	2	1.7%	121	100.0%

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.140 ^a	2	.219
Likelihood Ratio	3.275	2	.194
Linear-by-Linear Association	3.036	1	.081
N of Valid Cases	121		

Symmetric Measures

	Value	Approx. Sig.
Nominal by Nominal Phi	.169	.179
Cramer's V	.169	.179
N of Valid Cases	121	

Q11 How many medication administration errors do you think you will make in your first year as a qualified nurse?

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Q.11 No. of errors when qualified * Condition	108	86.4%	17	13.6%	125	100.0%

Q.11 No. of errors when qualified * Condition Crosstabulation

			Condition			Total
			1	2	3	
Q.11 No. of errors when qualified	1	Count	7	6	6	19
		% within Q.11 No. of errors when qualified	36.8%	31.6%	31.6%	100.0%
		% within Condition	21.2%	15.4%	16.7%	17.6%
		% of Total	6.5%	5.6%	5.6%	17.6%
	2	Count	4	10	7	21
		% within Q.11 No. of errors when qualified	19.0%	47.6%	33.3%	100.0%
		% within Condition	12.1%	25.6%	19.4%	19.4%
		% of Total	3.7%	9.3%	6.5%	19.4%
	3	Count	22	23	23	68
		% within Q.11 No. of errors when qualified	32.4%	33.8%	33.8%	100.0%
		% within Condition	66.7%	59.0%	63.9%	63.0%
		% of Total	20.4%	21.3%	21.3%	63.0%
Total	Count	33	39	36	108	
	% within Q.11 No. of errors when qualified	30.6%	36.1%	33.3%	100.0%	
	% within Condition	100.0%	100.0%	100.0%	100.0%	
	% of Total	30.6%	36.1%	33.3%	100.0%	

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	2.227 ^a	4	.694	.705		
Likelihood Ratio	2.289	4	.683	.701		
Fisher's Exact Test	2.250			.706		
Linear-by-Linear Association	.010 ^b	1	.921	.939	.491	.061
N of Valid Cases	108					

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.81.

b. The standardized statistic is .099.

Symmetric Measures

	Value	Approx. Sig.	Exact Sig.
Nominal by Nominal Phi	.144	.694	.705
Cramer's V	.102	.694	.705
N of Valid Cases	108		

Q12 Scenario: A nurse has committed a medication administration error. Please rank factors that contribute to such an error. 1 is most important. 2 second most important...

Distraction

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Distraction	115	1.79	1.072	1	5
Condition	121	2.01	.791	1	3

Ranks

	Condition	N	Mean Rank
Distraction	1	36	63.31
	2	44	56.35
	3	35	54.61
	Total	115	

Test Statistics^{a,b}

	Distraction
Chi-Square	1.660
Df	2
Asymp. Sig.	.436

a. Kruskal Wallis Test

b. Grouping Variable: Cond

Lack of Knowledge

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
LackofKnowledge	112	3.07	1.425	1	5
Condition	121	2.01	.791	1	3

Ranks

	Condition	N	Mean Rank
LackofKnowledge	1	35	54.97
	2	42	58.82
	3	35	55.24
	Total	112	

Test Statistics^{a,b}

	LackofKnowle dge
Chi-Square	.364
df	2
Asymp. Sig.	.834

a. Kruskal Wallis Test

b. Grouping Variable: Conditio

Incompetence

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Incompetence	111	3.37	1.612	1	5
Condition	121	2.01	.791	1	3

Ranks

Condition	N	Mean Rank
1	35	48.73
2	41	58.28
3	35	60.60
Total	111	

Test Statistics^{a,b}

	Incompetence
Chi-Square	2.922
Df	2
Asymp. Sig.	.232

a. Kruskal Wallis Test

b. Grouping Variable:

Condition

Workload

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
WorkloadTime	113	2.12	1.240	1	5
Condition	121	2.01	.791	1	3

Ranks

	Condition	N	Mean Rank
WorkloadTime	1	36	58.07
	2	42	59.20
	3	35	53.26
	Total	113	

Test Statistics^{a,b}

	WorkloadTime
Chi-Square	.763
Df	2
Asymp. Sig.	.683

a. Kruskal Wallis Test

b. Grouping Variable: Condition

Illegible Prescription

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
IllegiblePres	114	2.69	1.256	1	5
Condition	121	2.01	.791	1	3

Ranks

	Condition	N	Mean Rank
IllegiblePres	1	36	63.82
	2	42	56.19
	3	36	52.71
	Total	114	

Test Statistics^{a,b}

	IllegiblePres
Chi-Square	2.284
Df	2
Asymp. Sig.	.319

a. Kruskal Wallis Test

b. Grouping Variable: Condition

Q13 People experience different feelings when they make a medication administration error. What did you feel when you realised you made a medication error in the simulation / heard that others made medication errors in the simulation?

Test Statistics^{a,b}

	Anxious	Embarrassed	Fear	Happy	Angry
Chi-Square	.210	1.966	.184	.312	1.395
Df	2	2	2	2	2
Asymp. Sig.	.900	.374	.912	.855	.498

a. Kruskal Wallis Test

b. Grouping Variable: Condition

Appendix M Long-term Qualitative Interview Study: Consent Form / Information Sheet

INFORMATION SHEET FOR PARTICIPANTS

Follow-up study Interview cover sheet - provided at the beginning of interviews

REC Reference Number: PNM/08/09-129



YOU WILL BE GIVEN A COPY OF THIS INFORMATION SHEET

Title of Study: Using drug administration simulation as a learning tool

We would like to invite you to participate in this **postgraduate** research project. You should only participate if you want to; choosing not to take part will not disadvantage you in any way. Before you decide whether you want to take part, it is important for you to understand why the research is being done and what your participation will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information.

We would like to invite you to participate in a project that is being conducted by a research group within the School of Nursing at King's College. The aim of this project is to determine the experience and impact of different ways of teaching about drug administration in College. You should only participate if you want to; choosing not to take part will not disadvantage you in any way. Before you decide whether you want to take part, it is important for you to understand why the research is being done and what your participation will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information.

When we teach about practice-based topics it is often hard for us to know whether students see the relevance to their practice. One such topic is drug administration and in particular the errors that can occur. We are currently examining the impact of different approaches to teaching this topic.

One year ago your class was randomly divided into three groups and were delivered one of three teaching sessions; a, a computer simulation on drug administration, b, a teaching session looking at drug errors and the effect of distraction and the results of the simulation, and c, a teaching session looking at drug errors and the effect of distraction only.

Thank you for agreeing to be interviewed. The interviews should take approximately 30-45 mins. They will be tape recorded and / or notes will be taken. You may withdraw your data from the project at any time up until it is transcribed for use in the final report (2012). Recordings of interviews will be deleted upon transcription. *You will be receive £10 for the time and effort involved in participating. You will receive this payment even if you choose not to complete the interview*

If you have participated in *any* classes in which you were taught about drug administration errors your opinions would be valued.

There are no risks or consequences to yourself because of the answers you give as the questionnaire is entirely anonymous. It will not be seen by anyone other than researchers on the project.

By participating you can help us to develop and decide the best approach to teaching this topic.

It is up to you to decide whether to take part or not. If you decide to take part you are still free to withdraw at any time and without giving a reason.

If this study has harmed you in any way you can contact King's College London using the details below for further advice and information

For further information contact Sinead Helyar (sinead.helyar@kcl.ac.uk) Peter Griffiths
peter.griffiths@kcl.ac.uk

Consent form for interviews in follow-up study



Please complete this form after you have read the Information Sheet and/or listened to an explanation about the research.

Title of Study: ___Using a drug administration simulation as a learning tool

King's College Research Ethics Committee Ref: PNM/08/09-129

- Thank you for considering taking part in this research. The person organizing the research must explain the project to you before you agree to take part.
- If you have any questions arising from the Information Sheet or explanation already given to you, please ask the researcher before you decide whether to join in. You will be given a copy of this Consent Form to keep and refer to at any time.
- *I understand that if I decide at any other time during the research that I no longer wish to participate in this project, I can notify the researchers involved and be withdrawn from it immediately.*
- *I consent to the processing of my personal information for the purposes explained to me. I understand that such information will be handled in accordance with the terms of the Data Protection Act 1998.*

Participant's Statement:

I _____

agree that the research project named above has been explained to me to my satisfaction and I agree to take part in the study. I have read both the notes written above and the Information Sheet about the project, and understand what the research study involves.

Signed

Date

Investigator's Statement:

I _____

confirm that I have carefully explained the nature, demands and any foreseeable risks (where applicable) of the proposed research to the volunteer.

Signed

Date

Appendix N Long-term Qualitative Interview Study: Interview Summary

Interview Rules of Conduct:

Listen to answers and respond to them –don't butt in or lead

Questions –Be short clear and straight forward

Be neutral in the questions and the way the interview is conducted- no 'good', 'exactly' etc

Passive prompts – not leading ones.

Record

Introduce self and what will happen during interview

Ensure there is an overview of how the interviews will be conducted – their thoughts, there is no right or wrong, confirm receipt of consent form and payment tape recorded, and will reiterate the and review the interview at the end

Questions

Review – what you are saying

Interview Themes

What do you remember about the medication administration simulation?

What did you learn from it?

How did it impact upon your clinical practice? Can you give examples?

Do you think you will use that learning in the future?

In what way?

How did it work in conjunction with other medication administration learning, such as lectures?

Potential Interview Questions –

(depending on what the interviewee says. May not use some if the interviewee brings the subject up independently)

Take me through your experiences of being taught medication administration in university and on placement

How did the teaching in university and on placement work in conjunction together?

Take me through your experiences of completing the medication administration simulation?

How clearly do you remember it?

Please describe the simulation

What happened at the end of the lesson?

Did you learn anything from completing it?

Was completing the simulation relevant to your practice? Can you give examples of using it in clinical practice?

How important is to you the theory behind administering medications? – Did completing the simulation affect this?

Did you make any errors in the simulation? Hear about others making an error?

How did it make you feel and why?

Did you learn anything from this? Did it relate to your practice? How?

Perceived levels of risk

Did you notice any form of distraction in the simulation?

Did you learn anything from this? Did it relate to your practice? How?

What is the previous / current / intended use of checking procedures?

What do you perceive is the likelihood of you committing a medication error in the future? Has this been affected by completing the simulation – How – In comparison to other nurses?

Appendix O Long-term Qualitative Interview Study

Interviews

Participant 1.

I-Introduction and explanation of how interview will be conducted...

P -Yeah sure.

I Tell me about how you were taught medication administration_your medication First thing is can you just relate to me your experiences from when you first stated at Kings about drug administration, what you were taught, how you were taught it and your experiences on the ward. What is your story...

P - Um during our practical times we were taught about drug administration I think its been taught the principles of it first um and the systematic approaches you should follow follow all the steps and the little acronyms you need to do, um and then a few practical cases, checks of the drug chart as well on top of what you would do, physically checking it and checking the routine that you had to go to and then actually performing the task. With you know other people and the clinicians with you and things like that, so its quite a systematic approach. It may fade a little bit when you are in practice because after a while you know the patients you work with depending on the ward that you are in so that you understand that that is the person, that is their name that is their date so it sort of skims a little bit, but as student nurses we are told that it has to be the same, 5 steps, 5 rights, 5 checks and you follow on other things that might not be seen. So I think as you progress, from our first year it was regular checks and then as you progress a little bit more its been able to, you should be able to check everything, check the whole card, check the signatures, check the dates, and then consider the drugs as well, you know, which you should be doing from the beginning also. But and then from that we have had a few new electronic changes where you are given a few tasks and a few pictures and diagrams and then your meant to say if you would give the medication here, so you think more, more of the process and from the process to more of the theory behind what you would do to that patient, so its kind of being a bit on the development

I -Ok and it that the electronic process was that at school or was that in placement?

P -At school yeah while in college.

I - What year was that?

P-I think it was more in second year they were still piloting the programme and now I think it has been introduced properly throughout the rest of the curriculum

I- And how did it work?

P-Umm you were given a few scenarios and they would say this is the drug chart you would click and a pdf chart would come up and then you would read through that and then you were given a list of drugs and doses and your given a diagram of patients, so then you would select the right patient and you would check the information that comes up once you have selected that patient to the information on the card you are given in pdf and then you would decide whether you would give that or not. (13, 10, 2, 1,4,)And then from that you would go and select the drugs from the list you were given and er calculate the dose and then drag and drop into this imaginary bin of a patient and it would tell you whether you got it right or wrong

I-And did you get them right or wrong?

P-Right, although there were a few glitches in the system at the time...

I- In what way?

P-It was piloted so some of the drugs were written a bit wrong and things like that, but obviously we picked things like that up thinking it was a forced mistake, but it was just a piloted programme.

I-Was that helpful or unhelpful?.

P-Yes, absolutely. It made you think more about things that could go wrong)and maybe not only see things as numbers but consider them more as a holistic approach, that it is more than just a tablet that you are giving that you need to think about, that you need to know what you are giving and you need to consider how that is going to affect the patient completely while they are on the ward so it moves the task from the physical to the more holistic approach of considering everything.

I-When you did that particular administration task, did you notice any tricks that they tried to implement with you?

P-Changes of patient date of birth, any queries on the drug chart, signatures, times, if things were given prn or whenever necessary, and then you were told to give another dose so you then had to query that. Change of patients, they moved the patient pictures around so although it said some person was John, it was a picture of a woman instead so you would question what you were doing,. Drug allergies. You would see that they were allergic to penicillin but you would see that they were prescribed a penicillin based drug um and in some other cases if there was more pain relief needed. So I think by that point, because we were piloting a new programme I think they were trying to push it into the first year, which I think is the best move forward to try and get it out of just the normal routine.

I-And you were taking about something that you had in the first year. Can you explain that for me?

P-What was the first year? The clinical OSCEs and things? As part of the training you were given a drug chart and under supervision, you would have an actor there and then you would follow the process, highlight the bits that you would go through and then actually physically give the drug or a fluid to the patient who was there with you, although it was a tic tac at the time, so nothing serious, so that was more the whole physical process because there wasn't any questioning because you didn't have the option of questioning. You

would be tested on your physical ability to read a drug chart, decide on how many tablets and give that to a patient after you check it.

I-Out of all the different teaching strategies that you had, you have mentioned that you have completed practical procedures in an examination context, you had to do a computer simulation

P-Yes they tried to push that out with clinical skills

I-And you had theoretical classroom teaching in addition to your practical placements do you think they all were helpful in teaching or did different strategies assist you more than others?

P-I think that because it was universal and that the methods that they were teaching were the same, ways as you would follow on the wards, because some wards might not know the five rights but by having that universal way made it more consistent um. I didn't like the way that on the wards your mentor might not ask you the question what you are doing, what the dose is, where as on placement, the lecturers were able to make you consider more things, that you are not just a drug dispenser. You need to be able to consider everything that you need to be doing for patients (9). I felt that to be able to be considered that your opinion does matter and you are questioned by the teachers and by different methods here, it did make you consider that more in practice. Like you say you do cut corners sometimes or you see it in practice.

I-Can you give an example of cutting corners?

P-Like not checking regular patients if you know them. You do mentally check them but you need to consider other things when you see them again, if they are having new medications you may want to check them again to cover your back with accountability and things.

I-And in practice, you don't always see that being done?

P-Well sometimes it is mentally done and that may not be seen by everyone or it may just be seen as just handing to the patient as if nothing could go wrong as the patient has been prescribed. But at some point you may not see people consider is this working you know, do the whole nursing process, re evaluate what you are doing just because the doctors have written it, doesn't mean it is right

I-With regards to your development and your understanding of the medication process and administering medications safely from your first year to now, when you are almost ready to qualify

I-What things has the teaching helped you with apart from the 5 rights?

P-I think it has been good that our teaching has been, whenever they have been teaching medication administration, it has followed alongside our actual module of pharmacology so its nice to be able to put actual theory into what you are doing with drugs so it kind of gives you the whole kind of view of what the drugs are and what things are actually going on.

I-When you talked regarding the simulation about people changing positions and that sort of thing, did that highlight anything to you or not at all?

P-It did show that it has occurred in a few places Names are one thing, and the whole assumptions, nurses shouldn't assume.) A person could be called something, they may be male or female, nurses shouldn't assume. And that should be checked. And like handing over patients, there you may not know a whole set of patients and not know anything at all about them and to be able to think of other things that may happen. You may think that the actual simulation was wrong, but it wasn't, it was testing your ability to understand that things do change on the ward and that you should stay there and watch them take the drugs and should be able to see it be swallowed and that person may not be in the bed and they may move around.

I -Has that impacted upon your clinical practice at all or not?

P- I think it has made me more aware and that if someone questions you, you should be able to say confidently and competently that you did it right and you know you did it right and I think it did highlight the importance that although you may be giving paracetamol, you know you will need to be there and say to the patient, I will have to watch you take that tablet. There are people you don't know who may not take them and it could end up in an over dose or it may not be taken at all and it may result in more problems if it is some other drug (8). So I think it highlights that I am accountable at the end of the day and that to rely on me and not on the patient.

I -How memorable was it?

P- I always remembered it in myself, even now when I am on practice and I still remember the five rights and the whole procedure and it gets drilled into your head what to do systematically, not only with the rights with the drug charts It all comes together in the end.

I- And when you were either doing the simulation or the OSCE, if you can described them individually, when you realised there were some tricks to it. Can you expand further on that?

P-Sometimes people, you think, it expands your feelings about being a student nurse that you have that ability to question things can go wrong and if you did see something on a drug chart you shouldn't just automatically give. It is not just the role doctor nurse relationship that it was, that doctors are right all the time. That they do try and encourage you to think outside of the medicine box as it were. I.e. if you think that was wrong or maybe there is a funny number, but that you should always question your practice, always, and always re-evaluate what you are doing. I think that is the crucial point that you come to and even though you know you are being tricked, you know everything suddenly gets a microscope out and you check everything thoroughly, which is what you should do anyhow

I -Can you give me any particular example, where it may or may not have helped in practice?

P-Umm, what the whole systematic approach? Ok... I think for something for me to question, one way would be, I know there was a load of pain killers were given to a patient, but there wasn't much

prophylactic medication that was given, such as omeprazole, because it could cause gastric problems, constipation and at those points, you can apply it with the pharmacology knowledge that you have gained and say to them, actually do you think it is worth prescribing these extra precautions. I think that was a good highlight about being able to identify that there were problems and think of a treatment in your head and then plan. It makes you a more comprehensive nurse.

I-Did anything that you did in university, such as the lectures, the simulation and the OSCE, did any of that help or hinder at all?

P - It did make you check, especially more regular medications so they made in more practical to the hospital setting so you would consider more seen drugs and consider their interactions and what you may or may not do. It did help to highlight... consider everything, don't always go through everything with a fine tooth comb. It is not always going to be wrong, but its good to keep on questioning and keep on the ball what you are doing .

I- And you said that you didn't make an error in the simulation – did you receive error scores?

P - No I think the personal student knew their own error rates, but there was one glitch with the system with one question, so we all queried that and we did go through the answer together, we didn't get anymore collated information from the simulation. Obviously, the students were just participants and not results.

I-When you speak about the medication administration simulation, the one that you 'sat in your second year', did you do you just do one or were there two of them?

P-With medial administration, we've had clinical skills, second OSCE, where it was analysing a drug chart.

I-So you were given more than one OSCE, in more than one year?

P-Yeah, one OSCE every year. I think its got more advanced as you go along. So we had the first initial one which was giving the medications to someone, the second one was analysing a drug chart so you were given , you were at a table and given a drug chart and a BNF and made to analyse things to go through.er such as doctors not signing and to highlight as many errors as you can. Find in oned rug chart. Um and then the simulation was just a pilot programme but it wasn't implemented in our system, within our cohort. But we have had subsequent training with our OSCEs really.

I- So the simulation, that was a pilot scheme, just done once.

P-Ahuh

I-And that was in your second year?

I-Fine. So – what year are you in?

P- I am in my third year.

I- So that would have been last year?

I-Ok fine. With regards to the medication simulation, can you just describe to me exactly how... You mentioned pictures swapping and a pop up box, Can you describe the whole thing to me.

P-You would log on to a system and you were given a scenario that says you are a new staff nurse or a student nurse with your mentor on the ward, and you have to do the drug round. Erm you have four patients to your bay and it will give you their names and it will give you their pictures all in one row. And it says you now need to click on a patient and you need to look at the medications they are prescribed. So you would click on one patient and it would say medicine drug chart, you would click that and it would come up, within the actual programme itself erm, what looked like a scanned front sheet of a normal drug chart and then go through that in front of you and then decide for yourself what will be given and there was a little side pop up box which you could say how many tablets, how much. You could select the drug from a big list and select the amount you would give and whether or not you would keep it and you had a bucket in which you could put your medicine once you have selected that. Erm and then from all of that you would the say whether or not you would give and then review what you had selected what you had out into your box and that was it. And then you would go through each one and each name would change and you would have a new set of patients. And it would say it was 10 oclock, you need to give the 10 oclock drugs to, you know, John and you go and click – you find his name and then you look his picture and you click on and carry on from that(10).

I-Ok, And you highlighted that the patients would sometimes swap over, perhaps a john smith would become a woman or something like that. What other errors did you pick up upon?

P-Whether or not they were allergic to certain medications, or if they had a history of asthma and they are on ibuprofen or something like that, NSAIDs, penicillin allergies and they were prescribed penicillin based medicine or if. I think the major one which was much more easier to do, especially with being in the second year erm was whether or not, what time you would give something and if this was an appropriate time to give this medication and if it was properly signed and whether or not the changes were made, cause the drug chart itself could be modified, different patients could come up, so then you could see that the doctor didn't sign, that he's prescribed this and how much he prescribed wasn't written clearly, so you then could then select not to give the medication because you weren't sure.

I- Did you take anything away from the simulation or not?

P-For me in general I learnt, you know, to keep yourself in check), and to make sure that things are not always black on white and as white as they seem and there is that unpredictability in the workplace and that things do change and you should be able question and know exactly what you are doing. That's all I think.

I And did the experience impact upon your clinical practice or not? You were talking about how your teaching did impact upon your practice.

P-Yep.

I -Was that as a consequence of everything collectively, from your university teaching, or was that specifically from certain element from your teaching that you received?

P-I think collectively, it has gone from a slow upward process where you start of small, cause you can't be expected in the first year to be able to understand everything and then from that being able to add on more knowledge and think of everything in the bigger picture so I think its being able to get you from one stage to actually start nursing nearer the end, erm , but of course clinical practice, depending on your mentor as well, if they are able to push you forward and intrigue you into different areas of drug administration. And I think, from my practice, I've been able to have some, learn a lot more drugs and learn ways of giving medication that you may not learn in your actual administration- everything is not oral, so you need to think, it is good to be able to know that practice develops your medical administration, but it doesn't actually do it on purpose really, its more that it is something you are required to do and you get learning from yourself, you are questions, you are intrigued to ask .

I-Did the simulation, contribute to this or not?

P-Yes, I think with the simulation, more information could be given)and more detail could be given, whereas if you are in a practical situation, sometimes not all that is available at a click of a button and you know you do a get a little bit, with the amount of people in a room, its good to be able to do it with other people, because its not going to be simply you and a patient in a quiet room when you give medication. But Its good to have all the rest of the information that you would normally have available at a click of a button,

I-And did the simulation help with your learning or not?

P-The simulation? Yes The Simulation was able to give you direct feedback, should you have done something wrong or should you have considered something else, it actually told you may you want to look back at that ir give you direct feedback when you need it). Although, its not a substitute for a lecture at the sametime, it does, it can give you more and apply different areas or consider different points which can be a bit harder for one lecture to do with twenty odd students (14).

I-Certainly, ok. With regards to... The learning your received, in general on medication administration, how did they educate you to ensure you take the learning into your career?

P-How did they do it?? From university I will never forget anything I have learnt from here especially when it comes to these practical OSCEs. Everything that they have taught me and everything that they have taught all the students to make sure that you check everything and they've drilled into safety aspects, especially when it comes to medication administration and from everything I have learnt in practice I don't think I would forget anything learned in university. Its all been a fundamental line to what I actually do, which is not the trusts way of doing administration, though that may change, but the fundamental things I have learned here is what pushes my practice forward. And the simulation itself was just a reiteration in a different form from the things Ive actually had here in university, so its similar, just a different way of

learning for other people It was beneficial, but it wouldn't have changed anything that I learned from different sessions

I-To clarify - Was it just an add on or was it something to confirm?

P-I think it was able to give me different situations that you may not be able to receive in a lecture slot so you consider things other than just hearing what you should do, you were able to practically, although not really practically, be example it yourself as if you were in charge

I-So, when you were saying you won't forget anything that you have learned, do you feel the different ways of learning in university lectures , the simulation and the OSCEs, are they all relevant to you?

P-Yes, I think its all forms of teaching and learning, people learn differently um and I think the theory and the lectures we had were able to give you your actual knowledge, you attitudes to learning how importance it is, background to the NMC with the passion of the clinical leaders and then with the simulation you could then actually have a practical simulation, on the computer first, and then go to your OSCE, you get all different forms of seeing things. Its great to be able to do all things together and it gets you ready for actually doing it in practice

I-An do you think using simulations is a helpful or unhelpful way of learning?

P-I think the simulation of medication simulation is great for tidying the knots of what we were told, but there is not different from actually doing in practical so in the session we had the theory, we also had the practical, so you had a practice test with your mentors first, with your actual lectures, and your OSCE was the final exam, but that's an exam. I think a simulation is great for adding on and solidifying the knowledge that were given through other bases but practical should always be a fundamental part of learning.

I – Thank you

I-I there anything else you want to discuss, or mention about the ways you've been taught or just any other experiences you have had?

P-I think the lectures have been passionate, obviously, medication administration is serious, having people being passionate and highlighting the problems and actually being given examples of bad practice was a good way of showing it is not just a tablet in a pot, it is your registration and the way you perform it is important and to realise the lecturers have done this is important , and it did make you consider how important it

I-And one last question would be about the medical simulation, the medication administration simulation, you have explained how it assisted you in gaining a more holistic view about what is going on being a nurse etc, if you didn't have that, so you think it would be of any detriment to your teaching and learning?

P-We are taught in other modules, and then to then... when they want to apply that to medical administration would be through small examples during that lecture, so that might have lowered it down a

little bit. But for a simulation to actually ask you to consider other parts of things.. its a good way of adding.. you know, like changing things around) opening your eyes a little bit more (inaudible) blinkers for looking at everything holistically so I think being challenged in that way within the practical aspects of would be a good way of changing things around I would know that eventually, through other modules I would have to learn things like this and manage my patients properly and I think it should be a fundamental aspect of any part of medical administration that they should consider it to be more than just a tablet to a patient.

I-And the simulation has helped you with that?

P-Yes Thankyou.

I-Any other last minute comments?

P-No, I think the simulation is great but it should be a good mix between things , to be able to aid everyone

...Summary of interview and conclusion....

Participant 2

...Introduction including explanation of how the interview will be conducted...

I-Great. Tell me about how you were taught medication administration.

P-Oh right ok. Erm so i think the first one in the first year we had a medication administration session that was teaching us for a osce and that was oh gosh it was a long time ago, it was quite basic teaching and was only erm using the example of paracetamol and multi vitamins I think, ERHER. They went through the five rights and gosh, really just helping us look a drug charts and things like that because we had not been in placement at tyat point in time. It was just to introduce us to it.

I-So, were you not taught about the five rights before you went on placement?

P-No, we were on this session we were taught about the five rights and then we went onto placement.

I-Oh I see.

P-No that is fine. I believe it is slightly different now.So basically we did that session before we went into practice erm so that was fine, so we kinda new the basics before we went into practice and then when we went in erm, yeah i think the nurses on the ward all tend to teach it the same, they take you on a drug round first, on the first drug round, you would sort of tell them what you would do. Its a drug round where you can choose the medication and pick it up and show them what you would do if it was in date and things like that, but actually going through everything there, erm, so yes, so there the nurses on the ward are slightly different in that way and they take you through it, but of course there are time constraints on the ward isn't there.

I-Yes of course.

P-They have to finish the drug round before they have to takeover or whatever, but erm, am I going on the right track?

I-Absolutely fine. Because it is about what your experiences are which can be very different to somebody else's, so it is completely valid

P-Ok. Yes, so you... I've learnt best by actually doing it to be honest on the wards because you have the added fear of actually administering the medication, so there is the added, you know, I better check that up in the BNF you know or that if you don't know. Its a good way of learning I think sometimes.

I-To clarify - because you are actually doing it and you are seeing the patients in front of you.

P-Exactly...

I-Where there any other techniques used in university to help you learn about drug administration?

P-Erm, yeah, we did have a session, oh gosh, it must have been in our second year, yes second year, yes, where some people came to see us, from outside the university I believe where they created a programme on the computer erererem where it was an IT based thing and you had to basically do a virtual drug round erm which was very good actually to highlight interactions and doses and how much you would give for each dose and things. It was quite a good programme for that, but again it wasn't very realistic... There were a few problems.

I-Ok so two points you have made there, one it wasn't very realistic , and there were a few problems. So with regards to the realism of it, erm, what were the issues there and why so?

P-Ok i think the realism of it was erm you had a bubble saying you had to administer this patient er this medication, erherm, and if the medication was due you had to give them it, but of course with some of them, you couldn't do the things you needed to do in medicine administration, like, you know, giving the ibuprofen, you couldn't ask them if they had eaten or erm, you know that kind of thing, quite important things , quite important things when you are doing the drug round.

I-So it wasn't quiteas interactive as it could have been – any other issues?

P-Yeah, again i think it was the interaction really, but yeah, and also, there were a certain number of options, I can't remember if it was multiple choice or whether you had to, I can't remember exactly how it was done, it was a while ago now , but i remember it wasn't completely up to you, you just had options yyyes and things like that

I-So i suppose it was a little bit erm stricter in what you were able to do because on the wards, because on the wards you have the medicines trolley which has lots of medicines in, plus also you can talk to the patient and really analyse what they need and what is going on with them.

P - Yes, that's it and I mean there are a number of occasions where you think actually I am not going to give that medication to that patient for this reason ererehum and you know you can write it on the drug chart to say why which is always covered in a session but, there is always a multitude of reasons why you wouldn't give a medication, yesyesofcourse which can't be all covered in college

I- No, no, ok, erm, you said, when you first mentioned the computer programme, you mentioned, i can't remember your words exactly, but you said, IT was quite good, or you mentioned something reasonably positive about it, why was that?

P-Erm , i think, i don't know, i think it gave, in a way, I think it kinda gave you an idea of whether you were right or wrong at the end i know that sounds silly because obviously, it is always going to be right or wrong, erhum, you kind've you had to do a drug round with a certain number of patients and then at the end it told you how many drug errors you made, YEP which was actually very good because of course everyone thinks they are doing everything perfectly all of the time, and of course you get to the end and it would show you have made two or three drug errors. you know and your not really sure about that, but it was actually quite an eye opener to see that actually. HUHUM. I it was quite useful actually, as a student nurse it was very useful to highlight how easy it was to make a mistake and not really realise OK.

I-And did you make any mistakes?

P-Yes I think one , but I can't remember what it was.

Huumm, I can't remember what it was.

I- OK, and did you have any reaction to this?

P -Huum. I felt terrible, ,because I thought gosh, if I had made that mistake when I qualify, am I going to make a mistake and not realise, I don't know. I think it went back and showed you the mistakes that you made I think it was... I clicked on one and a half tablets and should have given them two smaller tablets, or something like that, when you wanted to give them a half tablet... that sort of thing. HUMMMM It wasn't a life-threatening error! I think that was quite good There did seem to be quite a lot of revelations in the class with everyone feeling a little bit guilty, but you know, you made an error Whereas in the practical sessions in uni, you don't really get the opportunity to make an error because if you are going to make it, it will be highlighted in such a way that makes you think oowwww They highlight it more often as you go along more often...

I-Yeah exactly. So, with this feeling of guilt highlighting the error, did this impact on your learning or not?

P-Humm, yeah, no I think it did help actually i think it erm, I think... yes it did because it highlighted to everyone can make mistakes I think HUMUM. And although no one thinks they are invincible, I think it did help, I did make us all realise it is easy to make a mistake and yes when I went onto the ward, I now do check everything and double check things now, but I don't know if maybe that is whether I have just got into the habit and got into the third year now where you, where they give you a lot more autonomy really

and you have to make sure you checked it because they are checking it as well. But you know what I mean, YES. They give you more UNCLEAR in the third year.

I - Yes yes, I do understand what you mean. So, do you think the simulation was useful or not to you for clinical practice?

P- Errmm. Yes, yes I think it was. I think the programme needed a bit more work I seem to remember HUHUM, but I am sure they have done some more work on it by now!! But yes I think it definitely has erm, but the only thing it didn't really take into account of, it took into account drug interactions, so you couldn't give someone cocodymol and paracetamol for exampleHUHU, but again it didn't take into account the environment or the situation the patient was in. So, you know, so, well you couldn't, for certain medications, you might not give them all the pain medication for example, if the patient's pain is more under control

I-But in the simulation you were essentially required to give it?

P -Errm, I don't think we had anything much stronger than paracetamol on there, but yeah! Yes I would say yes, we had go give what was given. You didn't really think it was a bad thing at the time, but of course it was a simulation and you had to...I felt when I went in that it was more like, I didn't feel I was being tested or anyway really, but I felt like it was a pop quiz or something you know when you are multiple choice things YES on the computer, where at the end you think oh great I did well or oh dear. I didn't think I was accountable to anyone, but when I came to the end of it I thought oh dear actually.... I feel a bit bad now that I made an error!!

I-Ok. At the end of the class, did teacher discuss the simulation results after?

P-Errmm...I ...It was some from out side that did the session , or inside, whoever was making the programme at the time and erm I think they were... We discussed it between ourselves.ERERM I am not sure whether we were prompted I can't actually remember, but I remember we did discuss it between ourselves.

I- You did discuss it between yourselves. Ok that is absolutely fine...

P-But I am sorry, I can't remember if anyone taught us to discuss it or whether we just did.

I -No, no that is absolutely fine. And with regards to the discussions between yourself and your colleagues that you do remember, erm, what sort of opinions or sort of feelings did people have if they realised if they made an error? You mentioned you felt a bit guilty

P- Erm, it was a really varied response actually cause a couple of them said oh well the programme is wrong essentially because of the inflexibility in the programme – Well that is not what I meant, so the programme is wrong and some were, well it is unrealistic anyway and I think there were guilt feelings, the same as mine probably, yeah, and then others were just like me thinking oh gosh actually it is quite easy to make an error

.I think it depends on what type of learning you do, whether you are more reflexive or you know, or not so good at the reflection you know, YEAH but yeah it was a real varied response in reaction to it... UNCLEAR (few seconds).

I- Ok , the simulation itself, as you say wasn't very interactive, and it was essentially quite a basic simulation, So for example, you say about giving someone paracetamol, when they perhaps didn't need it.

P- I think it is generally accepted that was the case. And I think when you ask about learning techniques, on the wards it is must more of a realistic learning technique, OF COURSE, something you can't represent in college. I think it is very important in college to have those kind of training sessions because you need to know that the students are able to look at a drug chart and interpret it I suppose. YES.

I-I see. Did you think the simulation helped you understand medication administration or not in clinical practice?

P- Erm, I think it completed that role, erm, i think it is easy to pick holes in it as a student as well when you haven't made the programme.

I -Of course!

P- It is easy to pick holes in it if you were to ask me which way is better, to learn in practice or to learn in college you obviously there is a difference there but, learning in college as a half way measure is, yeah, as long as students are willing to accept that it is a half way kind of thing and kind of get on with it I think actually, yeah, it worked for me. I think, you know, It was definitely a positive experience for me

I -Uhuh...

P Back then, erm, you know the training sessions i got something from every training session I have been to, so in respect of admin so... you have to follow every word i think, haven't you...??

IThe learning on medication administration you received at university, do you think they helped you or not?

P -Yes.

I -Now, do you recall ever seeing that the pictures of the patients would change position?

P-Oh gosh you have... oh gosh, yes, you have reminded me now. It was so long ago we did this you know...I think we were ticked off about it actually .

I-In what way?

P- Like, not in a bad way, just being aware that your patients can move around, I think, or something like that, or may be, unless one of the other students tipped me off, I can't remember, but I am not sure I would have noticed it myself I have to admit.

I -And did it affect have any impact or not?

P- I was definitely a lot more vigilant after it was mentioned. I think so actually. I can't remember myself actually applying the five rights when I was doing the programme though, I think I kind of didn't put the two and two together when I did it if you know what I mean

I -Yep

P- So I didn't kind of think I must do the five rights for each patient. I kind of thought right ok... I suppose I did do the five rights but I didn't apply it as a process per se It might have been helpful to have may be said at the beginning it helps to apply the five rights because some people may have done it a bit more systematically (5,4). So those kind of like watching out for the bits that were there to trip me up I suppose

I-Uhuh.

P- Basically (Inaudible)

I- Do you think it affected the way you viewed the 5 rights?

P - Erm. I think it highlighted the possibility for error I can't remember coming out of it thinking about the five rights erm but I do remember coming out thinking about the serious possibility for error and I suppose... but I can't remember if at the end if they at the end ... I don't know... I think maybe at the beginning it might have been helpful but to have been guided by I think someone who could have talked about the five rights beforehand then people may have concentrated at bit more.

I-Yes (Both laugh). Do you think the experience will affect you in the future or not?

P-Yes, I think actually... I think it was one of the first realisations that I really had about how easy it is to make a drug error

I -Do you remember it well or not?

P-Erm I remember doing it but as we have established, I don't remember a huge amount of detail , but one of the things I do remember quite clearly was thinking oh gosh... I am going to kill someone That wasn't quite what the feeling was, but the feeling was oh gosh, originally I couldn't quite work out what I had done wrong to the patient

I - That's fine

P-I couldn't work out... so I felt if I can't even recognise it when I have done something wrong, I felt like... oh gosh... But yes, so the memorable thing that came out of it was how easy it would have been to make a drug error

I -Yes. And you have also mentioned to me as a consequence, you check a bit more vigilantly etc.

P-Yes I do. Yes I suppose, I think that is when I really started really checking and double checking I suppose
No I think everyone learns in their own way. Some learn like I do, some learn in other ways. So yeah

I-Of course. And as a learning tool, do you think it was effective or ineffective?

P -Yes I think it was effective.

I -Why?

P – Because it made you think

I-And you said that the simulation in many ways was not a realistic representation of clinical practice and that is what some of your colleagues were saying in class afterwards. What other ways was it realistic or unrealistic? You have mentioned the lack of interactivity making it unrealistic.

P-Erm, I think the way it did... I forgot about the patients moving!!!...I guess erm, it did have a few more complications... a certain amount of complications which I suppose was good It wasn't just you know, it wasn't just a simple exercise, it was more complicated I think erm it also... it did use...I think what I liked at the time, it confused me a bit, so it was erm, it did use a range of medication and at the time I think all the simulations we had done before, like in class had just been using very simple medication and it was a chance to have a bit of a go with other medications which weren't quite so... well just a couple of medications. So you have to be a bit more vigilant about that ... And erm...Erm..

I-O No, no carry on...

P-No it's just that I am struggling, not thst it wasn't good, I am, trying to think back to what I thought was good at the time.

I-No that's fine. And if you remember the drug chart, did you think it was a realistic representation albeit on the computer or not?

P-Erm... I can't remember the drug chart that clearly.

I-No, that is fine. Do you remember having... when you used the simulation, do you remember having problems actually using it, aside from erm, the representation of you doing the ward round? Did you have problems knowing where to click or how to do it?

P-Erm, I think at the beginning everyone was a little bit confused, but we weren't prep'd for it at all, it was just timetabled and we all turned up and then it just happened to be that of the unit. That was probably intentional! But, yes, there was a bit of confusion to start off with, but once we had done the first couple of people, we all just slipped into it a bit easier then. I think there were quite a lot of hands, people putting their hands up and asking what strengths certain drugs were. There were funny little details that hadn't been put in that may have made a difference about drugs – I can't really remember. But you know that was that.

I-That is absolutely fine. I think we have covered everything that I wanted to cover. But erm, is there anything else you wanted to say that we haven't clarified .

P-Erm, no I don't think so.

I-Ok.Thanks very much. Do you have any other comments to make?

P-No

...Summary of interview and conclusion...

Participant 3

...Introduction and explanation of how the interview will be conducted...

I- How were you taught medication administration?

P - Erm . In university we did in like skills lab, training how to give medication and somebody had to be the nurse and we just went through it like, same as you would did it like on placement, like the five rights and all that. Erm and then we had the computer one, where we had to like match the prescriptions to the person on the computer, which was quite good as well

I- And can you remember more about that?

P-I think we did it in first year so it was quite a long time ago.

I-Is that both the skills lab and the computer?

P -Yes, aye, they were both first year.

I- And how did it work in conjunction with you being taught in placement about medication administration?

P-Well, they tell you basically the same, as what we done, what they taught us at uni obviously with another nurse there,) just going through the five rights and doing the drug round at least once a day.

I-What was useful and what was unhelpful?

P - Erm, the computer thing was good because we checked like the names, but the people would move beds so then like when it came up that you've got five wrong, I thought oh I've got five wrong, and then I had to go back and see oh yeah which bits were wrong and it was because like people had been moving beds and so you were giving medications to somebody who had been sitting in the wrong place! If that makes sense.

I -Yes. It certainly does

P-But that was quite useful.

I-Ok and so, you say it was useful, in what way was that useful?

P-In just to make you think that it didn't occur to me before that you could have the right patient/drug and then have another patient sitting in somebody else's bed space, so just to make sure you check the name band every time. It was the same people that were coming up just sitting in different places erm so it did make you think and I had not thought of it before

I-Was that related to practice or not at all?

P-Erm, oh yes I relate it to practice, like you definitely make sure like, even if you were doing like the second drug round of the day, so you don't know... you go back just to double check the name bands just in case they were sitting somewhere differently.

I-Did that stay with you?

P-Erm yes, like so every time you in practice now

I-Can you go through completing the simulation?

P- Erm.. it was kind of like... I think it was.. I really can't remember, that I can't, it was so long ago. I think it was just like multiple choice arm, and the answers bit at the end and I did it again just to make sure

I-Ok and at the end of the simulation, you were talking about...were you informed about the errors of other people or just of yourself?

P-Just of ourselves but obviously we chatted to people sitting next to us but it wasn't like, we didn't hear what everybody got.

I- Ok and did you make any errors at all?

P-Yes about four or five I think.

I-Ok and how did that make you feel?

P-Horrid and well it made you think you definitely have to double and triple check everything had it been real, that would be good. You don't want to do that for real... real patient.

I-That's absolutely fine, that's fine. And did you notice any form of distraction in the simulation?

P-Erm, no I don't think so, I don't know.

I-No, that is fine. Ok and what... since you have completed the simulation, do you think it has altered the chances of you making an error in the future?

P-Erm, yes I think so.

I-In what way?

P-To check and to like double triple check again

I-Ok And do you think... what do you perceive is the likelihood of you committing a medication error in the future in comparison to other nurses?

P-Er, maybe less

I-Erhuh Ok And how do you completing the medication administration simulation in comparison to the other methods used in university to learn about safe drug administration?

P-Erm I think I obviously you have to do both of them because with computer you can't physically check the nameband and the drugs and stuff but the computer simulation is just that bit extra.

I-Ok fine.

P-You have to have both

I-In what way?

P-I don't know, just do...

I-Ok and is there anything you can remember that would have improved it or made it easier to use?

P-Err I don't think so, I remember it being quite easy, quite straight forward.

I-Ok and can you remember what the opinions of your other colleagues in the class was regarding completing the medication administration simulation?

P Yeah, people quite liked it and most people made the same error, well the people that sat near me made the same error as I did.

I-And can you remember what sort of errors you made?

P-It was the people were moving bed spaces and because you already had administered medications to that person, you didn't check their name again, I think that was the main one, yes. Yes, ahah, that was the main thing I think I got out of it

I-And trying to find how much impact it has on you guys, just to clarify the points that you have made,

P-Uhuh,

I-You did bring up that you completed the simulation without me prompting you, so I am assuming from that it was a lesson you remember quite clearly in comparison to some of the other lessons, although you didn't remember all the details particularly well.

P-I remember doing it, but not the exact details of doing it. I remember it was quite easy. Yeah and straightforward.

I-And so, you think it was reasonably memorable as a lesson although the details were unclear to you.

P-Yeah. Just not the exact bits

I-The other thing is the erm lessons that you have learned from completing the simulation, you seemed to have remembered, just not the exact specifics of the simulation itself, would that be a fair assessment?

P-Erh yes,

I-It would ok,

P-You said when I asked you about how it made you feel making errors, it made you think, any thing else?

I-Er yes, I mean if it was a real error I would feel guilty

P-Yes of course it is a different matter doing it on the computer than in reality and that I imagine that is the whole point of being a nurse, that you are doing something to an actual human being which is a different matter entirely.

I-Yes. The other thing is that you have said that it was relevant to your practice and you were able to learn lessons from it, and that your... it has highlighted that it is a bit more of a risky procedure to actually complete medication administrations, that you have to be a bit more aware and consistently check the patient's name band and their other details.

P-Yes, uhah, because I thought when I finished it was a bit odd. I thought I definitely got them all right and was a bit shocked when I realised that I didn't get them all right.

I-The whole point of changing people around was to evoke exactly that response and there was quite a lot of research put in to try and ensure that response had been achieved. So don't worry about that in the slightest, that is absolutely fine. And the other thing is you felt that the computer simulation was a good representation although you can't remember the particular details of it.

P-Ah yes, I think it was.(good representation). It was definitely a positive experience for me because it did bring practice into the classroom

I-Ok and it was reasonably easy to use, because of course for us, we need to make sure it doesn't require people to learn swathes of IT.

P-No, no it was really easy.

I-Ok that is absolutely fine.

P-Is there anything that you need to ask me. I have got all the information that I require. Anything else you want to clarify or ask about?

I-Ehh... no I don't think so. Sorry I can't think of anything more?

P-That is absolutely fine. No problem. And it is interesting to know that some people say they remember it quite well whilst others don't. It is useful to know and identify the whole variety of opinions from the students

I-Thank you. Do you have any other comments you would like to make?

P- No, that's it.

...Summary of interview and conclusion...

Participant 4

...Introduction and explanation of how interview will be conducted...

I-Can you take me through your experiences of being taught medication administration both at university and on placement.

P-Erm, I think yeah, at university, I think at around the first year, when it was obviously relatively new erm and on placement it very much focused on the method of doing calculation, but it very much focused on the multiplication, the long division, whatever it was you needed to do like what I would call standard traditional teaching of mathematics. In placement it was much more focused on exactly what you needed to do and why you needed to do it with reference to the drugs and I found there was a bit of a disconnection between what you were taught and what you actually needed to know. Moving onto the second year, I think second year it was primarily based on what we did need to know in terms of erm, you know, types of drugs and strengths of drugs and calculations that we used, IV infusions and things like that. Erm, that was better in placement with practise. And in third year, we are not really taught it at all so all of our knowledge is from what we get actually from on the wards. Erm yeah I think that is pretty much it. There was a bit of a disconnection in the first year. I did think what we were taught didn't actually have a bearing on what actually happened on placement.

I-And can you give an example of that?

P-Erm yeah let me think of an example? Erm we were ask to calculate strengths that in reality didn't actually exist. Erm and also combinations of calculations that we were being asked to do and you wouldn't actually be asked to do that even when you are qualified, you have to go specialist courses to do that and things like that. For in hospital, for instance, to do IV training, to administer IVs, you have to go on a course to do that and also do infusion calculations as part of that course, so those kind of things, which didn't really seem relevant where we were at that particular time.

I-Ok, and the actual methods that they used in university to actually teach you about drug administration, what sort of circumstances and situations did you encounter?

P-Erm, it was so limited actually, if I remember the first specific lesson, as such, which wasn't actually the first year, we, I think, we had one introductory session and the other sessions were optional, I think there were another two, I can't really remember to be absolutely honest. I just remember thinking at the time

erm, why haven't they made this every Wednesday at one o'clock or something like that, given the specific times of it, given that it is that important, why is it optional?

I-Ok, and whilst you were on placement, what sort of methods did your...did you encounter to teach you about correct drug administration there?

P-Actually that is a very good question, because in university we had to do everything mentally. But in the wards we found that wasn't actually necessarily the case. But when we were asked to do calculations as part of the assessment at university, we weren't allowed to use calculators, but in the wards they do yes so there again, there was a kind of discrepancy there between the way you were taught, which personally I think is better for you because then you have to do it mentally and so you always have that to fall back on. Erm but in the wards they use, most of the time, not all of the time, but most of the time a calculator so there is a difference there, and so in terms of the calculations that we were using we weren't actually learning in placement how to do those mental calculations because nine times out of ten, we did then with a calculator.

I-Can you remember completing a computer simulation on medication administration?

P-Yes I can.

I-Erm, and when I asked you what sort of methods university used to teach about medication administration, you didn't mention that specifically. Can you explain that to me?

P-Yes, the reason why I didn't mention it is because it was a one off. It was part of a pilot and it was a one off and wasn't embedded in our curriculum in any way shape or form, so that is why, to me that wasn't really the essence of what we were learning at that time.

I-Yep. Sorry, I am just taking some notes.

P-No, no that is fine.

I-Ok. And em, although I brought the subject up of the simulation myself, How easily and how clearly do you remember completing it?

P-Erm, I remember completing it, I remember doing it, erm I remember thinking actually this is quite relevant, because a lot of the sessions we had had up until that point had been optional or had been based upon the traditional method of multiplication, long division etc. I remember thinking actually this is a bit more relevant because it kind've fuses what we needed to know theoretically and what we are going to be doing practically. But like I say it was a one off so I can't remember in depth but I remember them saying it was a pilot study. Erm, and I remember some of the calculations that we were asked to do we would have done in practice.

I-Can you, from what you remember, you summarise that you don't remember fully, can you remember some of the actual screens of the simulation and try and describe how you went through the simulation?

P-Yeah you to give drugs to one of three patients whose pictures and details were there. You clicked and opened a drug chart and give them. I can't remember it in depth I think. Yeah, it was like on the ward and it was good because it was different from the rest, stood out, but can't remember exactly, if that makes sense! Just a different set up, yeah that was good and also I made some mistakes I remember that. Which were a bit embarrassing, that was a bit of a shock I thought I was fine. I thought I did the five rights but obviously didn't!!! That was helpful it reminded me why they are important Of course I know they are, but it just, what did I say it fused.

I-Did you take anything away from this?

P-Gosh, yes the patients can change position –I think that was the error I made, I think. Yes, realised I could make that mistake. So yeah it is still important to check that the patient has no allergies and it is the right patient and the right dose and that kind of thing, so yeah, I think I took that away from it. Question everything, I think that sums it up, question everything.

I-You said making an error was embarrassing and a shock, what aspect?

P-Just I could have hurt someone and what will happen when I am giving out medication by myself. I though oh Gosh, I have to be more careful, that was a shock, the damage I could do. Thankfully it was only a simulation. So actually I remember feeling relieved. Does that make sense??

I-How long did that last for?

P-What the feelings...? Oh not long, but I remembered it when I was on placement. And when I see mistakes happening. You are vulnerable and it is important to check

I-You have eluded to this before, but the theory behind administering medications safely, how important is that theory to you in your daily practice?

P-Incredibly important, really important, because you cannot as a nurse, bearing in mind the professional code of practice you operate under, you sign up for, you have to, that has to be a given, you have to make sure your practice is safe.

I-And did completing the simulation impact upon this at all; the importance of the theory to you?

P-Erm, yeah I think it did. I think it erm yes, it did, I think it did. I think er, yeah it really conserved it kinda like embedded it.

I-Erm, did completing the simulation alter your perceptions at all of the risks involved in administering medications?

P-It made me, it made, for me. It made me aware of how high the risks are whereas before I was just made aware that medication errors happen all the time and near misses and that kind of stuff, so to actually partake in it erm, it kinda gave me that extra dimension. People tell you what to think, but until you do it

yourself you don't fully understand it and I think that is something that the simulation did build upon. And it kinda like really brought it home how easy it would be to make those kind of errors.

I-And can you give any specific examples of using the simulation and what you have learnt whilst in clinical practice?

Erm, in respect of, like I say, making me more cautious, but that's not really tangible I suspect, but, I suppose it is laying the foundation for me to build upon in practice in terms of making sure that I was always safe in drug administration. So it kind've developed my knowledge and from that I learnt. You know, like anyone, but for me, the best way to do things, whatever it happens to be it just made me much more aware how to be safe and like not just going off because another nurse told you it was ok to give and making sure you check the prescription yourself, making sure the date, it is just really confirmed how important safety is. You have to do everything you possibly can to ensure your practice is safe. Though in that respect, like I said, it is not a tangible example, but it is something that I kinda like took away from that and you know still practice, is still with me today.

I-Ok, what do you perceive is the likelihood of you committing a medication error in the future.

P-Oh golly, I would hope it would be low, but to be honest, oh gosh, that is really hard to say actually, not being a qualified nurse, I would hope, I would really really hope it would be very very low, I can't say it would be zero though, I don't think that would be realistic, but I would hope it would be low low. But I think other elements come into play with that, because if you are only looking after four or five patients the chances are your errors are going to be lower than if you were looking after twelve to fifteen patients and so other factors do come into play in that. Erm, but I would hope gosh yeah, I would hope that I wouldn't make any. I can't say but every single nurse I have spoken to has admitted to making errors.

I-That's qualified nurses?

P-Pardon?

I-You mean qualified nurses

P-Yeah yeah. And thankfully not fatal errors, but, if qualified experienced nurses are making errors than I can't possibly say that I will not make an error.

I-This perception, has it been affected by completing the simulation?

P-Yes I think it has, yes, yeah it has. Like I say it has kind've reinforced the importance of checking and rechecking and doing all that is within your power to do. Some things are out of your control, erm, something's you cannot control for, but, the things that are within your control, you have to make sure you complete practice as safe as you can possibly do

I-So, from that you mean that you are less likely because of the reinforcement and the fact that you have mentioned about checking and rechecking and being quite meticulous.

P-Yes, I would hope an error, if it did happen it would be an extremely rare thing for me, but like I say, I can't put my hand on my heart and say I don't think I will ever make a drug error. Like I say every nurse that I have spoken to have made errors and that is from qualified you know may be two years to qualified twenty-two years. They have all admitted making errors and how easy it is to make errors when you are in those pressurised situations. And I think the situation that you are in plays a really big part in that, so like I say, if you are short staffed, you've got too many patients, or one patient that it is really unsafe for you to have, all those things come into play so I think a nurse can only be as good as she can be in any given situation. That is not to say that she is incompetent, but just to say, you know, that a lot of other factors do come into play and you know I think you can't do it in isolation.

I-Okay. And what about in comparison to other nurses with similar training and experience?

P- Erm, I can only compare it to ones, the students that I know. I can't really compare, I don't know how other programmes are taught. Erm so I would say, I would imagine that my opinion is similar to other nurses, with similar conversations that I have had with other students erm, about the simulation, I think yeah, we were all sort of singing from the same hymn sheet.

I-Okeydokey, and you mention at the beginning of the teaching session the other teaching sessions that you had, you weren't wholly complementary of some other teaching methods that you had regarding medication administration whilst in university. But how did all the different administration learning techniques such as lectures, plus the simulation, plus placement, how did they all work together for you.

P-Erm I think some they worked together okay, but for me, if anything could change, I would think it should be in the way of practical sessions in the university as a way of teaching, rather than just sitting in a lecture with a pen and a paper doing maths calculations, rather like a maths test. A lot of students couldn't see the relevance of that to practice. So I feel if anything, yeah if anything, although those three methods worked okay for me, but I think, to enhance the learning, it would be better if you could actually apply what you are learning to practice in a practical environment. We had the practical sessions on various other things. I think we were given one one hour lecture, one hour practical on drug administration which really isn't enough in the clinical skills environment. If you are going to be asking students to go into practice and give drugs every single day, sometimes four or five times a day, or even more to a variety of patients, then I think you really need to build up the knowledge and confidence throughout the three years and not just give them, yeah as I say, I think it was an hour and a half at least in a clinical skills environment in the whole of the year. And I don't think that is good enough really given the severity of what happens if it all goes wrong.

I-Just purely thinking about the simulation the way we did at the university, do you think using a simulation was a useful method of learning for you or not?

P-Yes I do, yes I do. I did think it was very good. I think it was just one session, and I think it would have been good if there were more than that and perhaps also tie that in with a reflection at the end. I reflected with my colleagues but there was no guided reflection at the end and I think that was something that perhaps the simulation could be done. Because it is designed to show people I think how easy it is to make

errors, but also to show you how errors occur. And I think perhaps a reflection, where you could sit down and kinda like, not a lecture, but in an environment with a few other colleagues and go through what you felt was difficult or challenging and then from their experiences as well that would help.

I-Uhuh, ok and although you couldn't remember the simulation particularly well, not necessarily from your learning experiences, but just purely from the practicality of it being a computer simulation representing something that you deal with in real life, in practice, how well do you think the simulation actually simulated medication administration?

P-Um, very well, yes, the way it was laid out was very similar to how it would be in a practice environment.. But that is the difference between that method and a traditional classroom based method...Is that the traditional classroom based method is quite far removed from the practice environment, the reality of the practice environment. Whereas I think the simulation was much more like that.

I-Ok, and with regards of just thinking about the simulation and improving it, for the future years, are there any alterations or improvements that you could recommend?

P-No, as I say just now, I think it would be good if it was done more than once, so that it was something that you did on a regular basis. I don't know how regular (difficult to make out) I don't know how regular that should be. Have a defects and reflection in a classroom environment shortly after you done it, so maybe I don't know an hours' simulation and the forty minute class reflection on elements that people found challenging or things that people found surprising or difficult or whatever that might be so that you can learn from other people as well. What I think would happen, which is what happened with myself and my colleagues is that you all make a similar mistake and learn from that because you are aware on how you make your mistakes, and you are likely to be more aware of that when you go into practice and kind of pay more attention to that. So I think providing some kind of reflection and having as discussion at the end would be good, but also yes, but more than once. I know it is only a pilot to test out, but if it were brought in as a method of teaching in university then I think that institutes drug administration as a really really really important part of nursing and it just needs to be given more recognition I think. So perhaps more scheduled sessions on a simulator would be good.

i-Ok, that is then end of all my questions, erm, is there anything else you would like to comment on or offer a suggestion at all?

P-No, that's absolutely fine, I just wanted to know when does this research finish?

I- am sorry?

P--When does this research all get put together and erm...?

I-I've got a number more students to interviewed and then it all needs to be transcribed and then we are going to be doing some content analysis to try and find out whether or not your experiences are similar to other people's experiences, what sort of contributions could be made regarding altering it or improving it and also the whole teaching session, whether or not we put it together and give it to students more

frequently etc. It is being done slowly at the moment, because transcribing whole numbers of interviews will take ages!

P-It will take forever!

I- Do you have any last comments to make?

P- No.

...Interview Summary and conclusion...

Participant 5

...Introduction and explanation of how interview will be conducted...

I -Right, can you take me through how you were taught medication administration in university and on placement?

P-Okay, erm I think we got skills lessons and we got taught the five rights and then how to use the BNF and that is all I can really remember from the university side. I think we had one or two maximum lessons on that. Erm and then in placement it varies from mentor to mentor erm some are like, really like to go on the drug round and will explain everything and watch you do it, yes, that is really good, erm, on other wards, you don't get a chance. You keep asking, oh please can I do the drugs, and they are like yeah... but they just get on and do it. A shame, but the good mentors do go through things and ask oh what does this drug do. Has that answered your question – I am not sure it has?

I-As I said before it is about your experiences so, although somebody else might have answered differently, it is about your viewpoint. So if it is right for you, then it is exactly what I need.

P-Okay

I-Erm, now with regards to when the mentor helps you and does the drug round with, you have said that is actually good. Explain why that is good?

P-Because I am seeing ... the hands on experience is good because you can always tell people ok check the dose, check the prescription drug chart etc, I didn't really know, especially in first year what the drug chart looked like or how when I was ready through where the signature was meant to be and then under the boxes themselves, they are all different and you are looking for expiry dates in different places and the doses and erm, yes actually doing it was much more helpful in the real world and actually being able to do it proficiently from then on. Because I can read it out of the book really easily, I can say yes you need to check the right patient and the right drug, and all these kind of things, but getting on and doing it, erm meant that it reiterated it to me and I actually learnt how to do it properly.

I-Ok and with regards to your experiences in university you have mentioned skill lessons, the 5 rights and the BNF etc and that you received a maximum of 1-2 lessons...

P-That I can remember yeah!

I-Can you go through those lessons as much as you can for me?

P-In the classroom, erm we were in small groups and they said... I think there was a presentation going through the five rights and why each were important and then the skill bit came... we were opening a bottle that had a tic tac in it and told that was a multivitamin in it erm and popping it into one of the little medicine pots and recording that we had done it by singing for it in the correct place, apart from that, I don't think there was anymore elaboration on it, or, yes.

I-Okay, and do you remember at all completing a simulation on medication administration.

P-Yes, yes.

I-Okay, erm, you didn't initially say that that was part of your tuition. Erm, why was that?

P-Erm, so we were told it was an option thing and we weren't being forced to do it. Ahah, it wasn't first of all put on our time table and then, I remember this quite clearly, the day before we were meant to do it, an email came round saying erm, it would be greatly appreciated if you could come and then give your feedback. And I remember the tone behind it definitely felt that if you weren't going to go, I don't know, something bad would happen...

I-Ehuh,

P-So I didn't know it was part of the curriculum from the start. Yes that was...it was quite a good exercise, (1)the fact that, what I remember from that is the patient, when we were giving the drugs, wasn't always the patient we thought it was, and I was like, oh okay, patients wander, that you had to actually think about the five rights as you were doing it. So yeah.

I-How clearly do you remember doing it?

P-Oh yeah, like very easily.

I-And why is that?

P-Erm, probably because of the negative that I just mentioned, but we were kind of told that we had to go along even if people had planned doing stuff on a day off. Sorry...

I-No, no, no, that is fine. Okedokey, and can you describe the simulation to me? What steps did you have to go through?

P-Okay, so erm I think there were multiple choice things that you had to click as to whether erm ...laughs... I can't quite remember but, we were given the scenario and then erm the drug to give to the person or if... bit like different people like may be three on a screen at a time, and you had to click the right one. Yeah, I don't remember much more than that.

I-Erhu, okay. Did you learn anything from completing the simulation or not?

P-Erm. Yes I think that my big take home point was the patient might not always be the patient you are expecting it to be.

I-And why was that?

P-Because yeah, erm, I think the ones that I got wrong were those ones that it was the patient one that ... those were the ones that stuck with me I thought I had better remember that one for the ward.

I-Okay, so, you say you made an error while doing the simulation?

P-I didn't hear that sorry.

I-Sorry. You say got some wrong so you made an error whilst doing the simulation?.

P-Yes.

I- And can you remember how many you made?

P-Two or three? I think after I made the first couple I learnt the next.

I- Ok and how did it make you feel when you realised you made an error and why?

P-Err it made me feel a bit stupid because I was like well...if it had happened in the ward, that would make me feel really sick, erm and yet I was glad that I had done it on the simulation and not in practice, yes.

I-And these feelings, you feeling a bit stupid did that remain for a while or did it just last for a short duration during the lesson?

P-Yes, just a very short duration, I don't think I told any other people. I knew other people were making mistakes, but erm as soon as the class was over, that was it. I have to admit I didn't carry on feeling a bit of an idiot.

I-And erm, you were talking about erm, what you learnt, or what stuck from the simulation. Is there anything different that you learnt from committing an error – How did this work?

P-Erm, I think, this is going to sound a bit funny. But erm I learnt how hard it would be to report the error even, like I said, I didn't even tell my friends that I got some wrong. In terms of drug administration itself, not too much.

I-So I take it from that you noticed that the patients did swap positions?

P-Yes, sorry, I just have to speak to someone quickly . (Briefly speaks to some one else). Sorry about that!

I-No, no, no, not at all

P-Ok

I-Erm did you learn anything from that at all apart from patient's are not always where you expect them to be?

P-Not really.

I-Ok that is fine. Erm, did you notice any form of distraction that was included in the simulation?

P-Erm, I didn't .

I-Ok and do you think completing the simulation was relevant or not to your clinical practice?

P-Erm, I do now, at the time I didn't.

I-And can you expand on why you didn't and why now?

P-There, I think it at the time I was thinking this is just a, I feel bad, just a waste of an hour or however long it took when I could be getting on with. Well we had just been taught all this stuff in clinical skills. Whereas I didn't see all the need in the first year to the revision. Where I think it might be seeing it differently now is purely because of this interview. Like I'm thinking what did I learn from it and that will stay with me. I think without this interview and I still have the problem with that in the first year, I would have, yeah, forgotten it and not reflected back on it. So, yeah.

I-Ok, erm, you mentioned about the, you were taught stuff in clinical skills, was that done shortly before you completed the simulation?

P-Erm I think it was, within two months.

I-And you also mentioned something about the period of time, the fact that sort of, it wasn't the right time to have done the simulation. Is that because you were in the first year or..?

P-I think it was because I hadn't yet been in practice to see how, yeah, things, for us are reality.

I-Ok, and can you give, you talk about the fact that you feel you have learnt something now because with this interview you are critically reflecting upon the experience of the simulation.

P-Yeah

I-That being said, do I take it from that you wouldn't be able to give me any examples of using the learning from the simulation whilst in clinical practice?

P-No!

I-So, why has the interview in itself with regards to the critical reflection, why has that been useful?

P-Because it made me think back to first year. I wouldn't have ever in my own time thought, oh yes what have I learnt in my first year? Erm and yeah, I would never have thought what have I learnt from it. And

erm, not attributed it to that. Now I always do check my patient's name band and that kinda thing before I give the drugs but I wouldn't have attributed it to the skills session itself, the simulation thing.

I-And erm, now that you are reflecting on it, would you say that part of your checking was attributed to it or not at all?

P-Erm I think it probably was yeah Yeah, yeah.

I-Okay, how important is it to you the theory behind safe medication administration, you have mentioned the five rights, so essentially the five rights?

P-I take them, yes, it's of paramount importance I think to know why you are doing stuff, because otherwise I think people would be tempted not to do them and just pop the pills, yeah, I think sorry, very important.

I-And completing the simulation affect this at all or not?

P-Erm, yeah, definitely?

I-Can you expand on that at all?

P-Laughter. Yes -because of the patient moving thing. I think other people, all my friends did report oh okay I was giving the wrong dose and all the packets looked the same, this kind of thing, So, knowing I need to check that the patient's right and the tablet is right erm arose from those mistakes made. Erm and if I hadn't made them and hadn't known why it was important, but you know the patient has to have the drug prescribed then I wouldn't know to change my practice.

I-Ok, erm, did completing the simulation impact on your perceptions of risks involved with administering medications or not.

P-Yes.

I-Can expand on that at all?

P-Just sort of the five rights thing.

I-And did this affect your practice at all?

P-Yes, I always do practice the five rights.

I-So with regards to that do you feel you are able to relate it to the simulation or not at all?

P-What was the question sorry?

I-Sorry, you mentioned about the five rights and how you always do initiate the five rights when you are administering medications...

P-Yep...

I-Are you able to relate that to completing the simulation or not at all?

P-Can I say half way in the middle?

I-You can say whatever suits you.

P-A little bit.

I-And erm, do you think you will use the learning from the simulation in your future practice?

P- Ah, yes the issues again, will influence my practice. Yes.

I-And what is your current use of checking procedures. You have already said that you always do use them.

P-Yeah.

I-Ok, and how, what do you perceive is the likelihood of you committing a medication error once you are qualified?

P-Erm, I think it might be quite high. I know that is understating myself, but I know that when things are really busy it is really easy to make mistakes. I hope that, because I am aware of that I would be rigorous in my checking. Erm but yeah I think it is probably be quite likely, but hopefully not too often. I don't know!!

I-Okay, alright, and this been affected by completing the simulation?

P-Erm, going back onto the reflection yes, but before I did it, I hadn't done even in practice giving drugs so I probably thought oh, it is easy, you check, you check and you pop the pill to the right people. Now, I know that it is not as easy as it has been.

I-Ok right, how have you, if at all, taken the experience of completing the simulation erm into clinical practice, in comparison to some of the other teaching methods in university?

P-Erm more so than the others, even though I said it was very little! I think the lectures and stuff like that I will know in my head but not take with me through to practice. Most

of what made me able to pass my competencies and become what I believe is a proficiently able novice nurse is that stuff I have learnt in practice, the more hands on stuff. So yes, more so than lectures and stuff like that.

I-Ok, we have nearly finished now. Erm, with regards to the actual simulation itself, how useful is a simulation for you as a method of learning?

P-Erm, I don't tend to, that is the only one I have ever experienced. Erm, I think it works well erm, but I think, other simulations, if it was erm, done differently, more the introduction to it explained a bit more thoroughly, it could be of much more use. If you think of the media it is quite cool and works quite well for the future.

I-What would be additional advice you would give with improving the simulation?

P-Yes, so the introduction to it, why are we doing it, not just part of someone's research. The research is being done because we want to improve your clinical skills and its part of class and whatever and people have learnt things... yeah.

I-So that information being provided after I suppose?

P-Yeah,

I-Ok, And, although you were able to remember some things accurately, from how the simulation was presented, without looking at the learning outcomes that the university were hoping you would gain from completing the simulation, just remembering from the simulation, how it was presented, erm, the fact that it was a computer representation of medication administration. How well do you think it did that? And also are there any alterations or improvements that you could suggest?

P -Erm, I think it did it really well. I wouldn't know how to improve it as a computer simulation in itself. 10

I-And in what was did you think it did it rather well?

P-Erm. Ahhh, all the points of the theory, ie, the right drug, right dose etc, were covered. And the there was more than one option, there were multiple options and scenarios changed as they kind of would on the ward. Yes.

P -They are all my questions that I wanted to go through. Is there anything else that you feel we haven't covered or that you would like to also offer?

I-No, that was good.

...Interview Summary and Conclusion...

Participant 6

...Introduction and explanation of how the interview will be conducted...

I-Great. So you have already mentioned about the medication 'quiz'. Can you tell me what you remember about it?

P-Erm basically, all I can remember it was about drug administration. That basically everybody was given, everybody was given, I think it was the whole year that did it, erm and people were separated into groups into what kind of testing we were going to be doing. About what form of simulation. I don't know what the other groups did, may be they did something on paper. My group was chosen to do something using the computers so that is all I can remember.

I-Okay and the actual computer simulation itself, the screens and that sort of thing, can you erm describe it to me?

P-Erm, it basically what it, what I can remember was that it had I think pictures of people on the screen, and then we had to, we were asked questions about erm their medication, what time they were due their medications and so basically we had to pick out the right patient's for the right drugs.

I-Ehum...

P-Yes, so it was pretty much along the terms of like the five rights so it was the five rights, or something like that.

I-Okay, as I said I am just writing down a few notes to discuss with afterwards, so if I am slightly quiet, it is because my erm, I can't write very quickly ok, so that is all I am doing at the moment. Erm can you remember if you learnt anything from the simulation?

P-What I think I learnt from it? Erm, it was a lot, in terms of drug calculations or if, because I can't remember the reason why we were doing it, But I think if we was sort of if that was the new was of possibly doing drug calculations then I think that would be an easier way to do it but then again there wasn't that much calculation in it. Basically, a lot of it just seemed to be about the five rights, knowing your patient, knowing what time we had to give the drug erm to the patient, erm a nd time, things like that. It was a good experience. It was a bit confusing but it was a good experience.

I- Okay, you have brought up two points there, one that it was a good experience, but also that it was confusing. Picking up on the confusing aspect, what was confusing about it?

P-Erm, I am not too sure, but I think, I don't know, I think we were under a time restraint so I think, I don't know, I think there was some sort of pressure towards it, or I think names got muddled up and I am sure the simulation didn't go how it was actually supposed to. Like may the name was wrong, it didn't match with the right patient or something like that. Cause I remember a few of us were talking about it afterwards and then, or may be like on the next question it would be the same picture of that person but they have got a totally different name so...

I-Okay, erm and so with regards to you saying it was a good experience, can you elaborate on that at all?

P-Erm, it wasn't stressful. It was er, it was something that you would do on a day to day basis as a nurse. Erm so in that respect it seemed like it was, it was like a day on the ward basically as opposed to going into a drug calculation test. It did seem more real with being under pressure.

I- Okay erm, from that when you say it seemed quite real, the simulation in itself, how well or badly did it realistically represent doing a ward drug round?

P-Yes because you had the face, you had the name, erm, like I said, erm and it basically you felt like you was, okay, you wasn't there in an actual hospital setting, but erm you could see that it was just an ordinary drug round.

I - Okay, alright, just picking up on something you mentioned before, you said that some of the names got muddled and some of the pictures moved around etc. Erm, from that can you remember if you made any errors in the simulation?

P-Yes I am sure I did!! I am sure I did. Not that I can remember from the top of my head! But to my knowledge, I think I would have. Erm yeah I would have. I think just because the muddle, that ..the kind of confusion that I said.

I-Okay, and knowing that you made an error and with regards to the muddling and the confusion, did that tell you anything?

P-Erm, I would say yes because obviously I would not act so hasty in doing it, but then I know when I am out in practice I don't act like very hasty. I, I always check and double check and I always check with my mentor anyway because of anything I am ever unsure about erm and you're not, like I said you're not, on the wards you are not under that pressure when you are a student. You are under pressure, but it is different when you are a qualified nurse because you have got other people and other things to do. But erm, I just think in a ward setting, that when you are doing drug administration you shouldn't be distracted so er, you can do the drugs properly. So, yeah I did learn something from it.

I-Okay, erm do you think error is a useful way of learning,?

P-Oh definitely, I think, we are human and we can all make mistakes erm so yes I suppose we can all learn something from mistakes. We can try and learn from it and get better.

I-When you realised you made errors, did it make you feel anything and if so, why?

P-Yes, because you could have potentially killed a patient! Erm in my drug calculation tests I have always got ten out of ten, in my summative. So that has made me feel that I haven't killed or potentially harmed anybody. Erm but in that simulation when I knew that I possibly made an error, that's a thought that went through my mind that I have potentially harmed someone. That I have given them something that potentially they shouldn't have been given, or I have given it at the wrong time, or it's just totally the wrong patient. So yeah, that's my feeling with drug administration, a bit guilty really.

I-Okay, if you can describe an emotion associated with that, would there be any emotion that you could describe it as?

P-Scared.

I-Scared. Okay, and erm, feeling that from the simulation, did you take that into your practice at all?

P-Erm, No, I didn't.

I-And the feeling of feeling scared and the fact that you mentioned there you potentially killed a patient. Erm did those sorts of feeling stay with you or was it quite transient – the feeling finished just as you finished the simulation?

P-Erm, no, it kind of prayed on my mind throughout the day. Erm, yeah, as I say it prayed on my mind throughout the day and after that I forgot about it.

I-Erm, did you notice the patients swapping position?

P-Yes.

I-Did that teach you anything or not?

P-Erm, I just thought it was...no it didn't teach me anything. I just assumed that maybe because it was a simulation maybe it wasn't planned properly and maybe it was like some sort of technical error.

I-If it wasn't a technical error, could you see any relevance to it in your clinical placements?

P-Definitely. It is about checking and rechecking and getting somebody to double check it.

I-Alrighty. Was completing the simulation at all relevant to your practice or not?

P- Erm, no because nothing beats the real thing when you are there in person. Erm, I don't think anything can really prepare you for the real thing, when you are actually doing it.

I-Ok, and as a supplemental educational experience in university to assist you in clinical placement can you see... do you think it is useful or not at all?

P-Erm, I think it can be useful. Erm cause it can be seen as, like a mini preparation of what you are going to be doing. But then possibly not to have it in the first year, because when you are in the first year, you don't, well in my experience, you don't really get exposed that much to doing erm useful drug administration. So possibly like in the second year or the third year. So possibly then it would be beneficial. I mean it is good to have that, like as a little taster, erm I don't see how it would be beneficial.

I- Ok, erm, you have already mentioned about the five rights of safe medication administration as that is part of the theory behind doing it safely. How important to you is that theory for your practice?

P-The five rights? Very, very. Because like I said it is if you don't have that in mind, if you are not thinking about that in drug administration then obviously there room for that potential error, so whenever I am thinking about drug administration that is the first thing that comes into my mind...I mean I have just finished an OSCE last week. And I was thinking to myself, I was doing bloods in one of my OSCEs and I was thinking, I kept on saying to myself blood is a drug, blood is a drug so you have to be careful of who you are giving it to. Erm making sure you have got the right patient, the right blood, just things like that. Because like I said, any kind of error can occur.

I-Okay and did completing the simulation either affect this, help this or contradict this at all?

P-Say that question again.

I-Did completing the simulation affect how important the theory behind safely administering drugs is to you or not?

P-Erm, no not really, because like I said that is always on my mind anyway so whether I did the simulation or not, it erm it wouldn't have made a difference to how I do drug administration. (-1,2,3,4)

I-Okay. Erm, did completing the simulation at all alter your perception of the risks associated with administering medications?

P -No, it just highlighted the fact that there is room for error and, yeah, so no.

I-And did completing the simulation at all impact on your practice or not

P-No.

I- No. Erm, you say how the simulation highlighted the fact that there was room for error erm and you did mention slightly earlier the importance of checking and rechecking. Erm, do you think you will use that sort of learning in future when you are in clinical placement?

P-Yeah, I think so because you are dealing with vulnerable people, sick patients so if you are unsure of anything, you shouldn't just go ahead and administer the drug anyway. You should check and recheck or and get somebody else to do it for you or if you are unsure you get clarification from somebody. You don't ...

I-Okay, did you notice any form of distraction whilst completing the simulation?

P-Yes other students!

I-Other students.

P-Yes other students, probably having the same issues as I had, like patients moving around.

I-But as you said before, you put that down to a technical difficulty and not as a planned incorporated part of the simulation.

P-I didn't know if it was something that was planned or a technical difficulty.

I-Okay, and was that, from what you remember, baring in mind it was a couple of years ago, erm can you recall if that was just your opinion or your colleagues as well?

P-Erm, I think it was a lot of my colleagues opinion as well, cause we didn't have much insight into it anyway what was going to be happening. We weren't told that patients would be moving around and things like that.

I-And can you remember whether or not it was explained to you afterwards?

P-No.

I-Okay, alright. What is your intended use of checking procedures with regards to administering medications in the future?

P-Say that again.

I-When you qualify, which will be very soon as a qualified nurse, the checking procedures, which you have already mentioned the five rights, how do you intend to use them when administering medications?

P-Erm, how I would normally would basically. Erm through myself and instruction erm gathering my patients drug charts and going through each drug, so I wouldn't like, so I would do one drug at a time erm and make sure i am giving it at the correct time, to the right patient and to use the additional information and go through the right route. Like I said, it is all about the five rights.

I-And erm, when you are a qualified nurse, what do you perceive is the likelihood of you committing a medication error at sometime in the future?

P-Oh my gosh, I would hope that I wouldn't. I really hope that I wouldn't, erm but like I said we are all human and so I mean I know I wouldn't intentionally do it but I am not going to say that I am going to be free from error, no I wouldn't.

I-Okeydokey. And the fact that you don't think you would be free from error but you wouldn't intentionally commit one erm, has that perception been affected at all by you completing the simulation or not?

P-Would it affect me completing the simulation?

I-By the fact that you have completed the simulation?

P-No I don't think so.

I-Okay, how likely or unlikely do you think you are to commit errors in comparison to other nurses of similar education as you and experience?

P-Erm, I'm quite vigilant and I take my job quite seriously. I think it is a very, I don't know, I think drug administration and the risk of potential error is very serious and so I find it quite unlikely, however, perhaps.

I-Okay and then talking about the potential for error, has that been highlighted at all by the simulation? Has completing the simulation aided you in that realisation?

P-No.

I-And completing the simulation, how did it work in conjunction with other medication administration learning, such as lectures and the OSCE?

P-How did it help?

I-How did it work for you in conjunction?

P-Erm, I don't know, I never really thought about it like that, I was, I just thought it was erm, I just thought it was a different way of learning. That is the way I looked at it. I looked at it as a different way of learning drug administration .

I-Ehuh, as a different way of learning, do you think it was a useful method?

P-Erm, yes because it was like a simulation of the real thing, like the real thing, being on the ward and doing it for real.

I-And from what you can recall of the simulation, do you think it was an accurate representation of doing it on the ward, bearing in mind it was actually designed as a low cost simulation?

P-Erm, I can't think... possibly...because with the confusion of the patients moving around, if that was intentional then I can see how that is relevant, because people do move around. You do on the odd occasion get patients who have got the same name in that respect, yes it can be seen as being close to the real thing.

I-You started off the interview with actually mentioning the simulation in itself, 6 Up until that point, how memorable was the simulation?

P-I had totally forgotten about it. I had totally forgotten about it. It wasn't that memorable

I-And when you remembered and realised what it was about was it easy to recall?

P-Not really.

I-Okay. One last thing which I need to speak about... you said that, with regards to the form of distraction we had incorporated into the simulation, erm, did you notice it at all?

P-What distraction?

I-That is fine. You mentioned about distraction...

P-Yes, from the students.

I-Are there any points or issues that you would like to bring up concerning what we have just discussed? They are all the points that I want to ask you about.

P-No.

I-Do you have any other questions that you would like to ask or anything that you want me to clarify?

P-Erm, no I think I do remember, they were given bed numbers as well.

I-Yes they were, that's right.

P-Yeah, I think that is why the confusion was, I was thinking, I thought they were in this bed but now they are in that bed.

I-Yes, it was purely to whether or not people were checking properly each time and if they weren't then they would make an error and realise how you have to keep checking and rechecking and really to underline the importance of the five rights essentially, erm and we are just trying to evaluate the effectiveness of using a simulation as a learning tool in the long-term for nursing students to see if it is worthwhile for further students to complete it in years to come.

P-Yes, because as a first year student we hadn't been out to practise yet and erm so as a first year student, I wasn't actually thinking about patients who can move around like that...

I-Ehuh... That didn't enter my thoughts, but obviously now being out in practice and seeing how easy it is for patients to move from one ward to another erm it is definitely resonant. It wasn't a technical hitch!

P-No, not at all, it was designed in. Now that we have discussed it how easy has it been for you to remember it? Erm, yeah, slowly but surely certain things are coming back and I can see the relevance of it, erm, from like I said I thought it was a technical hitch with people moving around but then if you think from learning as a nurse, it's not, patients do move around the ward, so yeah I still can look on it that way and see and know the relevance of it.

I-Okay, thank you very very much for participating and thank you very very much for taking the time to answer my questions. Best wishes for when you start your placement.

Summary and review

Participant 7

...Introduction and explanation of how interview will be conducted...

I- First of all, can take me through being taught medication administration both at university and on placement?

P-Erm, in uni it is really only in the first and second year that I can recall. In the first year it mostly involved teaching us how to read the drug chart and make sure you know where to look. It was obviously learning the medication, but we did have the pharmacology module which taught us some about it. Erm but obviously in practice goes beyond what we are taught in university. So you obviously get more practise, your mentors will be teaching you about every drug that you come across. Obviously you get some mentors in practice who say oh, just dispense them and want you to give the medication without necessarily understanding about them, erm and then it ends up being an individual student's nurse prerogative to turn around and say no, I actually want to know what it is I am giving. Er, but obviously that is circumstantial depending on who you get as your mentor, who you are working with that day or mentors even.

I-Okay then, and you mentioned that you had pharmacology in university and you other teaching, predominantly in the first and second year, learning the drug chart. Was there anything else at university that you can remember regarding being taught about drug administration?

P-I think looking at the drug chart, I think the first year was more about looking at the drug chart, looking at how to read it and the second year was looking more about how to make sure you pick up any mistakes, where there aren't signatures or where written down two types of medication in different places and other forms of error. It came into a lot of the modules so when obviously you are talking about looking after a patient you automatically consider drug administration and what kind of medications they are going to need. And sometimes you get more specific classes on specific routes, oral or IV medication, drug administration. So I had classes like an OSCE about to give IV medication and obviously just fluids and things.

I- And when you are talking about the aspects of erm, predominantly in your second year I think you said, looking at the whole drug chart looking at mistakes, making sure you read the entire drug chart, making sure you are not leaving out something or repeating something, can you explain that for me?

P-Yeah, erm basically in the first year obviously the standards they expect you to work to are different, so in the second year they expect you to work at a more competent level, erm and they expect you to pick up on any mistakes, erm, so you take more responsibility and accountability for yourself and the medications you are giving with your mentor. Er, so we are looking at whether you feel the medications are appropriate to the patient, making sure the allergies are noted if any, erm if you spot any common errors, for example if Paracetamol is written on its own and then combined medication, Erm, you have to pick up on the errors and make sure you take the appropriate action. You are taught what sort of action to be taken and that means not giving the medication and asking for a medical review or having to refer back to your actual mentor and asking.

I-Ok. Can you remember completing a simulation on medication administration?

P-Er, yeah, I think that was in the first year wasn't it on the computer? Erm, where you kind of, you could click on the patient, you read their name and then you found their right drug chart and then you had to click on kind've the medication dispensing part of the computer, click which tablets they needed at the time and you were told who you were dispensing them for and you had to make sure you were giving them to the right patient at the end.

I-And do you remember completing it?

P-Erm, I still remember it actually

I-Sorry, you blotted out just slightly there, could you repeat that please?

P-I still remember doing it, quite clearly actually. Erm I can still picture this computer screen and where you had to click and what sort of things went on

I-Ok then, when you say you still remember it, erm can you tell me why you think you still remember it, particularly in comparison to some of the other lectures that you have had that you may not remember?

P-Erm I think probably it was because it was more active, and I think probably although its still a simulation and its not in the ward environment, in comparison to lectures where you are sat and are told stuff, this one really felt more interactive because you could see where the errors might occur because in class you sometimes go through the drug chart but it is different when you have like a simulated patient and you realise actually no, there is room for error there as well. It needs to be an overall simulation of the entire scenario as opposed to just focusing on the one situation that you might do in a university class, erm and then obviously for placement, you can't remember everywhere you have ever worked, but for me I find that is the best place for learning, the more hands on experience or it is more realistic, and you do find sometimes you get more one to one education from your mentors than you would if you didn't get from your supervisors in class.

I-Okay, you briefly described parts of the simulation to me, you had to click on aspects of it to put into the.. to provide them to the patient. Can you describe anything else about the simulation? i.e.the different screen shots etc.

P- Erm I remember you had a few patients up there in pictures. You would click on a patient, see their name and you could click on their drug charts to see and read first to see what was due when what you knew what was due, you could then click on a kind've like a shortened BNF list of drugs er then you could click on the one you wanted, select how many tablets you wanted and then you pressed the dispense button and then they went into like a little drawing of a pot and when you felt you had all the medications that you had you would go back to the patient and sometimes the patient would have changed, they would have moved beds so you had to check that you selected the right one. Erm, I remember one of the first ones I made an error because I didn't realise the picture was different and so obviously I, er gave them to the wrong patient. that hasn't happened in practice! Erm, then yeah, then once you have found the right patient you can click it so it is different and then you can move on to the next scenario.

I-OK, and did you learn anything from this or not?

P-Yeah as I was just saying, I can't recall whether or not erm the simulation occurred before our experience in practice, erm, but I remember that kind've taught me or reiterated to me the importance of, sort of thinking through the process of drug administration in a logical ordergoing to the patient, getting the drug chart, checking the drug chart, dispensing the drugs, rechecking your patient, so I think the only issues I ever had when I did that I think was when I got to that part of the process was rechecking the patient. Erm obviously it is slightly different in practice because you come to recognise your patient and know them better, erm but I found it really important to remember the whole process and it made it a firm memory in my head of how to go through drug administration.

I-You have already mentioned that you made an error and you think it was giving medication to the wrong patient. Did you learn anything from that or not?

P-Yeah I think it scared me I know obviously it is only a simulation and at the time I kinda thought well learn from this, remember you have done this in the simulation, you don't want to do this anywhere else. Erm I

think it reminded me of just how important it is to always check the patient's identity erm being sure, even if you think you know the patient I check anyway , I don't know, not that I am paranoid, just...but I always check the wristband, even if I know the patient and have worked with them for days. I just confirm that the drug chart I have correlates with the drug chart I have

I-So, I am just making a few little notes hear, erm, ok. You said that it made you scared. Why did it make you scared?

P-I think, I was aware that it was a simulation and in my head I was thinking it was not quite realistic, er it kind of reminded me that no, I do need to take it seriously no matter what happens, Like I don't want to be complacent in what I am doing and obviously drug administration, you know, is an area of nursing where it can go wrong very easily, where just what can seem as a minor error can become complicated, , have major consequences, erm so I think maybe it was good and on the ward I never wanted to do that because obviously being a nurse is not a heartless occupation.

I-Yes, you said you felt scared, did you feel any other type of emotion at all?

P-Could you repeat that?

I-Sorry. You said that you felt scared. Did you have any other feelings towards making an error or was it just the scared feeling that you felt?

P- I think I felt very disappointed in myself because I knew I knew how to do this, but I still managed to do it wrong, so I think, I kind of berated myself and thought why why did I make a mistake. You know how to do this, you just need to focus more.

I-And that feeling, how long did it last with you?

P-For that individual circumstance it was just for the scenario or the simulation, but it still every day in practice I am constantly aware of the fact that I have to pay attention, make sure I always focus and do my best and always ensure that I have not been interrupted if I am doing my drug administration, I try to make sure I have done it to the best of my abilities, that I have done it safely.

I-Ok then, did you notice any form of distraction incorporated into the simulation?

P-I think the only distraction I had was there was obviously people walking around behind us so, kind've just watching what we were doing and if anyone was needing a bit of help with the simulation and people giving instructions saying you may have to click on here or there, so it was attention given to other people and not my own work.

I-Okay, so you are talking more about the lecturers themselves and the environment and not necessarily intrinsic to the simulation?

P-No, I never noticed anything in that.

I-Okay, did you find completing the simulation to be relevant to your clinical practice or not?

P -Yes, especially in the first year, for me I never expected it to be too complicated and I think obviously the simulation was in the third year, you would want a bit more to be incorporated into it, i.e. making sure there are spaces in the drug chart and to be expected to pick up on mistakes, and make it link to the competencies the nurses are expected to achieve throughout the year so obviously you progress a bit more from yourself.

I-Ok and can you give examples of remembering the simulation whilst in clinical practice and it being relevant to you at that point?

P- I think it was mostly obviously the attitude I remember and related to the simulation erm and it was more okay when your mentor is saying they'll do the drug round, you get a flash back to classes and the simulation and say ok, what process do I go through, what factors do I need to be sure of? And I always talk my way through things in practice so I say to my mentor I am now going to do this, and I am doing it because, or I am going to do this, when I am thinking of what I am doing it did relate back to the simulation, and obviously as I become more of a skill (skilled) that I am now, more skilled up, it is something that I do more often, I relate that to more to the entire practice than I do to the simulation now.

I- Okay, erm did completing the simulation alter your perceptions of the risks associated with administering medications?

P- I think I don't think it altered my perceptions, I think I knew the risks, erm I think I just became more aware of them, ones that I am more prone to myself. Erm, it helped me to realise what areas I needed to remember erm where I might have been complacent you know oh I am never going to be daft enough to get the wrong patient and things like that so erm I think things like drug amounts, I never, never felt concerned about because I already know how thoroughly I check it, whereas obviously the simulation brought to my attention that the patient identity was something that could be an issue even if it was only a simulation.

I- Okay, erm, when you are in clinical practice, clearly I accept that you are still a student, but with regards to your current use of checking procedures and how you intend to use checking procedures once you are an autonomous qualified nurse, can you describe what routine or method you are going to use to administer medications?

P-As a qualified nurse, to be honest, at this stage of my training, it is going to be very similar, because my mentors at this stage they allow me to undertake the drug taking while they are minimally supervising, so I do it as much as possible on my own, but if I have any queries I obviously have a mentor to refer to. Erm, I think obviously, when I am working as a qualified nurse, obviously won't have a mentor with me at all times, but I am part of a team that I can ask if I have any questions. So I think the process that I go through of making sure I have allocated time to drug administrations, the sequence that I go through of one patient with medications for this time, making sure that I have gone through the entire process of checking dosages, making sure I know what the side effects are erm and speaking to the patient knowing they are

comfortable taking the medication. The routine questions that you go through and then go on to the next patient and so on. I do that currently in practice but like I say the main difference really for me is knowing that I will be doing that independently without the mentor behind me like constantly, so I will always have that slot of knowledge from staff nurses if necessary.

I-You have mentioned the checking, how important is that to you when you're administering medications?

P-It is the most important thing for me, I always have the rights in my head erm, and I obviously think about consent issues and making sure the patients have thought about what they are taking, and thinking a lot of my patients don't know what they are offered in hospital and just take what is offered, erm, and whilst of course I am diligent with any drugs I give them, I want to make sure they are taking responsibility for anything they take as well. So I make sure that I know they are aware of why they are taking the medications they are and if they are aware of any new medication that they have been given. To make sure they are aware of what they have been given and what the effects are, what to look out for, any kind of issues that they are aware of. Er, it just comes as part of my routine. Especially like morning medications as well, it becomes part of the primary way in which you communicate with your patient on a one to one kind of basis so you can incorporate it into other areas of nursing care. Its about communication and I make sure it is something I always attempt to get to talk to them about everything, about medications.

I-Okay, so you say how the theory is vital and the most important aspect of you administering medications safely. Did completing the simulation affect this at all?

P- I think it came alive, especially when considering the errors that I made.. They were ones where I kind've obviously hadn't realised how erm important some of the theory is, obviously about identification and things. We had always been told, but obviously the simulation brought it to my attention just that much more. It reinforced it in my mind and I thought okay look, you've had your chance, don't do it again.

I-Okay, erm what do you perceive is the likelihood of you committing a medication administration error in the future once you are qualified?

P-I don't know of the likelihood. Er, but personally I feel I gave so many and go through the processes to avoid it, but hopefully it is a slim chance, but I do obviously know how I would react, how if I were accidentally to commit a drug error erm, and so although I will attempt to avoid it at all costs, I know how to respond if it were to occur and to make sure it didn't affect the health of my patients.

I- And, the perception you have of the likelihood of you committing a drug administration error at some point in the future, has that perception been affected by you completing the simulation at all?

P-I think now having completing it and knowing that I was perceptible to errors erm, it kind of made me more aware of the fact that I am perceptible and hopefully by being so I am now more stringent in how I check for drug errors because now hopefully I am less likely to commit drug errors. I don't know how much it affected me.

I-Okay, what do you think is the likelihood of you committing a medication error in the future in comparison to other nurses who may have not have used the simulation?

P-I don't know if I can answer that very well because I don't know what experience other nurses have had, I can't say how they learned best. For me, the simulation was the best way I know learnt, as opposed to just using theory, so I don't know.

I-How did having the experience of the simulation work in conjunction with the other methods of learning about safe medication administration?

P-Erm I think it obviously holds a different amount to each different student depending on the learning style they have. As I said for me it had a lot for me, I prefer that sort of lecture where it was very interactive, whereas the others it might be less so, where they would rather be in a lecture or rather be in practice. Er, but I think providing it is a lesson, and like making sure you provide some form of educational experience that would be useful for all students.

I- And with regards to the actual simulation itself, from your experiences, how well or badly do you think it simulated medication administration on the ward?

Erm I think it did quite well, obviously it provided the five rights er and obviously we didn't have what is accessible for practice so for like OSCEs when we had OSCE sessions for medication administration it would be nice to feel that you had a chance to practise, Erm, but again obviously, as you said it was a low budget simulation, but if it were to be put into practice, I think it would have to be developed in order to meet the learning needs of each year in nursing training. So if you were try and phase the simulation for the three different years, if there was one that was more advanced for the third year, like I said having the errors on the drug chart for example. I think using a simulation is good, it worked well

So they are a few improvements, which certainly I would accept that idea could be an improvement. Is there anything that you could offer to improve the simulation so it would work slightly better.

P-Erm, I don't know, I think it depends on how complex you want it to be. Perhaps if you wanted a simulation where you could read the side effects of the medications you are giving as well, you could combine it into more of the learning theory as well as the practice side. Again that is what your aim is, otherwise, not really no.

I-Okay thank you, I don't have any other questions or areas I want to discuss. Do you have any further comments?

P- No

...Summary of interview and conclusion...

Participant 8

...Introduction and explanation of how interview will be conducted...

I-What the plan of the interview is, I will ask you a number of questions about your drug administration education and once we have done that bit, I will taper record and take notes whilst we do the interview and I will go over the notes that I have made just to clarify that I have understood what you have said properly, ok just to clarify that I am not either leading you or erm having analysed it in a rather inappropriate way. If that is ok with you?

P-No problem.

I- Fine. Take me through first take me through being taught medication administration in both university and on placement?

P-Erm, in school we had skills sessions in the clinical skills centre and we were taught our five rights and we taught how to go through that and how read the drug chart and things like that so that was probably a couple of hours session. And on placement, I have always been allowed with my mentor or a nurse erm to just give a drug round to a few patients under supervision while they let me do it and if they saw me making any mistakes they would say why are you doing that or what is that medication for and obviously was taught you shouldn't really give anything unless you know what it does or what it is for and therefore you won't be able to say how it interacts with other drugs. And obviously in the first year we had the session on the computer

I-When you went through on placement administering the medications can you give me any examples of when the nurse maybe asked you questions about specific patient medications or when they asked you why you were doing something and your response.

P-Erm so they would tell you questions on giving atenolol and they would say what is that medication for and I would say it is for blood pressure and they would say ok or say no that was wrong and give me a BNF. Or if it was a medication that neither of us knew, I would say I have no idea what that medication is and they would say Okay, we will look it up in the BNF together. We would look it up and check the drug dose and things like that.

I-Ok and so part of that was realising that you didn't necessarily need to know all the drugs but to actually know how to give them safely and know how to get the information.

P--Yes.

I-Ok, you mentioned the computer session. Can you take me through what happened with the medication administration simulation, what happened with that?

P-It was a long time ago, but as far as I can remember, we went to a PAWS room as a big group and it was almost like it went through a teaching session on the computer and then it was like kind a like a test, a calculation test but with drugs. So that is all I remember of it. I remember it being quite realistic, but I don't remember the specific details about it.

I-Ok, so you clearly remember doing it but not the specifics of it.

P-No.

I-Can you, do you know why you remember doing it?

P-I don't know, I just remember us all being in B5 the big lecture theatre and told we were going to be split up and then we were split up into groups and so a load of us went into the PAWS room and I think some people stayed in the lecture theatre and other people went somewhere else, so that is what I remember of it.

I-Ok, and erm, actually completing the simulation and describing it to me, you say you don't remember very much about it. Is there anything you can remember about it?

P-I can't remember... I remember the patient required a certain mg of drug and whether it was available in the drugs box I think and then go on what would you have to do, what would you give, whether... if the patient was prescribed 1000mg of Paracetamol and your doctor prescribed 500mg tablets how many tablets would you give and then there were other things like, if the patient was prescribed 60mg of whatever I would have 10mg tablets of this drug available, how much tablets would you give. So although normally you might have the full dosage of the drug such as a 60mg tablet of whatever, you only have available dadah, you have to adapt with what is available with. I think that is all I remember.

I-Ok.

P-I do think that you are not always going to have available what you need to, unless that was a false memory?

I- No it wasn't a false memory. It was devised it so that something like warfarin, when you might have to give 5mg and you only have 1mg tablets giving 5 tablets might seem a lot, but you are still giving the correct dose as sometimes as a nurse we all have to adapt and as long as it is correct, which it would be, you can still give it, even though it may seem a bit funny!

P-Exactly.

I-Yes, can you remember what the explanation was at the end of the lesson was regarding completing the simulation?

P-No, (SOMETHING – inaudible)

I-Do you remember making any errors in the simulation?

P-I think I did make some errors in the simulation. I can't remember what it was. I remember being a bit peeved that I made an error and I then when I looked back on it, it was like the whole point of for them to say that drug errors may, despite the effort that I made, it really made you aware of how important it is not to make errors and be meticulous and systematic in your approach to administering drugs

I-And can you remember whether or not you discussed it with your colleagues afterwards of you experiences of making an error and how it made you feel?

P-Yes, yes I think we all did. I think the people who didn't make a mistake gloated and the people who did make a mistake were quite embarrassed and felt quite guilty because you never think that you would do that. I am thinking no I am always meticulous and would never make a mistake like that but then obviously in the simulation, it proven that it is quite easy to make a mistake.

I-Okay erm and so were you able to take anything away from that to learn and take it into your practice?

P-What from the simulation?

I-Yes.

P-Just to be systematic, meticulous with your approach to how you go about administering drugs because it is very easy to make a mistake

I-Okay when you completed the simulation, did you notice any distraction within it?

P-Within the simulation?

I-To encourage you to make an error.

P-No. Not that I remember.

I-Did you find completing the simulation to be relevant to your practice or not?

P-Yes I think I did.

I-Can you expand on that at all?

P-I think because when you are in practice on placement when you do drugs administration clearly can only be done one way. i.e. you administering drugs to the actual patient and you have to get the drug chart go through it, collect the medications, do all your checks, When doing the simulation, it provided a different way of doing that so I think different approaches for doing the same thing is beneficial because it doesn't make you get stuck in a rut. You are looking at things in a different way so I guess for people with different learning styles or whatever I think people might benefit from learning in class, and some might learn more from the computer, or some from being lectured to.. You are looking at things in a different way so I guess

for people with different learning styles or whatever I think people might benefit from learning in class, and some might learn more from the computer, or some from being lectured to.

I-Erm, you have already mentioned the five rights of safe administration. How important is that theory to you?

P-It is really really important. It is the easiest way not to make a mistake if you use it correctly. I think it is vital and so simple as well.

I-Did completing the simulation assist you with understanding this or not?

P-Say that again.

I-Did completing the simulation affect how important this theory is to you?

P-No they are important.

I-And the way you have described it, it is vital, it is simple, important. Is that because intrinsically the five rights are important

P-Yes I think irrespective of how it is taught to you it is a basic principle. How a basic principle is taught to you it doesn't matter, just as long as you use that, and you are able to understand that and understand their importance.

I-And so I am assuming from what you have said then, the importance of the five rights were pretty clear to you anyhow.

P-Yes.

I- And using the simulation, did it impact on your clinical practice at all?

P-I don't think so.

I-You spoke briefly about the sort of things you learnt from it, i.e. the fact that you did make a mistake, you implied you need to be more systematic and meticulous. Were you able to take anything else away from completing the simulation?

P- Erm, not that I can think of.

I- You talk about using the five rights and how you have to be systematic and meticulous with it. Erm, do you feel the checking procedures that you use, has that become more meticulous and systematic or was it always like that, and you just accidentally made a mistake completing the simulation?

P-Erm, no I think I have kind of gone on now that we are in our third year I think you have to become more and more systematic. I think it can be easy to become complacent but I

think that I have realised more and more at the closer you become to being a qualified nurse and therefore your responsibilities change significantly. I think you have to become more and more systematic because you are not just bound by you know the fact that you have to do the task. You have to do the task within a certain amount of time which means that by doing things in a systematic way means that you are able to do them right and you have to do them within a certain time period as well.

I-Because of course on the ward you have time pressures... The fact that you actually made an error, did that at all affect how you perceive the level of risk when administering medications?

P-Erm I don't remember any specific times where I thought erm I could be at a really high risk of making a mistake, but I think generally it highlights the fact that you are taking a risk everytime you are administering drugs because you can make a mistake.

I-Ok, and what do you perceive is the likelihood of you committing a drug administration error?

P-The likelihood? Oh gosh, I would like to say zero percent but then I remember the information we were given about how often mistakes are made erm, I wouldn't like to think of myself as a nurse who makes mistakes but I know that it is really easy to make a mistake and I have spotted other people who have made a mistake, in the ward setting and I know that

I-Knowing that it can be done and knowing that despite the fact that all nurses know about the five rights and knowing that mistakes are reasonably prevalent, do you think that the knowledge of you knowing that it is easy to make a mistake is helpful to you in preventing making mistakes?

P-I think so, I think it helps me, I don't know about other people on the wards working, but for me I think it helps me, definitely so. Knowing how easy it is to make a mistake, I think, , it means then you don't then become complacent ignoring things like for instance, if you go to the drugs cupboard three times a day and make sure that the drugs that you pick up are in date, because you used the same drug that morning and not assuming that is the same box you pick up in the evening. I have put myself in that position before where I know that that drug is within date and I have gone and I have checked and it is out of date and I am thinking it wasn't out of date in the morning when I checked it so it must be a different packet. It means that lots of people have made errors and it is not just me, it is not just my error that I need to keep an eye on, but not assuming that pharmacy will keep an eye on it and check all the boxes before they send them up to the ward, so issues like that you need to think about. You can't relax so you have to do the five rights test

I-And has completing the simulation helped in this awareness of how easy it is to make a mistake?

P-Yes definitely.

I-How has that done that?

P-I think on the computer system when I was doing it we went through the simulation and you religiously go through the five rights anyway, I know we were in our first year but you know, you would still go through them, and then of it says you got nine out of ten right or whatever and you think I've got one wrong, how did that happen? You know, you feel immediately guilty thinking how did it happen, what did I do wrong? And you think oh no, that could have been a patient, but luckily it was a computer system and not a patient and you've not given medication, but regardless, whether it was you were supposed to give them two

tablets of paracetamol and you only gave them one, it could easily be two tablets instead of one, and four tablets instead of two, so if a mistake was made and I think the simulation definitely reinforced that.

I-Erm, you talked about feeling guilty and embarrassed and having this sort of (CHECK) the shock of realising a mistake had been made.

P-Yeah,

I-Erm, did those feelings last long with you or were they just transient, quick which you then forgot about.

P-I think they were quite transient.

I-You talk about how you perceive the likelihood of committing a medication administration error in the future, Erm, how in comparison to other nurses, how likely is it for you to commit an error in the future?

P-I would like to say less likely.

I-You say you would like to think, you are not fully committing.

P-Only because I don't want to say that I will never make a mistake, because that is setting you up there. It is kind of admitting that...I don't know, it is kind of a bit arrogant to think that, but maybe it is because I lack confidence in myself. Like you say, after all the training that we have had and the experiences of what I have had make me stay on track to be as good as I can be, so that I will be less likely to make a mistake, so then, if I did make a mistake I would know that is a possibility, but I would try not to do. I would never not use the five rights.

I-Ok, the erm, how did using the simulation as a teaching method, how did that work in conjunction with the other teaching methods used, such as your lectures and your OSCE.

P-How did it work in conjunction? Erm I don't think it was better or worse, I just thought it was something different and something good. It was in pharmacology lectures are one thing, but knowing the background of drugs, how they work and then how to administer them, I think we did them in a pharmacology lecture and then a skills lesson for our OSCE, the process, so, having the drug chart there, having the BNF there, there was a patient with the drugs to do, the simulation was just an addition it was equally good as some of the others and it was definitely valuable, I think it was an essential part of the course

I-And how memorable was it completing the simulation in comparison to some of your other lectures that you have had in your whole course, more memorable or not at all?

P-It was very memorable, simply because we did the one session., I do have specific memories of other lectures, say for example pharmacology lectures and skills sessions.

I-And how many pharmacology lectures did you have, more than one?

P-Oh loads, about five lectures.

I-Ok, and from the perspective of, for example, the pharmacology lectures, is there one that you can remember more easily than some of the others?

P-I can remember specific pharmacology lectures because we were in the same lecture theatre each week and it was presented to us by the same lecturer as opposed to ... and so therefore when I look back I can remember specific details, but they all kind've merge into one module. Whereas if we had done a module on a computer based course, and we went into a PAWS room and we had a teacher helping us and it was always in the same PAWS room, and then I think that would have more of a memory, the experience would have built up over a period of weeks.

I-And when you talk about the memory, do you mean specifically how the memory worked or just the fact that you completed the simulation.

P-I think how the simulation worked. I remember being there in the room and I remember doing on a computer like on a course, but I don't remember any of the specifics, like I don't remember what the screen looks like or what the questions were.

I-Okay so the thing you found most memorable was doing it, just not the specifics?

P -Yes.

I-Whereas with the pharmacology lectures you remember the specifics because it was more of a long-term course.

P-Yes.

I-But as an individual lecture or segment of education that you experienced, the fact that you did the simulation was that the reason that you remember although you don't remember the specifics?

P-It was very easy to remember. I think that when we were asked to do this interview, and was invited to come, people were like what was that??? And I said it was when we were in our first year and we all got asked to go somewhere else and we were asked to do something on the computer and other people couldn't remember whereas I specifically remembered.

I-And were these people that you think did complete the simulation, because not all did complete it?

P-I don't know if they all completed the simulation. But I remember being in the lecture theatre and being told that you were going to be split up. May be I think it was the fact that I did the simulation, I did something different and that made it more memorable

I-The last question is, but you described it already anyway, what I wanted to ask you is about the specifics of the simulation, did you think it was a good or poor representation of completing drug administration.

P-Erm, from what I remember, I remember it being fairly good, but then I remember specific things like the drugs I had to choose from and then remember thinking you can't actually get a drug in that dosage or you

can't get it in a tablet or I don't know, fine details like that. The person who developed the programme would have thought this is a good way to test how well the person would act in this situation when you don't have all the normal drugs.

And is there anything else you wanted to comment upon?

No, I think, no, but I do think having the simulation was valuable and added to the course just because it was something different.

...Summary of interview and conclusion...

Participant 9

Introduction and chat

I-I will ask you a number of questions and once we have gone through everything that I think is necessary for the study, I am going to be taking notes throughout and I am also going to be recording this, but at the very end I am just going to go through the notes of your answers to clarify them with you, just to check that I have the right gist of what you are telling me. Is that okay?

P-Yes that is fine.

I-Fantastic. Now the whole of the interview is really concentrating upon your education of drug administration, safe drug administration. Okay?

P-Okay.

I-That is the whole arena. If there is any reason you want to stop, erm don't want to continue, don't want to answer a question, anything like that at all, please, I want you to be comfortable throughout, just say you don't want to answer or want to stop. There is no reason for that, but just in case. It is entirely at your discretion. Okay?

P-Okay that is great.

I-Fine, can you take me through being taught medication administration in university and in placement?

I-In university, we obviously had practical sessions where we literally went through scenarios having a chart and like a bottle of medication and an imaginary patient going through the five rights approach dealing with medication administration. Erm, we also had lectures sort of more approaching it from how important it is, what can go wrong, and sort the legal aspects to do with medication administration, our responsibilities as nurses. I

remember particularly in the first year getting shown videos of administration errors, and thinking that is me!! Erm, other than that, obviously pharmacologically, in that module, I guess we were included, we learnt a little bit more about our role administering them. Erm, I can't remember or think of much else apart from that one. One session we had on the computer.

On placement, it would really depend on your mentor, the person who you happened to be doing the drug round with. Some of them really give you the time and go through it slowly and go step by step, and are clear about things you have to think about and take account of. Sometimes you can be with someone who just wants to get the drugs out and given and you feel a bit rushed or feel like you are getting in the way or slowing up the whole process. It really depends on the person that you are with in practice. Erm I can't think of anything else. Is that okay?

I-No, that is fine and it is about your experiences so if you think it is relevant, then it is going to be relevant. Okay, if that makes sense?

P-Yes, that makes sense.

I-Fab. You said therefore, you mentioned about your lectures, the practical scenarios, the pharmacology lectures that you had, the fact that you did something on a computer and also in placement, sometimes your mentors were very helpful and went through things with you, quite specifically step by step and others you rushed through it, felt like getting in the way.

P-Yes.

I-Erm was that often dictated by the mentor themselves or the circumstances in which you found yourselves, or a bit of both?

P-A bit of both I would say, I mean sometimes she would have lots of patients with lots of medications, it is difficult with me to get it done and I can understand that they don't always have the time to slowly go through which one, step by step, you know, with a new nurse. Erm obviously, sometimes it is just personality, some people don't always want to take the time to go through it slowly. More often than not people do because it is important and more often than not, they are happy to go through it with you slowly, wait for you to do it in your own time.

I-You mentioned something on the computer, can you elaborate further about that?

P- Erm, yeah I mean, I think it was in the first year so it is quite a distant memory, but I mean I remember it being good for working out doses and erm the sort of calculation side of drug administration but maybe not so useful as to what it is like when maybe you are in that situation, when you are on a busy ward and being face to face with patients and looking at their symptoms and actually looking at the patient, sort of assessing what medications to give them, are you giving the right thing. I remember it being quite useful at the time., But to be quite honest I can't remember exactly what we did when we did that session because it was such a long time ago.

I-Okay, just focusing on the actual simulation itself, you say it is difficult to focus and it did happen quite a long time ago, can you describe it at all? If you can't, that is fine.

P-Er, I really can't remember... I remember it sort of having to select the right doses and things like that, but I really can't remember because we had nothing similar since then. It wasn't referred to again after that one session.

I-Okay.

P- It was like this one off thing, but we didn't really know, it wasn't in any context other than we just had that session. To be honest, it is very hard to remember. Had it been an ongoing thing, I think I would be able to better recollect I am sure. May be it just because of my memory that I can't remember!

I-No , if you did something in your first year, then it can be quite difficult to remember as you are almost finished now, so it was quite a while ago!

P-Yes it is quite a while in between.

I-Yes of course! Erm, so I asked you if you could describe the simulation and as it was a little while ago, you're not able to describe it particularly clearly because it is not in your memory but you remember doing things such as doses and you believe that perhaps if it was an ongoing thing you may have remembered it a bit more. Since completing it, up until now, you haven't done anything remotely similar at all.

P-No, not at all.

I- Erm, you say that erm you can remember doing it although you can't remember the specifics, how clearly do you remember doing it without remembering the specifics of completing it?

P-Erm I remember doing it quite well because we were split up into three separate groups, so I remember thinking, none of us knew why we were being separated into different groups and what we were going to do. And then it was obviously erm quite relaxed as something different, so erm and it was quite interesting, We were told we were just trying out a new approach to it. And obviously we were in a big PAWs room so there was a lot of us all doing it together. Erm, I can't really remember much more than that.

I-That is fine, and can you remember anything else about the lesson at all?

P -Just bits.

I-That is absolutely fine.Did you make any errors whilst completing the simulation?

P-. Erm, I can't remember, possibly, I possibly made some. Gosh I can't remember. I am sure, not many, the way it was laid out, the actual process made it difficult to make an error, but I am sure I must have made one or two, but I don't remember making many.

I-Okay and do you remember whether or not others in your group made an error?

P-Er, not that I recall. I think people were talking between each other, so perhaps they were asking have you done this? From what I recall. It wasn't under strict exam conditions or anything like that, we were

communicating between us. Perhaps people were working through it together asking people's advice as they went along. Erm, I guess they were similar experiences I imagine.

I-Okay erm and this may sound like a slightly bizarre question in light of what you have just said, but during completing the simulation, did you feel anything?

P-Em, I felt rubbish about making an error and I mean like (((you talk about doing))) it was something different and interesting, erm, Yeah, I suppose, it was like obviously it was like another additional sort of way of looking at medication administration and was useful, 14 I didn't feel that it didn't waste my time, it wasn't boring or anything like that. Hopefully it was something so...

I -Erm, so you say it was useful and additional, in what way was it useful?

P -Erm, I guess just, well just because of something precarious, like as well as the practical side it is good to sort of get you brain to think of plenty of things, making calculations in your head, looking what the patient needs and making sure you got the right dose for them and things like that, so in that way it was useful, ,but again I can't remember the content that clearly, it is difficult for me to say.

I- No, that is fine.

P-I like it yeah, but I haven't seen it recently.

I-Okay, erm, do you remember, taking on board that you can't remember the simulation particularly well, from your scant memories of it, do you remember if there was any form of distraction in the simulation?

P-Erm no not that I recall.

I-Erm did you notice that some of the patients would move around?

P-Yes, oh yes that's it.

I-What did that make you think?

P-I guess it sort of makes you think that you shouldn't just rely on things staying the same, like you just... Things can change all the time so not to rely on that the patient is, you forget the medications so not to give it to them without really checking. Erm, it just helps you keep on your toes sort of thing. That you always have to go through the checks all of the time and rather than you have done them once, to go onto auto pilot.

I -Okay, and do you think completing the simulation was relevant to your practice or not?

P-Yes yes I would say so 1.

I-Can you elaborate any further?

P-Erm, it was something for most nursing students I imagine it was something completely new 14, so not being someone who administers medication, so in that respect its valuable for the student nurse. I wouldn't say it should be the only way we are given that education.

I-Since completing the simulation, apart from the fact that we are talking about it now, have you remembered it subsequently or ever thought about it whilst in practice?

P-Erm, to be honest no.

I-That's ok. Remember it is about your opinions and your perceptions as a nursing student to help us feed into your learning. It is fully about your experience ok! Erm, you have mentioned the five rights already and that you have been taught it. Erm with regards to the theory behind medication administration, how important is it to you as a nurse?

P-Erm, very important,

I-Did completing the simulation affect this at all?

P-Erm, no I guess the way putting some of it into practice, but no.

I-Is that because it was already important to you?

P-Yes, it was

I-I am just writing that down, ok... Erm with regards to completing the simulation did at all affects how you perceive the risks involved with administering medications to patients?

P-Erm, it didn't change them, I would say other aspects did like watching other videos and things so... I think they helped more than the simulation did.

I-Okay, and if you could summarise the learning you received from the simulation, what would that be?

P-Erm, I don't know, sorry

I-That is fine. When you are currently using checking procedures when you are administering medications, although admittedly you are a student nurse at the moment and a registered nurse needs to countersign, would you say you always use checking procedures or do you generally use them... how often do you use them?

P-Erm, I think always at this stage because we still have the luxury as students to do our own medications, we don't have loads of patients a registered nurse might so we have the time to do the checks as the as students we don't do many of our own patients medications, so we feel like we are still learning we make sure we do all the checks, so now I do, but I can see how in a busy shift and in different circumstances..

I-And what sort of things make you aware of such things in the future?

P-Erm, I guess like the pressures on nurses when they have got a load of patients and they are being called to and fro and they have loads of other things to do. And doing the medication round, from what I have seen people do check, I guess some sort of because they are so used to it, do do it on auto pilot a bit I suppose. Erm, like they check the medicines and they know their patients so they don't check the name of the patient.

I-That is something very well documented. So when you think about the fact that these circumstances are relatively common on an admissions ward or a MAU or a surgical admissions unit, erm do you believe your whole education has helped you be aware of the circumstances in which errors are more likely to occur?

P-Yeah I do actually.

I-Can you elaborate on that at all?

P-I guess with our practical sessions, our OSCE and things like that. I have always had to do checking and again ongoing things like in the first year, we had to do things like drug administration errors and what they would lead to and our code of conduct, ongoing I would say.

I-And when you talk about errors, was that in a lecture?

P-Erm, yes it was.

I-And so your intended use of checking procedures, do you think that is always going to be consistent and systematic or do you think you might not check as often as you ought to?

P-Erm, I'd like to think I would always do it and I see nurses in practice who do do all the checks. Obviously being human I know it is entirely possible on occasions I might just miss one of them, but I would like to think that yeah, I will do all of them.

I-Yes, and what do you perceive is the likelihood of you committing a medication administration error in the future once qualified?

P-Erm, I wouldn't say it is like a major worry erm just because you know human error even if you follow all the checks accidents can happen. It is a worry and it is entirely possible that I will make one.

I-And do you think completing the simulation at all helped you perceive that you are less or more likely to make an error in the future?

P-Erm I think just because it was a one off it didn't make such an impact. I think if had been a more ongoing process with our progression, it could be helpful, but it was just the one off, so it is hard to say.

I-Okay do you think there was any impact of using the simulation on your education or not?

P-Erm, with regards to the simulation? I don't think the simulation had an impact on its own I think it maybe did as part of what we were taught.

I-How would you evaluate the experience of completing the simulation in comparison to some of the other teaching methods? I think we have briefly touched upon this already.

P-Erm, I think we were in quite a big PAWS room and with lecturers going round and we were more or less left to get on with it with discussions with students, so I don't know what works better smaller groups or things like that. So yeah, it was useful, it highlighted certain things like drugs change and patients change..

I-Okay and although you can't remember the specifics of the simulation particularly well, the simulation aimed to represent medication administration. So baring that in mind, how well or badly do you think it represented the medication administration task?

P-Erm, probably as well as it can, but I think probably it is very different giving something on the computer than it is to physically like fix things, getting things out, dealing with a ptiant. I don't think, even if it was quite advanced I don't think it could replicate that. So I think that was the problem with it but otherwise, for what it was, it was fine.

I-What is your opinion of using simulation as a learning tool?

P-Okay I think, yes is helpful as it can be, but as I say it can't replicate the ward. 10

I-And is there anything else you wanted to add ?

P-Not really, all the stuff we have learned has helped but nothing can replace being in placement and actually doing it yourself. Erm, but obviously you don't know about all the theory behind it in placement so I think it is vital that we do have to learn that. It has been good so far from my experience.

Good.

SUMMARY reiteration of rest of interview.

Participant 10

Introduction and chat

I-Fabulous. I am tape recording it if that is okay with you just so I can obviously transcribe it at a later date and erm, essentially I am going to ask you a number of questions. None of them are particularly taxing, but I do have to stress that if there is anything you don't want to answer or don't understand, please say so, that is fine, say you don't want to answer or ask me to repeat or that sort of thing. It is entirely at your pace and at your comfort. I can't foresee anything that will upset you at all, but I just like to make that clear to you because of course you are the interviewee and it is about you.

P-Okay.

I-We will go through the interview and I will be writing some notes down and tape recording it. At the end we will go through what I have written, just to clarify I ahve understood your meaning about what you have said ok?

P-Okay,

I-Erm, what do you remember about learning medication administration in college and at university?

P-Oh gosh, this is throughout the three years?

I-Throughout the three years, whatever you remember.

P-Okay, erm, well, to begin with I can remember that the BNF plays a big part of it, always have it to hand. Erm I think always having two of use to check medication, especially as a student you always need another person. Erm a lot of the checks to do with the actual drug chart, just like the importance of going through absolutely everything like all sides of the paper and reading everything that is written. Erm, even if, yeah the say before so being quite thorough, going through that. Erm I think also as well, always questioning things you are not sure of. It is really important, always asking the person you are with erm double checking, so like using the BNF, double checking what the drug is for if you are not sure and even if you are quite vague on it and knowing things as well like knowing what paracetamol is for, like temperature but knowing implications like side effects. It is really important. Erm, I am trying to think.

I-And how were you taught all these things?

P-Sorry,..

I-How were you taught them?

P-How were we taught? We had props I supposed is the word, so we had drug charts in front of us, and tablets and liquid medicines and we would go through it. In that sense we would go through it in pairs and we would go through it with the lecturer and erm yeah, so we did that and obviously we had exams in medication so we sort of had that sort of training as well so to make it more real before we went into placement.

I-How did it make it more real?

P-I suppose it showed us physically how to do it, so there was some experience

I-Okay and did you have any other form of tuition in university regarding drugs.

P-No, not er no. Not that I can think.

I-Okay.

P-Oh I suppose we had erm, we did have a pharmacology module and that... it vaguely... yes it talked about medicine and perhaps they touched on it. But nothing, no practical from what I remember.

I-Erm, do you remember completing a computer simulation regarding administering drugs?

P-Erm, yes, I do, it was like a multiple choice erm so yes I do remember that. Mentioning it I do remember it but very vaguely.

I-Vaguely, that is absolutely fine, remember this is me investigating what the student experience is so if you remember it vaguely, that is your experience and therefore is highly valid for our requirements, okay.

P-Okay.

I-Yes, I sense a slight sensitivity that I have asked you something you only vaguely remember, but these are your experiences that I need to know about so please do not worry about it.

P-Okay.

I-Now that we have touched upon it and I obviously have prompted you, about the simulation, can you take me through completing the simulation?

P-Erm, I can't particularly remember it very well. I think we have had quite a few exams in a similar format which were multiple choice and I think it was erm quite similar to our calculations exam, our calculations exam was all about medicine so erm I am not sure, are they the ones you are meaning?

I-It was on a simulation on a computer and it required you to look at three different pictures of patients, identify which patient needed medications and then open up a drug chart and in a simulation type format to administer medication to them.

P-Oh gosh, yes, do you know I really can't remember at all, sorry.

I-No no, that is absolutely fine. Since me asking you about it, you say you vaguely remember it, I take it that is a case of something very far back in your memory but nothing to erm clear or specific in your mind?

P-No, the only thing when I think of doing on the computer is like doing multiple choice regarding lessons, such as calculations exams which are like you have to give the patient 600mg of this and you have 300mg of it, how many do you give them, so that is what I, that is the kind of thing that I was thinking. The one... vague memories of something that you mentioned, but I couldn't say what was on it.

I- Couldn't say what was on it, okay. Erm, can you remember what you learnt from that, if you can't remember anything at all, that is fine. Can you remember learning anything from it or not?

P-No, I don't think so.

I-No, okay. And again when you did the simulation, the simulation would, it produced three patients, with simulation drug charts, their own allergy status, past medical histories etc. And when you were supposed to administer the medications, the pictures of the patients would swap around. Does that ring a bell at all?

P-Ooh, perhaps, yes vaguely. Yeah, the more you are saying the more I ... but I think I am having to be prompted rather than remembering it off the top of my head.

I-Okay, now that you sort of vaguely remember the whole simulation, can you describe it to me in a any more detail?

P-Erm, so as I remember it like you say, there were different patients, I need to rack my brain, actually I do remember something like when you click on something you had to go through the whole chart and there would be things to catch you out like similar names and things. Erm, but no, other than that, sorry...

I-No, that is fine. Now that I have prompted you, you do vaguely remember the patient's pictures swapping around? Did that highlight anything for you or teach you anything at all?

P-Well, I did think it wasn't particularly accurate or that helpful to do it on the computer. Erm, obviously I can see the principle of why they are doing it to make sure you know you always double check and if you are in a rush don't get the patient's mixed up. I didn't think it was particularly helpful on a computer thing, like on a computer based programme to do it. Sorry.

I-Okay, and why was that?

P-For me it is much better to do something practically, like it is just, you, the way that I relate to computer screens and the way I relate to patients in a hospital setting are quite different. It is just a different atmosphere and I think making it as realistic as possible to do it in practice is just a much better way of learning for me, yeah rather than a simulation on a computer.

I-Sorry, I am just making a few notes here as well...

P-Okay.

I-Okay erm, if there was anything that you could take away from using the simulation, is there anything at all?

P-Erm, I suppose it is good because I suppose you have it all on screen you need to check, you do have everything with you I suppose but er I don't think I can give a good enough answer, I don't remember it well enough to give a good answer!

I-No the best answer you can give is if it is an honest answer about what you think, so this is fine.

P-I can't think of anything.

I-Okay, now do you remember whether or not you made any errors in the simulation?

P-Erm actually now yeah I think I did.

I-And can you remember what the error was?

P-No. I can remember quite a few of use and we were like oh my god, but then, no I can't remember what it was.

I-What do you mean? Can you just explain your interaction with your colleagues in the class?

P-Erm what I think, I remember, when you were saying about the patients swapping over in the thing and I remember thinking erm there was quite a few of us and I remember something happening and it didn't

work or feeling that you were being caught out in a way so by the time you had chosen a patient or you had done something then something had changed and I remember being certain that everything and then clicking on something and then oh no the patients moved round or something, yeah.

I-Okay and you were saying, you mentioned some of your fellow students with reference to perhaps you were being caught out or things were being changed. Can you remember what was being said or the reaction that you and your colleagues had?

P-Well it was that feeling of being a bit caught out and also like well if it was perhaps in an actual situation, erm it yeah, I think... I am trying to think yeah, just about being caught out in a way and sort of not having the patient erm yeah, it felt like it was tricking you rather than testing you, if you see what I mean. Erm so yes.

I-And when you realised you made an error, how did that make you feel?

P -Erm gutted, you just kinda go ahhhh oh no!! It felt awful.

I-Were you able to relate that to your practice at all?

P-Pardon?

I-Were you able to relate that gutted feeling to your practice at all (GUTTED REMOVE?) when you were talking about feeling caught out?

P-I suppose so, I haven't felt it in practice, but erm I think I guess I have just been lucky. It hasn't happened in practice where I have been in a situation where that has happened. But I suppose on the computer I have, it went wrong but I haven't experienced that in practice.

I-Fine, with regards to making an error and feeling that you have been 'caught out' in the simulation, was that relevant to your practice or not?

P-Yeah I can, yes just to make sure that even when you are sure, just double check so yeah, I can see the logic.

I-Baring in mind you say you only vaguely remember the simulation and you are only really remembering these experiences now that I am prompting you. Did you see the point when you first completed the simulation?

P-Erm, possibly not, yeah, I think always when doing things on the computer, you can see the point and everything but it is not quite the same as the reality of actually giving stuff out yourself with real people and acting it out, so yeah.

I-Ok, how important is it to you the theory behind administering medications safely?

P-Erm important, very very important.

I-And did completing the simulation affect this at all?

P-Erm I think other things have had more of an impact than the simulation .

I-Such as?

P-Working with mentors in practice

I-Did completing the simulation alter your perceptions of the risks involved in administering medications?

P-Erm, thinking about it I suppose yes, erm but erm with the errors and things yes, but I don't know how like I don't know how much I refer to the simulation now if you know what I mean, so in hindsight perhaps but not really due to the simulation

I-And that hindsight is purely prompted by the conversation now?

P-Yes. I don't think I would have remembered the simulation otherwise. It was so long ago.

i-Okay, does learning from errors something that helps you at all or not?

P- Do I see any benefit from learning from errors? Definitely, it makes you more cautious erm and yes it means that you don't get lazy.

I-And erm, did you derive any of that sort of learning from the simulation? I realise that some of the questions are going over things we have already mentioned, so I appreciate that.

P-So have I?

I-Making errors in the simulation, did you derive any learning from that or not?

P-Erm no, not particularly, I probably will say no, even though I know I did make errors and I can see the importance of learning. But not due to the simulation is why I would be more careful.

I-Olay that is fine and what do you see is the likelihood of you committing a medication error sometime in the future?

P-Erm hopefully never, oh gosh, but I think, I'd like to think that there isn't one but erm I would say none.

I-Erm, and completing the simulation how do you feel has that contributed to your learning in comparison to other nurses

P-It hasn't had much of an impact

I-And erm have you taken the experience of completing the simulation into clinical practice or not?

P-Erm, I haven't.

I-Ok and from what you remember and baring in mind you remember it so vaguely how well did the simulation represent medication administration?

P-Erm I think it helped with the thought process, it made you think about erm but other than that, I can't think.

I-And as a simulation of an experience, looking purely at the simulation itself and how it was put together, do you think it was a reasonable representation of drug administration or not

P-Erm, I don't think so.

I-Why was that?

P-Erm I think just from what I can remember, it's just not real enough erm, I think it would work better, you know if rather than having even cartoon characters, having photos of people and moving those around, something, just more real.

I-Could you explain a bit more what you mean by real, just so I can have a better understanding?

P-Erm, so I think doing things other than medicine administration. If you get given like erm a camera in hospital and it is practical, you can see a nurse working round a person, rather than like a cartoon it is like a film so that it makes it a little bit more real and see everything around it, that is what I mean.

I-Okay, so a little bit more realistic to the realities of the situation?

P-Yes.

I-Can you remember whether or not you found it difficult to use the simulation?

P-Erm, I don't think so.

I-And regarding your experiences of the simulation and your experiences being taught safe medication administration in its entirety, is there anything else you could add or would like to comment upon?

P-No, no I can't think of anything.

I- Okay, cool. Thank you very much.

Summary and reiteration

Participant 11

Introduction and chat

I-Just before we start, I don't foresee any problems regarding asking you questions, asking you anything that you will feel uncomfortable with, but if that does happen, I just wanted to emphasise that you are at liberty not to answer questions if you don't want to, if you feel uncomfortable at any point or want to stop then please just say so, and that will be absolutely fine. Ok?

I am going to be recording the interview and then I will transcribe the script once it is done and then the recording of the interview will be destroyed (((REMEMBER))) and I will take notes all the way through the

interview just to keep me on my toes and also at the very end, what I will do if that is ok with you I will run through my notes and run them past you just to ensure I have understood exactly where you are coming from. Is that ok?

P-Yes that is fine.

I-Fabulous, okay, can you first of all take me through being taught medication administration in both university and on placement?

(REPEAT QUESTION).

P-My experience?

I-Yes please?

P-Oh, I remember that I had my pharmacology in the first year and in my first year I was really I had no clue at all because my pharmacology I had to do like twice, so I did not have any clue about what it was all about, you know time, so I did not fully digest it in university. When I went out in placement and I am having hands on the actual drugs it made much more sense so when I went back to university that is when it made sense, but I think, my memory first of all I think they shouldn't have done pharmacology in the first year, I think having it in the second year I would have had more of a chance, no, because in the second year, I didn't have to go back to the first year, because I thought in the first year, oh my god, you know, but it was not what I needed to know and I was only just understanding it and it was a push from college after just doing your A-levels you know.

I-Okay

P-Some of it was really good in uni, but when I went on placement, that is when I was getting the whole picture of it.

I-Okay and what sort of things happened in placement to help make you understand it much better?

P-Actually getting out the leaflets in the medications that was very helpful and some of them were actually no, rather like if one does if one doesn't no, so you can read and on top of that they taught you to use the BNF and we had much input of the BNF and even when I did my OSCE there was not anything. When we went into placement I am see all these and of course in placement you see all these different ones everyday when you work with a registered nurse, people are different and and you see things differently so that has actually given me more input and you know opportunity and everything.

I-And erm, you mentioned your pharmacology teaching at university, what methods did they use at university to try and teach you about medication administration, purely in university?

P-I think really it was the lectures and for me, for me they really put a lot of information for us, they pushed a lot of information and it reached the time well you just had to go to lectures to sign your name, we were not given further (Inaudible) everyone was used to it. Some lecturers would read through the slides and

then your just why did I come to the lecture, I didn't need to you know? But later I remember in my second year that was when they actually brought erm checking medication on line so that was the lecture actually again I found it very useful when we were doing, to see if we were giving out the right medication and you know later on you were able to see the results and I was so shocked to see that, you know, all my, a lot of simple things you know and actually making do a medication error so. They didn't BRING more of the computerised one the lecture we had so of again really, though it, it was really very useful because the simple simple things that are errors that make you learn better than not going for these simple lectures you know just coming out when you haven't understood anything.

I-Okay so you mentioned, was it like a simulation that you did?

P-Yes it was in the PAWS room, I think we had some special group in the university, just for the exercise online which was so so good.

I-Why was it good?

P-Because you were actually doing something and putting things into practice. The simple things that make errors, make you learn.

I-Okay and when you were doing the simulation, can you just run through what you did, what you can remember of it?

P-Oh, I remember a few bits. It was basically different questions with prescribed medications and some of them asked what are the simple things you can use to identify you know maybe giving the right patient the right medications and how do you calculate and find out the dose you know which is useful. I know that. And lots of things for example, one aspect you know asking us if this is the right stuff, the right medication for this patient and making the right checks. That is really what I remember.

I-Ok, and how clearly do you remember it?

P-Erm, Very well, *because* what I remember mostly is that there were and other members as well, thinking something was correct but later on when it gives you the result you find out actually it is wrong and you know you are like oh my god i didn't know I did anything wrong and it made me, you know rethink you know my practice and like some of the things again in practice were actually wrong in practice as well, and you think god you could have killed a patient in your care as well so.

I-Ok and when you said you made an error, can you remember what sort of error you made?

P-I think actually I made an error on erm maybe it was the actual dosage, I really can't remember.

I-Okay, when you realised you made an error, did you feel anything?

P-I really felt, I felt very horrible because the exercise was telling us every error you made and that is going to highlight deficiency in your skills, so it feels like, you know when you are doing things wrong, it made me feel oh my god, how many patients might I have killed? It was a lot of good, but also it was really very, it

really like enlightened me, made me to think more wisely before you know giving anything and you know to cross checking and things like that, because I just got shocked and I was like you know I really need to be more reading, more checking of why you are doing things and also just more cross checking every time especially when you are you know out there. Made me feel...

I-And when you say it felt horrible, can expand on that or erm were there any other feelings that you felt at all?

P-Yes, I just remember I felt so so low because despite the fact it was just an exercise, but I was putting myself in that shoe like I have been on the ward, you know people passing you all depending on me and not doing the right thing like medicines you know and it actually spoke to me, oh if I didn't do the calculations well, it means like oh someone has lost their life and I was thinking about the whole impact and not only on myself but the family you know they think why what do they think the fact that a clinical error has happened. It was that quite a lot of things went into my mind just in that small session. We, ...yeah...

I-When you said you felt horrible and erm it sort of highlight things to you, how long did that feeling last for?

P-Well I really, I felt I kept having that conscience all of, most of my second year time because each time I got out on placement I would not take anything, it made me just not take anything for granted because of the people you know and things like that, their lives are basically in my hands. It reminds me so all the time I am in practice, however much I feel I can do it, but because of the previous experience you know I use the opportunity to ask just for clarification, it made me all the time rethink of it and I just double check and with this feeling and taking it forward.

I-You have spoken at length about regarding making errors and the impact of making an error, if you can think about completing the simulation without making any errors, would completing the simulation in itself have taught you anything?

P-It erm it really taught me I think like because before I think that there was only one way of people make errors especially in nursing, all the stories like sometimes like I can hear but from that, I just learnt that all the different areas in nursing that you have to take it seriously because before I used to think it was more than just medication that people made errors. But doing that simulation exercise just made me rethink that like it is not only just medication, not taking other aspects, not caring for your patients no. I have to think of

things very carefully no. It just made me be serious about what the patient does and what type of area we are dealing with.

I-Okay, and can remember when you went through the simulation, actually on the computer screen, can you describe the actual computer pages to me, the actual simulation.

P-The computer?

I-Can you remember and describe the actual pages of the simulation, what did it look like and what did you have to do.

P-The actual pages, they came in slides and erm it's like basically having erm we had choices and clicking on a patient and then afterwards whatever you filled it would show if you have the right answer, so yeah, so that is how it was.

I-Erm, can you remember when you completed the simulation did you notice any of the patients swapping position?

P-Sorry any of the patients?

I-Did you notice whilst doing the simulation any of the patients swapping position?

P-Swapping position?

I-Yes did you notice any of the patients swapping position?

P- Oh yeah, I remember some of them swapping position, and er and some of the patients changed their name bands as well.. Some people changed their name bands and some actually er sometimes you would offer the wrong, sometimes you would offer the wrong medication to the wrong patient. And sometime you think maybe I didn't know that and sometimes you find the patient has changed position and you think this is a joke, this is not actually the one -giving maybe the right drugs to the wrong patient.

I-Okay and did you take anything from that or not ?

P-Yes it did teach me something. Always cross check, no matter how simple things seem, always cross check the right patient because sometimes patients can leave, even if just going for coffee, they can change when they are in the (CAN'T UNDERSTAND) everything, when they are... always cross check. Practicing in a safe, doing safe practice.

I-Okay, did you notice whilst doing the simulation that the simulation was trying to distract you at all into making an error?

P-Oh yes some of them. I do remember that very well.

I-Could you describe what you remember?

P-I think what I remember actually is erm about five patients I think also researched antibiotics and whenever the scenario first missed, I knew Mr X was the first one on the list and when I went to the second step I thought Mr X had changed the position so actually now he was in the middle bed, it didn't even come into my head so I really thought you know Mr X was in the first bed, but later on, you know when it showed me that I knew it was the wrong patient. Oh, I was like, but Mr X was on the top of the list and check back I realised there was an error.

I-And did that relate to your practice or not?

P-Yes, and remember again it is all about just cross checking you know, the right thing by the right person.

I-Okay and erm was completing the simulation relevant to your practice or not?

P-Yes it was relevant to my practice, I mean clinical practice. My example is, really still like maintaining my checks you know, patient, time you know. Making sure it is the right patient, the right time, the right thing you know. Is the patient in the right position that I think he is in, like going back by their bedside, if not is he really the right patient with the right medication maybe the ... Really more cross checking not just the right patients you know about.

I-With regards to the theory behind administering medications safely, how important is that to you and to your clinical practice?

P-It is very very important because am at the end of the day, the worst thing is to administer, you know I said about administering the medication to the wrong patient and at the end that medication will give a lot of advantages to that patient, I think it was a really mind opening stimulation because we had a lot of different different thing that we wouldn't know, like would it be a waste of time to check because I have already checked. Every time for me now I am going to be a newly qualified nurse and so you have a lot to learn so I think it was really certainly very good to see all the simple small things that can go wrong, no things that you don't even expect. So it is really very important.

I-And did completing the simulation impact upon your perceptions of the risks involved associated with administering medications?

P-Risks associated with er?

I-Did completing the simulation alter your perceptions of the risks involved associated with administering medications to patients or not?

P-Yes it did, Do you mean risks?

I-For example, as nurses, we administer medications all the time and it can become very much er sort of an activity that we do without really thinking about it. But you can make an error if you don't do it properly. As a consequence there are risks involved in not doing it properly as you have already eluded to before. So did completing the simulation affect how you perceive the risks associated with administering medications?

P-Yes I did detect some risks involved in erm administering you know the right medications. But what I thought most was the patient, if you don't give the right medication to the patient for example, you can cause many different things you know to happen to them.

I-Okay and if you learnt something from the simulation, what was it, if at all?

P-Possibility, about the simulation, the most important aspect about the simulation was that it was a medical simulation so that it was dealing with all about er, for example, really making sure that you were reading the drug chart and you were actually reading the drug chart correctly so you administer whatever is prescribed properly. and then it is really good to go back if you are not sure, to keep going back whatever the scenario. Like you at the end do the right thing at the right time so it taught me taking into account sometimes the patients they change so, it is really very good to cross check and if you are not sure just call to who is looking after that patient and also, having learned about many drug rounds, what, see how much medications and is it time. I think that is what I realised how many tablets, how many they are actually supposed to have you know with twenty four hours so having that sort of medication... behind you because sometimes you know, doctors sometimes write up things that, as a nurse you can see, no that is not right dose, so it is especially good to have that sort of knowledge behind you. Some people might say, oh no, that is not my area but it is still good to be aware of those things.

I-And do you think you will use that learning once you are a qualified nurse or not?

P-Yes definitely I will use it because first of all I don't want to be in trouble with the patients so I want to give the best care for them so it just shows how competent you are I just want to be a good nurse and look after people very very well and that is really very vital.

I-And what do you perceive is the likelihood of you committing a medication administration error in the future once you are qualified?

P-Ahh, well I will never say it will not happen, but the likelihood, it is still a very high percentage, but it is still something that I will always have to have behind my conscience and really to cross check things. It is not like, it has to be something very big, just the small things that we have to know that can make the errors. I will always be cross checking but I am not sure. I will always go and ask the more skilled ones you know. That is what I can only say.

I-This perception that you have just described to me, has this been affected by completing the simulation at all or not?

P-Sorry?

I-What you have just described about how you perceive the likelihood of committing a medication error in the future, and the fact that you always have to have it in your consciousness somewhere, has this been affected by you completing the simulation at all or not?

P-To an extent I would say yes it has been affected by erm, but I would say a really high percent because that simulation exercise it erm it put more highlight into that, it gave me actually a very positive effect, I don't know, it gave that perception, no, it is not just the big things that people...after all what do they mean by medication administration errors?? You know, it is not just like only giving you know may be like some overdosing the patient or something no, but I didn't think identifying the patient and giving the medications

to someone else would then be a medication error so it really gave me very positive effect, you know. So on the other side, but differences in just in wide it is just in my consciousness all the time and it is always oh my god, may be I am, making a mistake so it is not again giving me more confidence in doing things because all the time I just want to cross check.

I-Okay and what you have learnt in the simulation, erm are you likely erm likely to take that learning into the long-term throughout your nursing career or do you think it is just something that you have learnt over the short-term?

P-No because t is something that I have, even if it was just the short-term, but I learnt and always if something strikes your mind like normally something just passes into my head and making me be open and that consciousness you know, meaning to check everything, so I think it is something I am going to take on the long-term , and something I am going to learn more and add more onto it. So it is not something I am going to leave behind me and just forget in uni uni you know, no it is something I am going to take on for the rest of my career and involve more onto it.

I-Okay and how effective in your opinion is using the experience of error in teaching you about medication administration?

P-I think it is very effective because er it makes us think. Er a lot of, well I don't know but personally, before I used to wonder what medication error is, but this simulation exercise, it's like, it brought all the things, all the small, minor things that, you know, really I have seen some of my course mates when we were in uni, and we are thinking oh that is something else, and so it leading to something so big, yet actually it is something that can lead you to actually write out an incident form and all that, and so it was really something, you know, that was really very effective.

I- Okay, and how memorable was it, how easy or difficult was it to remember it regarding completing the medication simulation?

P-I think I remembered it... it's memorable because something it, because just like again not being conscious of it, but at the end of the day, when you have the information that is there it is something that you know, it is so meaningful, you know how to do it but it is still put it in a simple way and having all the pictures as well you know. But at the other side it is fun, but when actually look at it properly and , oh my god, it is fun, but at the same time I am learning things, it has such, it has a lot of information for me to learn, so that is how memorable it was, cause it was actually simple, but at the core it had something that was so meaningful, oh my god, the importance of doing it right. So in that way it was so great.

I-Okay and how did it work in conjunction with the other learning that you had on medication administration, such as lectures, the learning from placement?

P-Sorry, how it works in conjunction with...

I-So you had er, you already mentioned that you had lectures and you obviously learnt in placement. How did completing the simulation work in conjunction with those other teaching methods for you?

P-Er it was actually, they all worked together because erm, for example, when I was working in placement and one time we had a medication, because ... but actually seen erm certain medications that are prescribed and you have to consider the patient's weight and all that and that was my first time thinking of the simulation exercise to come across it to actually, so when I came across it on placement I was actually so excited, i am like, oh my god, so it was the simulation exercise that I was like, you know, was like that because we had to give certain medications due to the patient's weight. And we had to calculate and work out all these things and I was like, okay, it is so good and as well I remember the simulation exercise had the, I think had a form at the end you know, having all the you know 1 micrograms, in that it was arranged so it was that knowledge and with all the more practice so when I went on placement. It was so good and helped with the OSCE as well, preparing you...things to look out for, things about the patient and all that.

I-And when you qualify what is your intended use of checking procedures when administering medications?

P-Whether my?

I-What is your intended use of checking procedures when administering drugs once qualified?

P-Actually I intend to use them as often as I have to give out medications, even if, for example, if I am on a long day shift and I have to give out medications may be at 9 O'clock time, even if I come to the last time one, I will make sure that I still keep to those procedures and know that things might change and not think that oh that is how it was and that might lead to error, so I will think, oh yes that I will always check using the five rights. Always check to be on the safe side.

I-Did the simulation affect this or not?

P-It just really reminded me yes

I-How well or how badly did the simulation represent medication administration?

(HAD TO REPEAT THE QUESTION))

P-It worked. It definitely gave me, it gave me er,... it made me enjoy the medication administration, it made me, when I did a medication round on the ward, yes I can say... Before, whenever I came to medication administration, and maybe I am working with my mentor and saying about medication I would have that fright in me, oh my god you know, with all the medications, how do I do it??? But when we did this exercise but when we did this exercise, because it was such, simple, and clear, it made me enjoy it more, you know, I am like, you know, provided you go through your checks, the five rights you know, then you are not bound to go wrong and all these things. Read the drug chart from the start up to the ... you know.

I-Okay, and did you think the simulation itself, the physical simulation, did you think it represented medication administration and were there any improvements or alterations that you can think of to improve it?

P-Sorry...

I-Did you think the actual simulation itself was a good simulation of medication administration or ineffective?

P-Yes I think it was very good because... I think it was good because of the way the content was all laid out, so it made one enjoy it you know, not be like frightened which can make people make errors and all those things. So actually I think the exercise was a good exercise because of the nature of it, you know the nature in which it is actually you know being computerised you know and all the different, different, I remember it covering, it didn't cover one thing, I remember it covered all things, the different, different medications and all the different, different things that had to be included, so...

I-Okay and erm remembering the simulation itself, can you remember any improvements or alterations you would have made for other students to make it work better for them?

P-The simulation exercise?

I-Yes any changes that you would make to the simulation to make it better for further students?

P-Erm, I think the only thing that I would just say is that it shouldn't be for once only, it should be like a module. I really found it so useful, maybe coz for me, people learn in different ways you know, but I really learnt a lot out of that. Instead of just having lectures not all the time because (inaudible), Having the simulation exercise with pictures and all that I think, you know, it helped much.

I-Actually having a simulation as a learning tool, what do you think of that?

P-I would really support that, that would be so good. Because your... actually because of the pictures, because I like learning through pictures and that's the thing you know, it sticks in my head you know and then I am able to learn. I would say it is a really good way of learning because and as well, you do the exercise and you are able to see your errors and correct they give you the answers so you are able to correct yourself there and then and you are learning. So it really is a good way of learning.

I-I have finished all my questions. Do you have any more observations or comments that you would like to make?

Regarding the exercise?

Yes.

(REPEATED THE QUESTION))

The only thing I would like to add is I really support this exercise, you know. There you have it as a module, yeah, instead of having it within the pharmacology lecture, so having more of the simulation exercise to come from different, different areas you know in nursing. I think that will have a much more better impact on learning and actual medication assessment. There is nothing more I can really add.

Lovely thank you very much.

Summary of interview

Participant 12

General intro including stating the interview would be taped and written notes would be taken, don't worry if can't answer questions, it is about their experiences.

I-Can you take me through being taught medication administration in university and on placement?

P-Erm, well I suppose, I did do drug administration with my mentors erm on placement erm and obviously in our second year OSCE we had to sort of incorporate administration into our exam, so erm yeah, so I am not sure what more you want me to say.

I-Yep that is fine. And whilst you were at university, you mentioned the OSCE, did you have any other forms of tuition regarding how to administer drugs properly?

P-We had obviously a lecture for each OSCE station, so we get told roughly what to expect and things erm, and obviously drug calculations. Don't know how I forgot that! We haven't done that this year but in the second year we had drug calculation exams to do erm so i think that was about calculating the drugs, we practiced drawing up the drugs that we needed, we did that on placement. So erm, yeah depending on what sort of ward you were on depended what types of drugs you used.

I-Okeydokey. And do you remember at all taking part in simulation on drug administration?

P-I think that was in our second year, second year I think? Yeah.

I-an you tell me how clearly you remembered it, before I prompted you?

P-Erm, I mean it wasn't a particularly long set I don't think, so I don't really recall it much!

I-That is fine. Are you able to describe it at all? I know you can't recall it very much, but with that in mind, are you able to describe it at all, what you did in the simulation at all?

P-Erm, I think we were given a patient scenario and sort of er or patient's drug chart and you would give a drug and measure up the amount, pick up the amount... I don't know, it is sort of on a spreadsheet style perhaps. I can't remember, sorry it was a while ago and then we had to pick the right drug and dose and that at that point, I think! It was a while ago, so I can't really remember!

I-Oh course. It is your memories and your experiences and what you think occurred are important to us and so that is just fine, that is exactly what we are after okay. Erm, so you picked the right drug and can you remember the actual screen of the simulation at all?

P-Er, no, sort of had the patient scenario at the top I think and then something like erm obviously the options were there below it I think and you sort of clicked on whichever one you thought was correct. I think! It's a bit vague sorry!

I-No that... if it is your experience, that is what we want to know and you are the student so that is exactly what we want to know. So really do not worry if you feel that you ((CANT REMEMBER)) are not as clear as you wish. Just knowing what you remember is what we are after. So you described that to me as it was obviously quite vague but you have given to me a slight jist of what was presented to you on the screen and you have talked about very briefly that you had a scenario and you had to through a spreadsheet sort of orientation pick the right drug and give it to the right patient. Erm, did you learn from completing the simulation?

P-Erm, I think I did okay in it, but if it was real, I think I probably killed a patient so, there were a few mistakes, er yeah I did make one or two mistakes, I can't remember. 12But yeah when you sort of relate the seriousness of the test to real life, you obviously would get into a lot of trouble.

I-Sorry for the gap (PAUSE) I am just taking a few notes okay. Alright, and how well can you remember making an error?

P-Sorry?

I-How well can you remember making an error?

P-Erm, I don't think I was that bad, but I did make an error although I don't know what I did wrong.

I-Okay, and did you learn anything at all from making the error or not?

P-Erm, well I just thought about checking things, but being a student I wouldn't really have done that on my own I would have done that with a mentor so, I guess on my own I have to try and be thorough and more accurate. So...you don't make errors with patients – that would be awful...

I-Okay and when you realised you made an error, did it make you feel anything? Did you have any emotional response from making an error?

P-Erm, I guess I sort, or you know, well I like doing well in my exams so I was a bit, you know, disappointed that I did get something wrong, but also, when you think about it in a real life scenario then obviously you are in a lot more trouble so yeah erm, yeah I don't sort of getting things wrong.

I-And when you had that feeling of disappointment, how long did it last for, a short period of time or for a long period of time?

P-Erm, probably a short period of time.

I-Okay, and when you were completing the simulation, I acknowledge the fact that you only remember it vaguely, did you notice the patient's swapping position at all?

P-Erm, no, I er think that might have been something that happened erm, but yeah it is really vague sorry.

I-That is absolutely fine. Erm, the second question I wanted to go onto for those people if that had remembered the swapping was is did that teach you anything. Would you be able to offer a comment on that? Bearing in mind you only remember it vaguely?

P-Erm, Obviously with the patient swap you have to make sure you do the five rights so, you make sure you have the right patient and you check the name band first and remember things like that so perhaps when looking at the picture's names...

I-And when you were completing the simulation, again taking an acknowledgement of the fact that you only remember it quite vaguely, did you recall any form of distraction that was incorporated into the simulation?

P-Ern, I think my firends talking to me, it wasn't done in complete silence! Sorry! So yeah, it wasn't done in silence, so yeah it wasn't sort of done under exam conditions or anything so you know.

I-Okay so the distraction was not intrinsic within the simulation, but was you just chatting to your friends and colleagues?

P-Yes, sort of environment.

I-Okay and was completing the simulation was that relevant to your practice at all for you in clinical placement or not?

P-Erm, yes it was a good example of how to do things if you don't get a chance to go straight into placement, it is a good chance to have a go in your first year, sort of. Yes it is like when you had to choose what... I think you had to choose what dose and what drugs to choose and a what time and things like that. It was erm, yeah, I think it was useful, but we only did it once so I think it would be useful to do it more than once or have access to it regularly.

I-Okay so you feel that if you had access to it more regularly it would be a bit more useful than it was?

P-Yeah,

I-Right and can you tell me, you have already mentioned the five rights which of course is something that would have been initially introduced to you in lectures. Whilst you were on placement administering medications, how important is the five rights, the theory of it to you and your practice?

P-I think nurses and student nurses follow it automatically so I mean when my mentor is watching me you have to say it out loud you know about check the drug check the patient and you take the drugs to your

patient, you check the name band so you know to check that it is the right patient erm, and things like that. It becomes automatic after a while, the more you do it.

I-Okay, and did completing the simulation affect how important the theory behind medication administration is to you or not?

P-Sorry?

I-Did completing the simulation affect how important the five rights are to you on your placement, in practice or not?

P-Erm, yeah I think it did especially because ... (inaudible).

I-Sorry my love can you repeat that?

P-Okay, yeah it does, especially because I didn't get them all right, so yeah I think yeah it does.

I-Could you expand on how that would be?

P-Erm, well I mean just the fact that I made a mistake it sort of, I haven't made a mistake in practice so far but I did make a mistake in the simulation so it was quite er, a just wonder why, was I more relaxed or was I not taking it seriously, I mean, why was I not on the ball as I would obviously be in placement. There is a bit of added pressure when it is in real life.

I-Okay, and did completing the simulation alter your perceptions of the risks involved in administering medication to patients or not?

P-Sorry???

I-Did completing the simulation at all alter your perception of the risks involved in administering medications or not?

P-Erm, it didn't really alter them no, because I knew about the importance of them anyway. I'm not really relaxed about them anyway. Erm you need a requirement of it erm, it is just another way of practicing I suppose.

I-Okay and did completing the simulation impact upon your clinical practice at all?

P-Er, I am not sure really because obviously I didn't really remember completing it sorry,

I-No that is fine

P-And as I said before, unless you do it regularly, it sort of do it regularly, perhaps it will be useful for the student to have access to.

I-In what way?

P-Because then you will be able to remember it, doing it once makes it easily forgotten

I-Erm, what is... you have already eluded to this next question. But what is your current and intended use of checking procedures, the five rights when in clinical placement when you are a qualified nurse by yourself without your mentor?

P-What's my?

I-Why is your intended use of checking procedures in placement as a student and once you are a registered nurse without a mentor.

P-I would just follow on and use them always.

I-And when you are qualified, what do you perceive is the likelihood of you committing a medication administration error sometime in the future?

P-Well I hope not, I can't tell, I hope not, it is down to human error, erm, yeah, I can't really answer that one. I think I will just try really hard not to.

I-And has this perception been affected by completing the simulation or not?

P-Erm, I guess, because I haven't made an error in practice, but I did make an error in the simulation, and it was probably, yeah it made me more aware of I can make a mistake obviously, but erm yeah... i don't know...

I-That is fine. And erm, how likely do you think it is that you will make an error in comparison to other nurses?

P-Erm, I think perhaps as a graduate, it is fresh in your mind, you are fresh out of university, you have still got the pressure that you have in school to do everything right when perhaps as you go on you might become a little bit more complacent. I don't want to stereotype or anything, it is all down to the person and the situation, it is pretty hard to say.

I-Okay and how would you classify the experience of completing the simulation in comparison to other teaching methods of safe administration of medications?

P-Erm, I don't really remember much about my OSCE practice, er, sorry, I don't think we had enough... er we had lots of drug calculation tuition but as far as administering drugs I feel we had enough teaching in uni. So whether that or clinical skills labs or relation type scenarios with patients, yeah I don't know really.

I-Okay, and did teaching in university and on placement about drug administration, did you feel taht worked in conjunction together or not at all?

P-Erm, yeah, obviously putting theory into practice worked quite well so and you know, they taught the right stuff. It wasn't like we were taught something completely different in practice. Erm, yeah, although certain things not great but most of it was the same.

I-OK and the simulation, how useful a method do you feel it is to teach for learning.

P-Of it is used regularly, you know as access if feeling a bit rusty or when people go back on placement they might want to practice it. I think it was good as well, helpful as a reminder, but just as a one off I don't really remember much sorry .

I-That is fine, and a simulation as a method of learning in general, what is your opinion on them?

P-As long as you can put it into practice at some point and it is obviously better than, erm, instead of having someone standing up and telling you, it is a good way of putting theory into practice I suppose.

I-Okay and did you find this particular simulation useful for your learning.

P-Yeah I did because it made me aware of you know, that my perception lacked a bit and I made a mistake, so obviously it sort of makes you realise that you can make an error and to be more careful.

I-Okay, and just talking about the actual simulation in itself, erm did you feel, just to remind you that you said that you only remembered it vaguely, how well did you think the simulation actually represented and simulated medication administration?

P-Erm, I don't know it is really quite hard to say. I don't know if there was that many patient scenarios, I think we only did it for ten minutes, or for however long we did it for it wasn't that long...

I-It was ten minutes so you remembered that quite well!!!

P-Laughter. So obviously perhaps a lot more scenarios and more patients to choose from and I don't know really, I think it was a good tool to have and be available to students.

I-That is absolutely fine. You have sort eluded to some improvements such as having more patient's and scenarios, are there anymore alterations that you could suggest?

P-You know, I can't remember it very well enough to, I can't really remember... the way it was set out I think it was ok

I- Any thing else you would like to add?

No I don't think so – if we had it more often – that would be good.

Interview Summary

Appendix P Long-term Qualitative Interview Study

Thematic Analysis

Participant 1

Value to Learning

_ just a different way of learning for other people- what looked like a scanned front sheet of a normal drug chart

- It did help to highlight... consider everything, don't always go through everything with a fine tooth comb

-to more of the theory behind what you would do to that patient

-a few scenarios and they would say this is the drug chart you would click and a pdf chart would come up and then you would read through that and then you were given a list of drugs and doses and your given a diagram of patients, so then you would select the right patient and you would check the information that comes up once you have selected that patient to the information on the card you are given in pdf and then you would decide whether you would give that or not

- pening your eyes a little bit more (inaudible) blinkers for looking at everything holistically so I think being challenged in that way within the practical aspects of would be a good way of changing things around

- I think a simulation is great for adding on and solidifying the knowledge

- Yes helpful, absolutely

- It did show that it has occurred in a few places Names are one thing, and the whole assumptions, nurses shouldn't assume.

- You may think that the actual simulation was wrong, but it wasn't, it was testing you ability to understand that things do change on the ward and that you should stay there and watch them take the drugs and should be able to see it be swallowed and that person may not be in the bed and they may move around.

- I always remembered it in myself, even now when I am on practice and I still remember the five rights and the whole procedure and it gets drilled into your head what to do systematically, not only with the rights with the drug charts

- is the crucial point that you come to and even though you know you are being tricked, you know everything suddenly gets a microscope out and you check everything thoroughly, which is what you should do anyhow

- It did make you check,

-I think it was able to give me different situations that you may not be able to receive in a lecture slot so you consider things other than just hearing what you should do, you were able to practically, although not really practically, be example it yourself as if you were in charge

- I think the simulation of medication simulation is great for tidying the knots of what we were told, but there is not different from actually doing in practical

- its a good way of adding.. you know, like changing things around

This Is Quite Relevant - Relevant to Practice

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- It made you think more about things that could go wrong
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- is the crucial point that you come to and even though you know you are being tricked, you know everything suddenly gets a microscope out and you check everything thoroughly, which is what you should do anyhow

Still With Me Today -Bridging Practice Theory Gap

- to make sure that things are not always black on white and as white as they seem and there is that unpredictability in the workplace and that things do change and you should be able question and know exactly what you are doing.
- I think it was able to give me different situations that you may not be able to receive in a lecture slot so you consider things other than just hearing what you should do, you were able to practically, although not really practically, be example it yourself as if you were in charge
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- that it is more than just a tablet that you are giving that you need to think about, that you need to know what you are giving and you need to consider how that is going to affect the patient completely while they are on the ward so it moves the task from the physical to the more holistic approach of considering everything.
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Go Through Checks - How We Should Check

- _ to make sure that things are not always black on white and as white as they seem and there is that unpredictability in the workplace and that things do change and you should be able question and know exactly what you are doing.
- _ I learnt, you know, to keep yourself in check
- _ It is not always going to be wrong, but its good to keep on questioning and keep on the ball what you are doing
- _ It did help to highlight... consider everything, don't always go through everything with a fine tooth comb
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- So I think it highlights that I am accountable at the end of the day and that to rely on me and not on the patient

- I always remembered it in myself, even now when I am on practice and I still remember the five rights and the whole procedure and it gets drilled into your head what to do systematically, not only with the rights with the drug charts

_ Yes The Simulation was able to give you direct feedback, should you have done something wrong or should you have considered something else, it actually told you may you want to look back at that it give you direct feedback when you need it

I Made an Error – Surprise and Questioning Current Practice

It's Easy But Not So Easy

_ to make sure that things are not always black on white and as white as they seem and there is that unpredictability in the workplace and that things do change and you should be able question and know exactly what you are doing

- opening your eyes a little bit more (inaudible) blinkers for looking at everything holistically so I think being challenged in that way within the practical aspects of would be a good way of changing things around

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_ It is not always going to be wrong, but its good to keep on questioning and keep on the ball what you are doing

_ It made you think more about things that could go wrong

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- So I think it highlights that I am accountable at the end of the day and that to rely on me and not on the patient

- it expands your feelings about being a student nurse that you have that ability to question things can go wrong

- is the crucial point that you come to and even though you know you are being tricked, you know everything suddenly gets a microscope out and you check everything thoroughly, which is what you should do anyhow

- its a good way of adding.. you know, like changing things around

-Yes, absolutely. It made you think more about things that could go wrong)and maybe not only see things as numbers but consider them more as a holistic approach

I Felt Terrible – Emotional Reaction

The Damage I Could Do – Appreciating Risk in Clinical Practice

- There are people you don't know who may not take them and it could end up in an over dose or it may not be taken at all and it may result in more problems if it is some other drug

- it expands your feelings about being a student nurse that you have that ability to question things can go wrong

- is the crucial point that you come to and even though you know you are being tricked, you know everything suddenly gets a microscope out and you check everything thoroughly, which is what you should do anyhow

I'm Accountable – Professional Responsibility

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- It did make you check

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- it expands your feelings about being a student nurse that you have that ability to question things can go wrong

- if you did see something on a drug chart you shouldn't just automatically give. (9) It is not just the role doctor nurse relationship that it was, that doctors are right all the time

- is the crucial point that you come to and even though you know you are being tricked, you know everything suddenly gets a microscope out and you check everything thoroughly, which is what you should do anyhow

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- Yes The Simulation was able to give you direct feedback, should you have done something wrong or should you have considered something else, it actually told you may you want to look back at that it give you direct feedback when you need it

Ordinary Drug Round – Sufficiently Realistic

-to more of the theory behind what you would do to that patient

- what looked like a scanned front sheet of a normal drug chart

-a few scenarios and they would say this is the drug chart you would click and a pdf chart would come up and then you would read through that and then you were given a list of drugs and doses and your given a diagram of patients, so then you would select the right patient and you would check the information that comes up once you have selected that patient to the information on the card you are given in pdf and then you would decide whether you would give that or not

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- But Its good to have all the rest of the information that you would normally have available at a click of a button

- Yes The Simulation was able to give you direct feedback, should you have done something wrong or should you have considered something else, it actually told you may you want to look back at that it give you direct feedback when you need it

-I think it was able to give me different situations that you may not be able to receive in a lecture slot so you consider things other than just hearing what you should do, you were able to practically, although not really practically, be example it yourself as if you were in charge

- I think the simulation of medication simulation is great for tidying the knots of what we were told, but there is not different from actually doing in practical

- opening your eyes a little bit more (inaudible) blinkers for looking at everything holistically so I think being challenged in that way within the practical aspects of would be a good way of changing things around

Watch Out – Clinical Practice is Changeable

- It made you think more about things that could go wrong

- to make sure that things are not always black on white and as white as they seem and there is that unpredictability in the workplace and that things do change and you should be able question and know exactly what you are doing.

-, that it is more than just a tablet that you are giving that you need to think about, that you need to know what you are giving and you need to consider how that is going to affect the patient completely while they are on the ward so it moves the task from the physical to the more holistic approach of considering everything.

-Changes of patient date of birth, any queries on the drug chart, signatures, times, if things were given prn or whenever necessary, and then you were told to give another dose so you then had to query that

- its a good way of adding.. you know, like changing things around

- It did show that it has occurred in a few places Names are one thing, and the whole assumptions, nurses shouldn't assume.
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So That's How Error Occurs

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Brought Practice into the Classroom

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Different Education Experience

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Participant 2

Value to Learning

- It was quite a good programme for that

- I think it was one of the first realisations that I really had about how easy it is to make a drug error

- I think, I don't know, I think it gave, in a way, I think it kinda gave you an idea of whether you were right or wrong at the end

- Yes I suppose, I think that is when I really started really checking and double checking I suppose

- YEP which was actually very good because of course everyone thinks they are doing everything perfectly all of the time, and of course you get to the end and it would show you have made two or three drug errors

- you know and you're not really sure about that, but it was actually quite an eye opener to see that actually. I think it was quite useful actually, as a student nurse it was very useful to highlight how easy it was to make a mistake and not really realise

- I was definitely a lot more vigilant after it was mentioned. I think so actually. I can't remember myself actually applying the five rights when I was doing the programme though, I think I kind of didn't put the two and two together when I did it if you know what I mean

- yes when I went onto the ward, I now do check everything and double check things now, but I don't know if maybe that is whether I have just got into the habit and got into the third year now where you

- I think that was quite good

- Whereas in the practical sessions in uni, you don't really get the opportunity to make an error because if you are going to make it, it will be highlighted in such a way that makes you think oowwww

- I think it did help actually I think it erm, I think... yes it did because it highlighted to everyone can make mistakes I think

- And although no one thinks they are invincible, I think it did help, I did make us all realise it is easy to make a mistake

- It is easy to pick holes in it if you were to ask me which way is better, to learn in practice or to learn in college you obviously there is a difference there but, learning in college as a half way measure is, yeah, as long as students are willing to accept that it is a half way kind of thing and kind of get on with it I think actually, yeah, it worked for me. I think, you know, it was definitely a positive experience for me

- I think it highlighted the possibility for error

- That wasn't quite what the feeling was, but the feeling was oh gosh, originally I couldn't quite work out what I had done wrong to the patient... .. I couldn't work out... so I felt if I can't even recognise it when I

have done something wrong, I felt like... oh gosh... But yes, so the memorable thing that came out of it was how easy it would have been to make a drug error

- Yes I think it was effective.. Because it made you think

-it did have a few more complications... a certain amount of complications which I suppose was good... It wasn't just you know, it wasn't just a simple exercise, it was more complicated. I think erm it also... it did use...I think what I liked at the time, it confused me a bit, so it was erm, it did use a range of medication

This Is Quite Relevant – Relevant To Practice

- It was quite a good programme for that

- So you have to be a bit more vigilant about that

-it did have a few more complications... a certain amount of complications which I suppose was good... It wasn't just you know, it wasn't just a simple exercise, it was more complicated. I think erm it also... it did use...I think what I liked at the time, it confused me a bit, so it was erm, it did use a range of medication

- Yes I think it was effective.. Because it made you think

- It is easy to pick holes in it if you were to ask me which way is better, to learn in practice or to learn in college you obviously there is a difference there but, learning in college as a half way measure is, yeah, as long as students are willing to accept that it is a half way kind of thing and kind of get on with it I think actually, yeah, it worked for me. I think, you know, It was definitely a positive experience for me

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Still With Me Today - Bridging Practice Theory Gap

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I Made An Error – Surprise and Questioning Current Practice

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- I think it went back and showed you the mistakes that you made I think it was

- I don't remember a huge amount of detail , but one of the things I do remember quite clearly was thinking oh gosh... I am going to kill someone

- and I think there were guilt feelings, (5,6,7,) the same as mine probably, yeah, and then others were just like me thinking oh gosh actually it is quite easy to make an error

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- I think we were ticked off about it actually

- I think it was one of the first realisations that I really had about how easy it is to make a drug error

I Felt Terrible – Emotional Reaction

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The Damage I Could Do – Appreciating Risk In Clinical Practice

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- It wasn't a life-threatening error!

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Ordinary Drug Round – Sufficiently Realistic

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- Yes I think it was effective.. Because it made you think

- it did have a few more complications... a certain amount of complications which I suppose was good... It wasn't just you know, it wasn't just a simple exercise, it was more complicated I think erm it also... it did use...I think what I liked at the time, it confused me a bit, so it was erm, it did use a range of medication

NOT Realistic

but again it didn't take into account the environment or the situation the patient was in. So, you know, so, well you couldn't, for certain medications, you might not give them all the pain medication for example, if the patient's pain is more under control

- I think the programme needed a bit more work

- I think that was quite good

- Whereas in the practical sessions in uni, you don't really get the opportunity to make an error because if you are going to make it, it will be highlighted in such a way that makes you think oowww

- but again it wasn't very realistic

-, but of course with some of them, you couldn't do the things you needed to do in medicine administration, like, you know, giving the ibuprofen, you couldn't ask them if they had eaten 10 or erm, you know that kind of thing, quite important things , quite important things when you are doing the drug round

- I think it was one of the first realisations that I really had about how easy it is to make a drug error

- again i think it was the interaction really, but yeah, and also, there were a certain number of options, I can't remember if it was multiple choice or whether you had to, I can't remember exactly how it was done, it was a while ago now

- occasions where you think actually I am not going to give that medication to that patient for this reason ererehum and you know you can write it on the drug chart to say why which is always covered in a session

the programme is wrong essentially because of the inflexibility in the programme. Well that is not what I meant, so the programme is wrong and some were, well it is unrealistic anyway

- learning in college as a half way measure is, yeah, as long as students are willing to accept that it is a half way kind of thing and kind of get on with it I think actually, yeah, it worked for me.

Watch Out – Clinical Practice is Changeable

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So That's How Error Occurs

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Brought Practice into the Classroom

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Participant 3

Value to Learning

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-In just to make you think that it didn't occur to me before that you could have the right patient/drug and then have another patient sitting in somebody else's bed space, so just to make sure you check the name band every time

- It was the same people that were coming up just sitting in different places erm so it did make you think and I had not thought of it before

- you go back just to double check the name bands just in case they were sitting somewhere differently

- like so every time you in practice now

- well it made you think you definitely have to double and triple check everything had it been real, that would be good

- To check and to like double triple check again

- It was the people were moving bed spaces and because you already had administered medications to that person, you didn't check their name again, I think that was the main one, yes. Yes, ahah, that was the main thing I think I got out of it

This Is Quite Relevant – Relevant To Practice

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- you go back just to double check the name bands just in case they were sitting somewhere differently

- like so every time you inpractice now

- well it made you think you definitely have to double and triple check everything had it been real, that would be good

- To check and to like double triple check again

- It was the people were moving bed spaces and because you already had administered medications to that person, you didn't check their name again, I think that was the main one, yes. Yes, ahah, that was the main thing I think I got out of it

I Made an Error – Surprise and Questioning Current Practice

_the computer thing was good because we checked like the names, but the people would move beds so then like when it came up that you've got five wrong, I thought oh I've got five wrong, and then I had to go back and see oh yeah which bits were wrong and it was because like people had been moving beds and so you were giving medications to somebody who had been sitting in the wrong place! If that makes sense

-In just to make you think that it didn't occur to me before that you could have the right patient/drug and then have another patient sitting in somebody else's bed space, so just to make sure you check the name band every time

- I thought I definitely got them all right and was a bit shocked when I realised that I didn't get them all right.

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It's Easy But Not So Easy

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I Felt Terrible – Emotional Reaction

-If it was a real error I would feel guilty

-Horrid

The Damage I Could Do – Appreciating Risk In Clinical Practice

- You don't want to do that for real... real patient.

I'm Accountable – Professional Responsibility

_the computer thing was good because we checked like the names, but the people would move beds so then like when it came up that you've got five wrong, I thought oh I've got five wrong, and then I had to go back and see oh yeah which bits were wrong and it was because like people had been moving beds and so you were giving medications to somebody who had been sitting in the wrong place! If that makes sense

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Like the Real Thing – Sufficiently Realistic

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- Which were a bit embarrassing, that was a bit of a shock I thought I was fine. I thought I did the five rights but obviously didn't!!!

- the patients can change position

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Watch Out – Clinical Practice is Changeable

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- It was the same people that were coming up just sitting in different places erm so it did make you think and I had not thought of it before

- practice, like you definitely make sure like, even if you were doing like the second drug round of the day, so you don't know

- you go back just to double check the name bands just in case they were sitting somewhere differently

- well it made you think you definitely have to double and triple check everything had it been real, that would be good

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Brought Practice Into The Classroom

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- It was the people were moving bed spaces and because you already had administered medications to that person, you didn't check their name again, I think that was the main one, yes. Yes, ahah, that was the main thing I think I got out of it
- It was definitely a positive experience for me because it did bring practice into the classroom

Different Education Experience

- _ all that. Erm and then we had the computer one, where we had to like match the prescriptions to the person on the computer, which was quite good as well
- the computer thing was good because we checked like the names, but the people would move beds so then like when it came up that you've got five wrong, I thought oh I've got five wrong, and then I had to go back and see oh yeah which bits were wrong and it was because like people had been moving beds and so you were giving medications to somebody who had been sitting in the wrong place! If that makes sense
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- It was the same people that were coming up just sitting in different places erm so it did make you think and I had not thought of it before
- but the computer simulation is just that bit extra
- It was the people were moving bed spaces and because you already had administered medications to that person, you didn't check their name again, I think that was the main one, yes. Yes, ahah, that was the main thing I think I got out of it.

Participant 4

Value to Learning

- _ I remember completing it, I remember doing it, erm I remember thinking actually this is quite relevant, because a lot of the sessions we had had up until that point had been optional or had been based upon the traditional method of multiplication, long division
- I remember thinking actually this is a bit more relevant because it kind've fuses what we needed to know theoretically and what we are going to be doing practically.
- you have to make sure you complete practice as safe as you can possibly do
- So it kind've developed my knowledge and from that I learnt.
- is that you all make a similar mistake and learn from that because you are aware on how you make your mistakes, and you are likely to be more aware of that when you go into practice and kind of pay more attention to that
- I did think it was very good. I think it was just one session, and I think it would have been good if there were more than that and perhaps also tie that in with a reflection at the end.
- Like I say it has kind've reinforced the importance of checking and rechecking and doing all that is within your power to do
- it is not a tangible example, but it is something that I kinda like took away from that and you know still practice, is still with me today

- Yeah, it was like on the ward and it was good because it was different from the rest, stood out, but can't remember exactly, if that makes sense! Just a different set up, yeah that was good and also I made some mistakes I remember that.

- laying the foundation for me to build upon in practice in terms of making sure that I was always safe in drug administration. So it kind've developed my knowledge and from that I learnt. You know, like anyone, but for me, the best way to do things, whatever it happens to be it just made me much more aware how to be safe and like not just going off because another nurse told you it was ok to give and making sure you check the prescription yourself, making sure the date, it is just really confirmed how important safety is.

- Which were a bit embarrassing, that was a bit of a shock I thought I was fine. I thought I did the five rights but obviously didn't!!!

- That was helpful it reminded me why they are important

- what did I say it fused.

- People tell you what to think, but until you do it yourself you don't fully understand it and I think that is something that the simulation did build upon. And it kinda like really brought it home how easy it would be to make those kind of errors.

- Yes, realised I could make that mistake

- it is still important to check that the patient has no allergies and it is the right patient and the right dose and that kind of thing, so yeah, I think I took that away from it. Question everything, I think that sums it up, question everything.

- I think er, yeah it really conserved it kinda like embedded it.

- It made me aware of how high the risks are whereas before I was just made aware that medication errors happen all the time and near misses and that kind of stuff, so to actually partake in it erm, it kinda gave me that extra dimension

- in respect of, like I say, making me more cautious

- I think that was something that perhaps the simulation could be done. Because it is designed to show people I think how easy it is to make errors, but also to show you how errors occur.

This Is Quite Relevant – Relevant To Practice

- I remember completing it, I remember doing it, erm I remember thinking actually this is quite relevant, because a lot of the sessions we had had up until that point had been optional or had been based upon the traditional method of multiplication, long division

- you have to make sure you complete practice as safe as you can possibly do

- it just made me much more aware how to be safe and like not just going off because another nurse told you it was ok to give and making sure you check the prescription yourself, making sure the date, it is just really confirmed how important safety is. You have to do everything you possibly can to ensure your practice is safe. Though in that respect, like I said, it is not a tangible example, but it is something that I kinda like took away from that and you know still practice, is still with me today.

- is that you all make a similar mistake and learn from that because you are aware on how you make your mistakes, and you are likely to be more aware of that when you go into practice and kind of pay more attention to that

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Still With Me Today - Bridging Practice Theory Gap

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Go Through Checks – How We Should Check

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-is that you all make a similar mistake and learn from that because you are aware on how you make your mistakes, and you are likely to be more aware of that when you go into practice and kind of pay more attention to that

I Made An Error – Surprise and Questioning Current Practice

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I Felt Terrible – Emotional Reaction

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- Just I could have hurt someone and what will happen when I am giving out medication by myself. I thought oh Gosh, I have to be more careful, that was a shock, the damage I could do

- Thankfully it was only a simulation. So actually I remember feeling relieved. Does that make sense??

The Damage I Could Do – Appreciating Risk In Clinical Practice

-Just I could have hurt someone and what will happen when I am giving out medication by myself. I thought oh Gosh, I have to be more careful, that was a shock, the damage I could do

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- laying the foundation for me to build upon in practice in terms of making sure that I was always safe in drug administration. So it kind've developed my knowledge and from that I learnt. You know, like anyone, but for me, the best way to do things, whatever it happens to be it just made me much more aware how to be safe and like not just going off because another nurse told you it was ok to give and making sure you check the prescription yourself, making sure the date, it is just really confirmed how important safety is.

- you have to make sure you complete practice as safe as you can possibly do

-And I think the situation that you are in plays a really big part in that, so like I say, if you are short staffed, you've got too many patients, or one patient that it is really unsafe for you to have, all those things come into play so I think a nurse can only be as good as she can be in any given situation

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- Incredibly important, really important, because you cannot as a nurse, baring in mind the professional code of practice you operate under, you sign up for, you have to, that has to be a given, you have to make sure your practice is safe.

-And I think the situation that you are in plays a really big part in that, so like I say, if you are short staffed, you've got too many patients, or one patient that it is really unsafe for you to have, all those things come into play so I think a nurse can only be as good as she can be in any given situation

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- It made me aware of how high the risks are whereas before I was just made aware that medication errors happen all the time and near misses and that kind of stuff, so to actually partake in it erm, it kinda gave me that extra dimension
- because if you are only looking after four or five patients the chances are your errors are going to be lower than if you were looking after twelve to fifteen patients and so other factors do come into play in that
- in respect of, like I say, making me more cautious
- laying the foundation for me to build upon in practice in terms of making sure that I was always safe in drug administration. So it kind've developed my knowledge and from that I learnt. You know, like anyone, but for me, the best way to do things, whatever it happens to be it just made me much more aware how to be safe and like not just going off because another nurse told you it was ok to give and making sure you check the prescription yourself, making sure the date, it is just really confirmed how important safety is.
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Ordinary Drug Round - Sufficiently Realistic

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- Which were a bit embarrassing, that was a bit of a shock I thought I was fine. I thought I did the five rights but obviously didn't!!!
- the patients can change position
- , yes, the way it was laid out was very similar to how it would be in a practice environment.. But that is the difference between that method and a traditional classroom based method...Is that the traditional classroom based method is quite far removed from the practice environment, the reality of the practice environment. Whereas I think the simulation was much more like that.

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- Some things are out of your control, erm, something's you cannot control for, but, the things that are within your control

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- People tell you what to think, but until you do it yourself you don't fully understand it and I think that is something that the simulation did build upon. And it kinda like really brought it home how easy it would be to make those kind of errors.

- I did think it was very good. I think it was just one session, and I think it would have been good if there were more than that and perhaps also tie that in with a reflection at the end.

-, yes, the way it was laid out was very similar to how it would be in a practice environment.. But that is the difference between that method and a traditional classroom based method...Is that the traditional classroom based method is quite far removed from the practice environment, the reality of the practice environment. Whereas I think the simulation was much more like that.

Different Education Experience

_ I remember completing it, I remember doing it, erm I remember thinking actually this is quite relevant, because a lot of the sessions we had had up until that point had been optional or had been based upon the traditional method of multiplication, long division

- I remember thinking actually this is a bit more relevant because it kind've fuses what we needed to know theoretically and what we are going to be doing practically.

- Yeah, it was like on the ward and it was good because it was different from the rest, stood out, but can't remember exactly, if that makes sense! Just a different set up, yeah that was good and also I made some mistakes I remember that.

-It made me aware of how high the risks are whereas before I was just made aware that medication errors happen all the time and near misses and that kind of stuff, so to actually partake in it erm, it kinda gave me that extra dimension

- People tell you what to think, but until you do it yourself you don't fully understand it and I think that is something that the simulation did build upon. And it kinda like really brought it home how easy it would be to make those kind of errors.

- Which were a bit embarrassing, that was a bit of a shock I thought I was fine. I thought I did the five rights but obviously didn't!!!

- I did think it was very good. I think it was just one session, and I think it would have been good if there were more than that and perhaps also tie that in with a reflection at the end.

-, yes, the way it was laid out was very similar to how it would be in a practice environment.. But that is the difference between that method and a traditional classroom based method...Is that the traditional classroom based method is quite far removed from the practice environment, the reality of the practice environment. Whereas I think the simulation was much more like that.

Participant 5

Value to Learning

- Yes that was...it was quite a good exercise
- I was like, oh okay, patients wander, that you had to actually think about the five rights as you were doing it. So yeah
- Yes I think that my big take home point was the patient might not always be the patient you are expecting it to be
- I think the ones that I got wrong were those ones that it was the patient one that ... those were the ones that stuck with me I thought I had better remember that one for the ward
- Two or three? I think after I made the first couple I learnt the next.
- Like I'm thinking what did I learn from it and that will stay with me
- now that you are reflecting on it, would you say that part of your checking was attributed to it or not at all?
- Erm I think it probably was yeah Yeah, yeah.
- I take them, yes, it's of paramount importance I think to know why you are doing stuff, because otherwise I think people would be tempted not to do them and just pop the pills, yeah, I think sorry, very important
- all the points of the theory, ie, the right drug, right dose etc, were covered. And the there was more than one option, there were multiple options and scenarios changed as they kind of would on the ward. Yes.
- because of the patient moving thing. I think other people, all my friends did report oh okay I was giving the wrong dose and all the packets looked the same, this kind of thing, So, knowing I need to check that the patient's right and the tablet is right erm arose from those mistakes made. Erm and if I hadn't made them and hadn't known why it was important, but you know the patient has to have the drug prescribed then I wouldn't know to change my practice.

No

- In terms of drug administration itself, not too much.
- Whereas I didn't see all the need in the first year to the revision. Where I think it might be seeing it differently now is purely because of this interview. Like I'm thinking what did I learn from it and that will stay with me. I think without this interview and I still have the problem with that in the first year, I would have, yeah, forgotten it and not reflected back on it. So, yeah.
- Yes, I always do practice the five rights
- And erm, not attributed it to that. Now I always do check my patient's name band and that kinda thing before I give the drugs but I wouldn't have attributed it to the skills session itself, the simulation thing

This Is Quite Relevant – Relevant To Practice

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Still With Me Today - Bridging Practice Theory Gap

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- I was like, oh okay, patients wander, that you had to actually think about the five rights as you were doing it. So yeah

- How clearly do you remember doing it? -Oh yeah, like very easily

- Yes I think that my big take home point was the patient might not always be the patient you are expecting it to be

- I think the ones that I got wrong were those ones that it was the patient one that ... those were the ones that stuck with me I thought I had better remember that one for the ward

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- I know that is understating myself, but I know that when things are really busy it is really easy to make mistakes. I hope that, because I am aware of that I would be rigorous in my checking.

Go Through Checks – How We Should Check

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I Made An Error – Surprise and Questioning Current Practice

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- Err it made me feel a bit stupid because I was like well...if it had happened in the ward, that would make me feel really sick, erm and yet I was glad that I had done it on the simulation and not in practice, yes.

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I Felt Terrible – Emotional Reaction

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The Damage I Could Do – Appreciating Risk In Clinical Practice

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- I know that is understating myself, but I know that when things are really busy it is really easy to make mistakes. I hope that, because I am aware of that I would be rigorous in my checking.

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I'm Accountable – Professional Responsibility

- I think the ones that I got wrong were those ones that it was the patient one that ... those were the ones that stuck with me I thought I had better remember that one for the ward

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-Yes, I always do practice the five rights

- But erm I learnt how hard it would be to report the error even, like I said, I didn't even tell my friends that I got some wrong.

-because of the patient moving thing. I think other people, all my friends did report oh okay I was giving the wrong dose and all the packets looked the same, this kind of thing, So, knowing I need to check that the patient's right and the tablet is right erm arose from

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Ordinary Drug Round – Sufficiently Realistic

-what I remember from that is the patient, when we were giving the drugs, wasn't always the patient we thought it was

- I was like, oh okay, patients wander, that you had to actually think about the five rights as you were doing it. So yeah

- Yes I think that my big take home point was the patient might not always be the patient you are expecting it to be

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- I know that is understating myself, but I know that when things are really busy it is really easy to make mistakes. I hope that, because I am aware of that I would be rigorous in my checking.

- I think it did it really well. I wouldn't know how to improve it as a computer simulation in itself.

- all the points of the theory, ie, the right drug, right dose etc, were covered. And the there was more than one option, there were multiple options and scenarios changed as they kind of would on the ward. Yes.

Reflection

I don't tend to, that is the only one I have ever experienced. Erm, I think it works well erm, but I think, other simulations, if it was erm, done differently, more the introduction to it explained a bit more thoroughly, it could be of much more use. If you think of the media it is quite cool and works quite well for the future.

Watch Out – Clinical Practice is Changeable

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So That's How Error Occurs

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Brought Practice into the Classroom

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Participant 6

Value to Learning

- so it was pretty much along the terms of like the five rights so it was the five rights, or something like that
 - Basically, a lot of it just seemed to be about the five rights, knowing your patient, knowing what time we had to give the drug erm to the patient, erm and time, things like that. It was a good experience. It was a bit confusing but it was a good experience.
 - Yes because you had the face, you had the name, erm, like I said, erm and it basically you felt like you was, okay, you wasn't there in an actual hospital setting, but erm you could see that it was just an ordinary drug round
 - it just highlighted the fact that there is room for error and
 - Oh definitely, I think, we are human and we can all make mistakes erm so yes I suppose we can all learn something from mistakes. We can try and learn from it and get better.
 - Yes, because you could have potentially killed a patient! Erm in my drug calculation tests I have always got ten out of ten, in my summative. So that has made me feel that I haven't killed or potentially harmed anybody. Erm but in that simulation when I knew that I possibly made an error, that's a thought that went through my mind that I have potentially harmed someone. That I have given them something that potentially they shouldn't have been given, or I have given it at the wrong time, or it's just totally the wrong patient. So yeah, that's my feeling with drug administration, a bit guilty really.
 - Yeah, I think so because you are dealing with vulnerable people, sick patients so if you are unsure of anything, you shouldn't just go ahead and administer the drug anyway. You should check and recheck or and get somebody else to do it for you or if you are unsure you get clarification from somebody. You don't ...
- NO
- no because nothing beats the real thing when you are there in person. Erm, I don't think anything can really prepare you for the real thing, when you are actually doing it.

- I think it can be useful. Erm cause it can be seen as, like a mini preparation of what you are going to be doing.

- I just thought it was a different way of learning. That is the way I looked at it. I looked at it as a different way of learning drug administration. Erm, yes because it was like a simulation of the real thing, like the real thing, being on the ward and doing it for real.

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No

- I mean it is good to have that, like as a little taster, erm I don't see how it would be beneficial.

Still With Me Today Bridging Practice – Theory Gap

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I Made An Error – Surprise and Questioning Current Practice

-I would say yes because obviously I would not act so hasty in doing it, but then I know when I am out in practice I don't act like very hasty.

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I Felt Terrible – Emotional Reaction

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-Yes, because you could have potentially killed a patient! Erm in my drug calculation tests I have always got ten out of ten, in my summative. So that has made me feel that I haven't killed or potentially harmed anybody. Erm but in that simulation when I knew that I possibly made an error, that's a thought that went through my mind that I have potentially harmed someone. That I have given them something that potentially they shouldn't have been given, or I have given it at the wrong time, or it's just totally the wrong patient. So yeah, that's my feeling with drug administration, a bit guilty really.

-Scared.

- Erm, no, it kind of prayed on my mind throughout the day. Erm, yeah, as I say it prayed on my mind throughout the day and after that I forgot about it.

The Damage I Could Do – Appreciating Risk In Clinical Practice

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I'm Accountable – Professional Responsibility

-I would say yes because obviously I would not act so hasty in doing it, but then I know when I am out in practice I don't act like very hasty.

-Scared.

-Yes, because you could have potentially killed a patient! Erm in my drug calculation tests I have always got ten out of ten, in my summative. So that has made me feel that I haven't killed or potentially harmed

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Like The Real Thing – Sufficiently Realistic

-Basically, a lot of it just seemed to be about the five rights, knowing your patient, knowing what time we had to give the drug erm to the patient, erm a nd time, things like that. It was a good experience. It was a bit confusing but it was a good experience.

-Yes because you had the face, you had the name, erm, like I said, erm and it basically you felt like you was, okay, you wasn't there in an actual hospital setting, but erm you could see that it was just an ordinary drug round

-, it wasn't stressful. It was er, it was something that you would do on a day to day basis as a nurse. Erm so in that respect it seemed like it was, it was like a day on the ward basically as opposed to going into a drug calculation test. It did seem more real with being under pressure.

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-- I just thought it was a different way of learning. That is the way I looked at it. I looked at it as a different way of learning drug administration. Erm, yes because it was like a simulation of the real thing, like the real thing, being on the ward and doing it for real.

No

-no because nothing beats the real thing when you are there in person. Erm, I don't think anything can really prepare you for the real thing, when you are actually doing it.

Watch Out – Clinical Practice is Changeable

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-or I think names got muddled up and I am sure the simulation didn't go how it was actually supposed to. Like may the name was wrong, it didn't match with the right patient or something like that. Cause I remember a few of us were talking about it afterwards and then, or may be like on the next question it would be the same picture of that person but they have got a totally different name so...

- I just think in a ward setting, that when you are doing drug administration you shouldn't be distracted so er, you can do the drugs properly. So, yeah I did learn something from it.

So That's How Error Occurs

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Brought Practice Into The Classroom

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- so it was pretty much along the terms of like the five rights so it was the five rights, or something like that

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Different Education Experience

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- I think it can be useful. Erm cause it can be seen as, like a mini preparation of what you are going to be doing.

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Participant 7

Value to Learning

- Erm I remember you had a few patients up there in pictures. You would click on a patient, see their name and you could click on their drug charts to see and read first to see what was due when what you knew what was due, you could then click on a kind've like a shortened BNF list of drugs er then you could click on the one you wanted, select how many tablets you wanted and then you pressed the dispense button and then they went into like a little drawing of a pot and when you felt you had all the medications that you had you would go back to the patient and sometimes the patient would have changed, they would have moved beds so you had to check that you selected the right one. Erm, I remember one of the first ones I made an error because I didn't realise the picture was different and so obviously I, er gave them to the wrong patient.

-I think it came alive, especially when considering the errors that I made.. They were ones where I kind've obviously hadn't realised how erm important some of the theory is, obviously about identification and things

-I think now having completing it and knowing that I was perceptible to errors erm, it kind of made me more aware of the fact that I am perceptible

-We had always been told, but obviously the simulation brought it to my attention just that much more. It reinforced it in my mind and I thought okay look, you've had your chance, don't do it again.

-Like I don't want to be complacent in what I am doing and obviously drug administration, you know is an area of nursing where it can go wrong very easily, where just what can seem as a minor error can become complicated

- you get a flash back to classes and the simulation and say ok, what process do I go through, what factors do I need to be sure of?

-I still remember doing it, quite clearly actually. Erm I can still picture this computer screen and where you had to click and what sort of things went on

- I know obviously it is only a simulation and at the time I kinda thought well learn from this, remember you have done this in the simulation, you don't want to do this anywhere else

-but I found it really important to remember the whole process and it made it a firm memory in my head of how to go through drug administration

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-I never, never felt concerned about because I already know how thoroughly I check it, whereas obviously the simulation brought to my attention that the patient identity was something that could be an issue even if it was only a simulation.

-was aware that it was a simulation and in my head I was thinking it was not quite realistic, er it kind of reminded me that no, I do need to take it seriously no matter what happens

This Is Quite Relevant – Relevant To Practice

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Still With Me Today - Bridging Practice Theory Gap

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I Made an Error – Surprise and Questioning Current Practice

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- I think I felt very disappointed in myself because I knew I knew how to do this, but I still managed to do it wrong

It's Easy But Not So Easy

- because in class you sometimes go through the drug chart but it is different when you have like a simulated patient and you realise actually no, there is room for error there as well

-I never expected it to be too complicated

-I think now having completing it and knowing that I was perceptible to errors erm, it kind of made me more aware of the fact that I am perceptible

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Ordinary Drug Round – Sufficiently Realistic

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- I think using a simulation is good, it worked well

Watch Out – Clinical Practice is Changeable

- because you could see where the errors might occur

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-I think it reminded me of just how important it is to always check the patient's identity erm being sure, even if you think you know the patient I check anyway , I don't know, not that I am paranoid, just...but I always check the wristband, even if I know the patient and have worked with them for days. I just confirm that the drug chart I have correlates with the drug chart I have

-Like I don't want to be complacent in what I am doing and obviously drug administration, you know is an area of nursing where it can go wrong very easily, where just what can seem as a minor error can become complicated

-We had always been told, but obviously the simulation brought it to my attention just that much more. It reinforced it in my mind and I thought okay look, you've had your chance, don't do it again.

-never expected it to be too complicated

So That's How Error Occurs

never expected it to be too complicated

- because you could see where the errors might occur

-I know obviously it is only a simulation and at the time I kinda thought well learn from this, remember you have done this in the simulation, you don't want to do this anywhere else

- because in class you sometimes go through the drug chart but it is different when you have like a simulated patient and you realise actually no, there is room for error there as well

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Brought Practice Into The Classroom

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Different Education Experience

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- I think using a simulation is good, it worked well

-, I prefer that sort of lecture where it was very interactive

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Participant 8

Value to Learning

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- and I then when I looked back on it, it was like the whole point of for them to say that drug errors may, despite the effort that I made, it really made you aware of how important it is not to make errors and be meticulous and systematic in your approach to administering drugs

- the simulation was just an addition it was equally good as some of the others and it was definitely valuable, I think it was an essential part of the course

- I just thought it was something different and something good

-it was you were supposed to give them two tablets of paracetamol and you only gave them one, it could easily two tablets instead of one, and four tablets instead of two, so if a mistake was and I think the simulation definitely reinforced that

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-yes I think we all did. I think the people who didn't make a mistake gloated and the people who did make a mistake were quite embarrassed and felt quite guilty because you never think that you would do that

-I am thinking no I am always meticulous and would never make a mistake like that but then obviously in the simulation, it proven that it is quite easy to make a mistake.

-Just to be systematic, meticulous with your approach to how you go about administering drugs because it is very easy to make a mistake

-When doing the simulation, it provided a different way of doing that so I think different approaches for doing the same thing is beneficial because it doesn't make you get stuck in a rut

- You are looking at things in a different way so I guess for people with different learning styles or whatever I think people might benefit from learning in class, and some might learn more from the computer, or some from being lectured to.

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-so issues like that you need to think about. You can't relax so you have to do the five rights test

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This Is Quite Relevant – Relevant To Practice

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Still With Me Today - Bridging Practice Theory Gap

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- It is really really important. It is the easiest way not to make a mistake if you use it correctly. I think it is vital and so simple as well.

Go Through Checks – How We Should Check

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I Made An Error- Surprise and Questioning Current Practice

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I Felt Terrible – Emotional Reaction

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-You know, you feel immediately guilty thinking how did it happen, what did I do wrong?

The Damage I Could Do – Appreciating Risk In Clinical Practice

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I'm Accountable – Professional Responsibility

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Ordinary Drug Round – Sufficiently Realistic

-I remember it being quite realistic

- It was devised it so that something like warfarin, when you might have to give 5mg and you only have 1mg tablets giving 5 tablets might seem a lot, but you are still giving the correct dose as sometimes as a nurse we all have to adapt and as long as it is correct, which it would be, you can still give it, even though it may seem a bit funny!

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NO

then remember thinking you can't actually get a drug in that dosage or you can't get it in a tablet or I don't know, fine details like that. The person who developed the programme would have thought this is a good way to test how well the person would act in this situation when you don't have all the normal drugs

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Brought Practice into the Classroom

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-And obviously in the first year we had the session on the computer

-So although normally you might have the full dosage of the drug such as a 60mg tablet of whatever, you only have available dadah, you have to adapt with what is available with. I think that is all I remember

- the simulation was just an addition it was equally good as some of the others and it was definitely valuable, I think it was an essential part of the course

- I just thought it was something different and something good

-You know, you feel immediately guilty thinking how did it happen, what did I do wrong?

- but I think generally it highlights the fact that you are taking a risk every time you are administering drugs because you can make a mistake

-I think it helps me, I don't know about other people on the wards working, but for me I think it helps me, definitely so. Knowing how easy it is to make a mistake, I think, , it means then you don't then become complacent

-so issues like that you need to think about. You can't relax so you have to do the five rights test

-ignoring things like for instance, if you go to the drugs cupboard three times a day and make sure that the drugs that you pick up are in date, because you used the same drug that morning and not assuming that is

the same box you pick up in the evening11-And has completing the simulation helped in this awareness of how easy it is to make a mistake?

-I think on the computer system when I was doing it we went through the simulation and you religiously go through the five rights anyway, I know we were in our first year but you know, you would still go through them, and then of it says you got nine out of ten right or whatever and you think I've got one wrong, how did that happen?

-When doing the simulation, it provided a different way of doing that so I think different approaches for doing the same thing is beneficial because it doesn't make you get stuck in a rut

- and I then when I looked back on it, it was like the whole point of for them to say that drug errors may, despite the effort that I made, it really made you aware of how important it is not to make errors and be meticulous and systematic in your approach to administering drugs

- You are looking at things in a different way so I guess for people with different learning styles or whatever I think people might benefit from learning in class, and some might learn more from the computer, or some from being lectured to.

- think I did make some errors in the simulation. I can't remember what it was. I remember being a bit peeved that I made an error

-yes I think we all did. I think the people who didn't make a mistake gloated and the people who did make a mistake were quite embarrassed and felt quite guilty because you never think that you would do that

-it was you were supposed to give them two tablets of paracetamol and you only gave them one, it could easily two tablets instead of one, and four tablets instead of two, so if a mistake was and I think the simulation definitely reinforced that

-I am thinking no I am always meticulous and would never make a mistake like that but then obviously in the simulation, it proven that it is quite easy to make a mistake.

-Just to be systematic, meticulous with your approach to how you go about administering drugs because it is very easy to make a mistake

- You are looking at things in a different way so I guess for people with different learning styles or whatever I think people might benefit from learning in class, and some might learn more from the computer, or some from being lectured to.

- May be I think it was the fact that I did the simulation, I did something different and that made it more memorable

Participant 9

Value to Learning

- I remember it being quite useful at the time.

- Yeah, I suppose, it was like obviously it was like another additional sort of way of looking at medication administration and was useful, I didn't feel that it didn't waste my time, it wasn't boring or anything like that.

-like as well as the practical side it is good to sort of get you brain to think of plenty of things, making calculations in your head, looking what the patient needs and making sure you got the right dose for them and things like that, so in that way it was useful

- I guess it sort of makes you think that you shouldn't just rely on things staying the same, like you just... Things can change all the time so not to rely on that the patient is, you forget the medications so not to give it to them without really checking. Erm, it just helps you keep on your toes sort of thing. That you always have to go through the checks all of the time and rather than you have done them once, to go onto auto pilot.

- with regards to the simulation? I don't think the simulation had an impact on its own I think it maybe did as part of what we were taught.

-it was useful, it highlighted certain things like drugs change and patients change

This Is Quite Relevant – Relevant To Practice

-guess just, well just because of something precarious

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Still With Me Today - Bridging Practice Theory Gap

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No

-but again I can't remember the content that clearly, it is difficult for me to say.

- no I guess the way putting some of it into practice, but no

Go Through Checks - How We Should Check

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I Made An Error – Surprise And Questioning Current Practice

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I Felt Terrible – Emotional Reaction

- Em, I felt rubbish about making an error

The Damage I Could Do – Appreciating Risk In Clinical Practice

I'm Accountable – Professional Responsibility

Ordinary Drug Round - Sufficiently Realistic

No

-, but I mean I remember it being good for working out doses and erm the sort of calculation side of drug administration but maybe not so useful as to what it is like when maybe you are in that situation, when you are on a busy ward and being face to face with patients and looking at their symptoms and actually looking at the patient, sort of assessing what medications to give them, are you giving the right thing

- I am sure, not many, the way it was laid out, the actual process made it difficult to make an error, but I am sure I must have made one or two, but I don't remember making many.

-like as well as the practical side it is good to sort of get you brain to think of plenty of things, making calculations in your head, looking what the patient needs and making sure you got the right dose for them and things like that, so in that way it was useful

- probably as well as it can, but I think probably it is very different giving something on the computer than it is to physically like fix things, getting things out, dealing with a patient. I don't think, even if it was quite advanced I don't think it could replicate that. So I think that was the problem with it but otherwise, for what it was, it was fine.

Watch Out – Clinical Practice is Changeable

- guess just, well just because of something precarious

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So That's How Error Occurs

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Brought Practice Into The Classroom

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Different Education Experience

- And then it was obviously erm quite relaxed as something different, so erm and it was quite interesting, We were told we were just trying out a new approach to

-like as well as the practical side it is good to sort of get you brain to think of plenty of things, making calculations in your head, looking what the patient needs and making sure you got the right dose for them and things like that, so in that way it was useful

- Yeah, I suppose, it was like obviously it was like another additional sort of way of looking at medication administration and was useful,

I didn't feel that it didn't waste my time, it wasn't boring or anything like that.

Participant 10

Value to Learning

No

- No, I don't think so.

- For me it is much better to do something practically, like it is just, you, the way that I relate to computer screens and the way I relate to patients in a hospital setting are quite different. It is just a different atmosphere and I think making it as realistic as possible to do it in practice is just a much better way of learning for me, yeah rather than a simulation on a computer.

- I am trying to think yeah, just about being caught out in a way and sort of not having the patient erm yeah, it felt like it was tricking you rather than testing you, if you see what I mean. Erm so yes.

- Erm, thinking about it I suppose yes, erm but erm with the errors and things yes, but I don't know how like I don't know how much I refer to the simulation now if you know what I mean, so in hindsight perhaps but not really due to the simulation

- Erm no, not particularly, I probably will say no, even though I know I did make errors and I can see the importance of learning. But not due to the simulation is why I would be more careful.

This Is Quite Relevant – Relevant To Practice

No

-I did think it wasn't particularly accurate or that helpful to do it on the computer. Erm, obviously I can see the principle of why they are doing it to make sure you know you always double check and if you are in a rush don't get the patient's mixed up. I didn't think it was particularly helpful on a computer thing, like on a computer based programme to do it. Sorry.

Yes

-Do I see any benefit from learning from errors? Definitely, it makes you more cautious erm and yes it means that you don't get lazy.

Still With Me Today - Bridging Practice Theory Gap

No

- Not that I can think.

- It hasn't had much of an impact

- Mentioning it I do remember it but very vaguely.

- vague memories of something that you mentioned

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- Yes. I don't think I would have remembered the simulation otherwise. It was so long ago.

- I think other things have had more of an impact than the simulation

Go Through Checks – How We Should Check

I Made An Error – Surprise and Questioning Current Practice

It's Easy But Not So Easy

I Felt Terrible – Emotional Reaction

- Erm gutted, you just kinda go ahhhh oh no!! It felt awful.

The Damage I Could Do – Appreciating Risk In Clinical Practice

I'm Accountable – Professional Responsibility

Ordinary Drug Round – Sufficiently Realistic

- I think it helped with the thought process

No

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- possibly not, yeah, I think always when doing things on the computer, you can see the point and everything but it is not quite the same as the reality of actually giving stuff out yourself with real people and acting it out, so yeah.

-Erm I think just from what I can remember, it's just not real enough erm, I think it would work better, you know if rather than having even cartoon characters, having photos of people and moving those around, something, just more real

-Erm, so I think doing things other than medicine administration. If you get given like erm a camera in hospital and it is practical, you can see a nurse working round a person, rather than like a cartoon it is like a film so that it makes it a little bit more real and see everything around it, that is what I mean.

Watch Out – Clinical Practice Is Changeable

So That's How Error Occurs

Brought Practice Into The Classroom

Different Education Experience

No

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Participant 11

Value To Learning

- But later I remember in my second year that was when they actually brought erm checking medication on line so that was the lecture actually again I found it very useful when we were doing, to see if we were giving out the right medication and you know later on you were able to see the results and I was so shocked to see that, you know, all my, a lot of simple things you know and actually making do a medication error so.

- it made me, you know rethink you know my practice and like some of the things again in practice were actually wrong in practice as well, and you think god you could have killed a patient in your care as well so.

- I would really support that, that would be so good. Because your... actually because of the pictures, because I like learning through pictures and that's the thing you know, it sticks in my head you know and then I am able to learn. I would say it is a really good way of learning because and as well, you do the exercise and you are able to see your errors and correct they give you the answers so you are able to correct yourself there and then and you are learning. So it really is a good way of learning.

- It just really reminded me yes (5 rights)

- oh my god, so it was the simulation exercise that I was like, you know, was like that because we had to give certain medications due to the patient's weight. And we had to calculate and work out all these things and I was like, okay, it is so good and as well I remember the simulation exercise had the, I think had a form at the end you know, having all the you know 1 micrograms, in that it was arranged so it was that knowledge and with all the more practice so when I went on placement. It was so good and helped with the OSCE as well, preparing you...things to look out for, things about the patient and all that.

- it's memorable because something it, because just like again not being conscious of it, but at the end of the day, when you have the information that is there it is something that you know, it is so meaningful, you know how to do it but it is still put it in a simple way and having all the pictures as well you know. But at the other side it is fun, but when actually look at it properly and , oh my god, it is fun, but at the same time I am learning things, it has such, it has a lot of information for me to learn, so that is how memorable it was,

cause it was actually simple, but at the core it had something that was so meaningful, oh my god, the importance of doing it right. So in that way it was so great.

- it is really very good to cross check and if you are not sure just call to who is looking after that patient and also, having learned about many drug rounds, what, see how much medications and is it time. I think that is what I realised how many tablets, how many they are actually supposed to have you know with twenty four hours so having that sort of medication... behind you because sometimes you know, doctors sometimes write up things that, as a nurse you can see, no that is not right dose, so it is especially good to have that sort of knowledge behind you. Some people might say, oh no, that is not my area but it is still good to be aware of those things.

- I think it was a really mind opening stimulation because we had a lot of different different thing that we wouldn't know, like would it be a waste of time to check because I have already checked. Every time for me now I am going to be a newly qualified nurse and so you have a lot to learn so I think it was really certainly very good to see all the simple small things that can go wrong, no things that you don't even expect. So it is really very important.

- Yes, and remember again it is all about just cross checking you know, the right thing by the right person.

- Yes it did teach me something. Always cross check, no matter how simple things seem, always cross check the right patient because sometimes patients can leave, even if just going for coffee, they can change when they are in the (CAN'T UNDERSTAND) everything, when they are... always cross check. Practicing in a safe, doing safe practice.

- but I was putting myself in that shoe like I have been on the ward, you know people passing you all depending on me and no doing the right thing like medicines you know and it actually spoke to me, oh if I didn't do the calculations well, it means like oh someone has lost their life and I was thinking about the whole impact and not only on myself but the family you know they think why what do they think the fact that a clinical error has happened. It was that quite a lot of things went into my mind just in that small session.

- It was a lot of good, but also it was really very, it really like enlightened me, made me to think more wisely before you know giving anything and you know to cross checking and things like that, because I just got shocked and I was like you know I really need to be more reading, more checking of why you are doing things and also just more cross checking every time especially when you are you know out there.

- Erm, Very well, *because* what I remember mostly is that there were and other members as well, thinking something was correct but later on when it gives you the result you find out actually it is wrong and you know you are like oh my god i didn't know I did anything wrong and it made me,

- though it, it was really very useful because the simple simple things that are errors that make you learn better than not going for these simple lectures you know just coming out when you haven't understood anything.

-Because you were actually doing something and putting things into practice. The simple things that make errors, make you learn.

-Oh, I remember a few bits. It was basically different questions with prescribed medications and some of them asked what are the simple things you can use to identify you know maybe giving the right patient the right medications and how do you calculate and find out the dose you know which is useful. I know that. And lots of things for example, one aspect you know asking us if this is the right stuff, the right medication for this patient and making the right checks. That is really what I remember.

- it made me just not take anything for granted because of the people you know and things like that, their lives are basically in my hands. It reminds me so all the time I am in practice, however much I feel I can do it, but because of the previous experience you know I use the opportunity to ask just for clarification, it made me all the time rethink of it and I just double check and with this feeling and taking it forward.

- Yes it was relevant to my practice, I mean clinical practice. My example is, really still like maintaining my checks you know, patient, time you know. Making sure it is the right patient, the right time, the right thing you know. Is the patient in the right position that I think he is in, like going back by their bedside, if not is

he really the right patient with the right medication maybe the ... Really more cross checking not just the right patients you know about.

- To an extent I would say yes it has been affected by erm, but I would say a really high percent because that simulation exercise it erm it put more highlight into that, it gave me actually a very positive effect, I don't know, it gave that perception, no, it is not just the big things that people...after all what do they mean by medication administration errors?? You know, it is not just like only giving you know may be like some overdosing the patient or something no, but I didn't think identifying the patient and giving the medications to someone else would then be a medication error so it really gave me very positive effect, you know. So on the other side, but differences in just in wide it is just in my consciousness all the time and it is always oh my god, may be I am, making a mistake so it is not again giving me more confidence in doing things because all the time I just want to cross check.

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- Yes it was relevant to my practice, I mean clinical practice. My example is, really still like maintaining my checks you know, patient, time you know. Making sure it is the right patient, the right time, the right thing you know. Is the patient in the right position that I think he is in, like going back by their bedside, if not is he really the right patient with the right medication maybe the ... Really more cross checking not just the right patients you know about.

- it made me, you know rethink you know my practice and like some of the things again in practice were actually wrong in practice as well, and you think god you could have killed a patient in your care as well so.

- Yes, and remember again it is all about just cross checking you know, the right thing by the right person.

- it made me just not take anything for granted because of the people you know and things like that, their lives are basically in my hands. It reminds me so all the time I am in practice, however much I feel I can do it, but because of the previous experience you know I use the opportunity to ask just for clarification, it made me all the time rethink of it and I just double check and with this feeling and taking it forward.

- Yes it did teach me something. Always cross check, no matter how simple things seem, always cross check the right patient because sometimes patients can leave, even if just going for coffee, they can change when they are in the (CAN'T UNDERSTAND) everything, when they are... always cross check. Practicing in a safe, doing safe practice.

- but I was putting myself in that shoe like I have been on the ward, you know people passing you all depending on me and no doing the right thing like medicines you know and it actually spoke to me, oh if I didn't do the calculations well, it means like oh someone has lost their life and I was thinking about the whole impact and not only on myself but the family you know they think why what do they think the fact that a clinical error has happened. It was that quite a lot of things went into my mind just in that small session.

- It was a lot of good, but also it was really very, it really like enlightened me, made me to think more wisely before you know giving anything and you know to cross checking and things like that, because I just got shocked and I was like you know I really need to be more reading, more checking of why you are doing things and also just more cross checking every time especially when you are you know out there.

- Erm, Very well, *because* what I remember mostly is that there were and other members as well, thinking something was correct but later on when it gives you the result you find out actually it is wrong and you know you are like oh my god i didn't know I did anything wrong and it made me,

-Oh, I remember a few bits. It was basically different questions with prescribed medications and some of them asked what are the simple things you can use to identify you know maybe giving the right patient the right medications and how do you calculate and find out the dose you know which is useful. I know that. And lots of things for example, one aspect you know asking us if this is the right stuff, the right medication for this patient and making the right checks. That is really what I remember.

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-Because you were actually doing something and putting things into practice. The simple things that make errors, make you learn.

Go Through Checks – How We Should Check

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- It just really reminded me yes (5 rights)

- To an extent I would say yes it has been affected by erm, but I would say a really high percent because that simulation exercise it erm it put more highlight into that, it gave me actually a very positive effect, I don't know, it gave that perception, no, it is not just the big things that people...after all what do they mean by medication administration errors?? You know, it is not just like only giving you know may be like some overdosing the patient or something no, but I didn't think identifying the patient and giving the medications to someone else would then be a medication error so it really gave me very positive effect, you know. So on the other side, but differences in just in wide it is just in my consciousness all the time and it is always oh my god, may be I am, making a mistake so it is not again giving me more confidence in doing things because all the time I just want to cross check.

- it is really very good to cross check and if you are not sure just call to who is looking after that patient and also, having learned about many drug rounds, what, see how much medications and is it time. I think that is what I realised how many tablets, how many they are actually supposed to have you know with twenty four hours so having that sort of medication... behind you because sometimes you know, doctors sometimes write up things that, as a nurse you can see, no that is not right dose, so it is especially good to have that sort of knowledge behind you. Some people might say, oh no, that is not my area but it is still good to be aware of those things.

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I Made An Error – Surprise and Questioning Current Practice

- But later I remember in my second year that was when they actually brought erm checking medication on line so that was the lecture actually again I found it very useful when we were doing, to see if we were giving out the right medication and you know later on you were able to see the results and I was so shocked to see that, you know, all my, a lot of simple things you know and actually making do a medication error so.

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It's Easy But Not So Easy

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I Felt Terrible – Emotional Reaction

- I was so shocked to see that

- you think god you could have killed a patient in your care as well so.

-I really felt, I felt very horrible

- I just remember I felt so so low

The Damage I Could Do – Appreciating Risk In Clinical Practice

- you think god you could have killed a patient in your care as well so.

- is going to highlight deficiency in your skills, so it feels like, you know when you are doing things wrong, it made me feel oh my god, how many patients might I have killed?

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I'm Accountable – Professional Responsibility

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-It erm it really taught me I think like because before I think that there was only one way of people make errors especially in nursing, all the stories like sometimes like I can hear but from that, I just learnt that all the different areas in nursing that you have to take it seriously because before I used to think it was more than just medication that people made errors. But doing that simulation exercise just made me rethink that like it is not only just medication, not taking other aspects, not caring for your patients no. I have to think of things very carefully no. It just made me be serious about what the patient does and what type of area we are dealing with.

-because the exercise was telling us every error you made and that is going to highlight deficiency in your skills, so it feels like, you know when you are doing things wrong, it made me feel oh my god, how many patients might I have killed?

- I think it was a really mind opening stimulation because we had a lot of different different thing that we wouldn't know, like would it be a waste of time to check because I have already checked. Every time for me now I am going to be a newly qualified nurse and so you have a lot to learn so I think it was really certainly very good to see all the simple small things that can go wrong, no things that you don't even expect. So it is really very important.

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Ordinary Drug Round – Sufficiently Realistic

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- just remember I felt so so low because despite the fact it was just an exercise

- It worked. It definitely gave me, it gave me er,... it made me enjoy the medication administration, it made me, when I did a medication round on the ward, yes I can say... Before, whenever I came to medication administration, and maybe I am working with my mentor and saying about medication I would have that fright in me, oh my god you know, with all the medications, how do I do it??? But when we did this exercise but when we did this exercise, because it was such, simple, and clear, it made me enjoy it more, you know, I am like, you know, provided you go through your checks, the five rights you know, then you are not bound to go wrong and all these things. Read the drug chart from the start up to the ... you know.

- Yes I think it was very good because... I think it was good because of the way the content was all laid out, so it made one enjoy it you know, not be like frightened which can make people make errors and all those things. So actually I think the exercise was a good exercise because of the nature of it, you know the nature in which it is actually you know being computerised you know and all the different, different, I remember it covering, it didn't cover one thing, I remember it covered all things, the different, different medications and all the different, different things that had to be included, so...

- oh my god, so it was the simulation exercise that I was like, you know, was like that because we had to give certain medications due to the patient's weight. And we had to calculate and work out all these things and I was like, okay, it is so good and as well I remember the simulation exercise had the, I think had a form at the end you know, having all the you know 1 micrograms, in that it was arranged so it was that knowledge and with all the more practice so when I went on placement. It was so good and helped with the OSCE as well, preparing you...things to look out for, things about the patient and all that.

- Possibility, about the simulation, the most important aspect about the simulation was that it was a medical simulation so that it was dealing with all about er, for example, really making sure that you were reading the drug chart and you were actually reading the drug chart correctly so you administer whatever is prescribed properly.

Watch Out – Clinical Practice is Changeable

-though it, it was really very useful because the simple simple things that are errors that make you learn better than not going for these simple lectures you know just coming out when you haven't understood anything.

- Yes it was relevant to my practice, I mean clinical practice. My example is, really still like maintaining my checks you know, patient, time you know. Making sure it is the right patient, the right time, the right thing you know. Is the patient in the right position that I think he is in, like going back by their bedside, if not is he really the right patient with the right medication maybe the ... Really more cross checking not just the right patients you know about.

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- I remember some of them swapping position, and er and some of the patients changed their name bands as well.. Some people changed their name bands and some actually er sometimes you would offer the wrong, sometimes you would offer the wrong medication to the wrong patient. And sometime you think maybe I didn't know that and sometimes you find the patient has changed position and you think this is a joke, this is not actually the one -giving maybe the right drugs to the wrong patient.

So That's How Error Occurs

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Brought Practice Into The Classroom

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Different Education Experience

- I think it was a really mind opening stimulation because we had a lot of different different thing that we wouldn't know, like would it be a waste of time to check because I have already checked. Every time for me now I am going to be a newly qualified nurse and so you have a lot to learn so I think it was really certainly very good to see all the simple small things that can go wrong, no things that you don't even expect. So it is really very important.

- Yes I think it was very good because... I think it was good because of the way the content was all laid out, so it made one enjoy it you know, not be like frightened which can make people make errors and all those things. So actually I think the exercise was a good exercise because of the nature of it, you know the nature in which it is actually you know being computerised you know and all the different, different, I remember it covering, it didn't cover one thing, I remember it covered all things, the different, different medications and all the different, different things that had to be included, so...

- Possibility, about the simulation, the most important aspect about the simulation was that it was a medical simulation so that it was dealing with all about er, for example, really making sure that you were reading the drug chart and you were actually reading the drug chart correctly so you administer whatever is prescribed properly. and then it is really good to go back if you are not sure, to keep going back whatever the scenario. Like you at the end do the right thing at the right time so it taught me taking into account sometimes the patients they change so, it

- it made me, you know rethink you know my practice and like some of the things again in practice were actually wrong in practice as well, and you think god you could have killed a patient in your care as well so.

- It was a lot of good, but also it was really very, it really like enlightened me, made me to think more wisely before you know giving anything and you know to cross checking and things like that, because I just got shocked and I was like you know I really need to be more reading, more checking of why you are doing things and also just more cross checking every time especially when you are you know out there.

- But later I remember in my second year that was when they actually brought erm checking medication on line so that was the lecture actually again I found it very useful when we were doing, to see if we were giving out the right medication and you know later on you were able to see the results and I was so shocked to see that, you know, all my, a lot of simple things you know and actually making do a medication error so.

-though it, it was really very useful because the simple simple things that are errors that make you learn better than not going for these simple lectures you know just coming out when you haven't understood anything.

-Oh, I remember a few bits. It was basically different questions with prescribed medications and some of them asked what are the simple things you can use to identify you know maybe giving the right patient the right medications and how do you calculate and find out the dose you know which is useful. I know that. And lots of things for example, one aspect you know asking us if this is the right stuff, the right medication for this patient and making the right checks. That is really what I remember.

- it's memorable because something it, because just like again not being conscious of it, but at the end of the day, when you have the information that is there it is something that you know, it is so meaningful, you know how to do it but it is still put it in a simple way and having all the pictures as well you know. But at

the other side it is fun, but when actually look at it properly and , oh my god, it is fun, but at the same time I am learning things, it has such, it has a lot of information for me to learn, so that is how memorable it was, cause it was actually simple, but at the core it had something that was so meaningful, oh my god, the importance of doing it right. So in that way it was so great.

-Because you were actually doing something and putting things into practice. The simple things that make errors, make you learn.

- oh my god, so it was the simulation exercise that I was like, you know, was like that because we had to give certain medications due to the patient's weight. And we had to calculate and work out all these things and I was like, okay, it is so good and as well I remember the simulation exercise had the, I think had a form at the end you know, having all the you know 1 micrograms, in that it was arranged so it was that knowledge and with all the more practice so when I went on placement. It was so good and helped with the OSCE as well, preparing you...things to look out for, things about the patient and all that.

- I would really support that, that would be so good. Because your... actually because of the pictures, because I like learning through pictures and that's the thing you know, it sticks in my head you know and then I am able to learn. I would say it is a really good way of learning because and as well, you do the exercise and you are able to see your errors and correct they give you the answers so you are able to correct yourself there and then and you are learning. So it really is a good way of learning.

Participant 12

Value To Learning

-yes it was a good example of how to do things if you don't get a chance to go straight into placement, it is a good chance to have a go in your first year, sort of. Yes it is like when you had to choose what... I think you had to choose what dose and what drugs to choose and a what time and things like that. It was erm, yeah, I think it was useful, but we only did it once so I think it would be useful to do it more than once or have access to it regularly.

No

-I think we were given a patient scenario and sort of er or patient's drug chart and you would give a drug and measure up the amount, pick up the amount... I don't know, it is sort of on a spreadsheet style perhaps. I can't remember, sorry

- well I just thought about checking things

- Erm, no, I er think that might have been something that happened erm, but yeah it is really vague sorry

-yeah it does, especially because I didn't get them all right, so yeah I think yeah it does

- Erm, well I mean just the fact that I made a mistake it sort of, I haven't made a mistake in practice so far but I did make a mistake in the simulation so it was quite er, a just wonder why, was I more relaxed or was I not taking it seriously, I mean, why was I not on the ball as I would obviously be n placement. There is a bit of added pressure when it is in real life.

- but I did make an error in the simulation, and it was probably, yeah it made me more aware of I can make a mistake obviously,

-Yeah I did because it made me aware of you know, that my perception lacked a bit and I made a mistake, so obviously it sort of makes you realise that you can make an error and to be more careful.

This Is Quite Relevant – Relevant To Practice

- yes it was a good example of how to do things if you don't get a chance to go straight into placement, it is a good chance to have a go in your first year, sort of. Yes it is like when you had to choose what... I think you had to choose what dose and what drugs to choose and a what time and things like that. It was erm,

yeah, I think it was useful, but we only did it once so I think it would be useful to do it more than once or have access to it regularly.

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Still With Me Today - Bridging Practice-Theory Gap

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Go Through Checks – How We Should Check

- well I just thought about checking things

-Yeah I did because it made me aware of you know, that my perception lacked a bit and I made a mistake, so obviously it sort of makes you realise that you can make an error and to be more careful.

I Made An Error – Surprise and Questioning Current Practice

-yeah it does, especially because I didn't get them all right, so yeah I think yeah it does

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It's Easy But Not So Easy

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I Felt Terrible – Emotional Reaction

- disappointed that I did get something wrong

The Damage I Could Do – Appreciating Risk In Clinical Practice

- So...you don't make errors with patients – that would be awful...

I'm Accountable – Professional Responsibility

- when you think about it in a real life scenario then obviously you are in a lot more trouble so yeah erm, yeah I don't sort of getting things wrong

-Yeah I did because it made me aware of you know, that my perception lacked a bit and I made a mistake, so obviously it sort of makes you realise that you can make an error and to be more careful.

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Ordinary Drug Round – Sufficiently Realistic

Watch Out – Clinical Practice Is Changeable

So That's How Error Occurs

- yeah it does, especially because I didn't get them all right, so yeah I think yeah it does

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Brought Practice Into The Classroom

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Different Education Experience

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- yes it was a good example of how to do things if you don't get a chance to go straight into placement, it is a good chance to have a go in your first year, sort of. Yes it is like when you had to choose what... I think you had to choose what dose and what drugs to choose and a what time and things like that. It was erm, yeah, I think it was useful, but we only did it once so I think it would be useful to do it more than once or have access to it regularly.

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Glossary of Terms

Accommodators: An experiential learning theory learning style relating to those who learn better when provided with “hands-on” experiences.

Act of Commission: Doing something wrong which results in, or has the potential to result in, an unintended outcome

Act of Omission: Failing to do the right thing which results in, or has the potential to result in, an unintended outcome

Action-based errors: Error due to a failure of skill.

Active failure: The immediate unsafe act made by personnel which directly results in error.

Active Learning: Learning through the process of self-experience and discovery.

Adult Learning Theory: Theory behind how adults learn.

Affect Heuristic: Experiential or association-based system of thinking, whereby individuals refer to images, metaphors and narratives in which to estimate the likelihood of an event.

Andragogy: Method and practice of teaching of adults.

Assimilators: An experiential learning theory learning style relating to those who learn better when presented with sound logical theories to consider.

Attention: Cognitive process of concentrating or awareness of stimuli or information.

Authenticity: Degree to which simulation replicates context.

Availability Heuristic: Refers to the perceived likelihood of an event.

Change Blindness: Psychological phenomenon within the domain of selective attention and is when an observer is distracted and fails to notice changes to non-attended items of a visual scene.

Checks: (Protocolised medication administration checks or ‘right’s) utilised within nurse education internationally to support nurses to administer medications safely, including the five rights, the eight rights, the nine rights and the ten rights.

Code of Professional Conduct: Document published by the Nursing and Midwifery Council which states the professional standards nurses and midwives must adhere to to maintain their registration.

Cognitive Load Theory: Cognitive Load Theory is based on the work of Sweller who developed a framework of instructional design on learning and failure to learn.

Concrete experience: First subcomponent of iterative phase of experiential learning theory: where the learner participates in an experience.

Constructionist Learning: Adult learning theory proposed by Bruner () and is based on the work of Piaget (1977). It refers to the ability of students to mentally construct information in a symbolic manner so that it can be stored and processed through active engagement in the learning context and content.

Contextual Causes of Medication Error: Range of causes of medication error which relate to the contextual, environmental or systemic factors.

Convergers: An experiential learning theory learning style relating to those who learn better when provided with practical applications of concepts and theories.

Cognitive Constructivism: Learning theory in which the learner develops and 'constructs' new learning ideas and learning based on their own experiences. Error Learning: Learning through a systematic process of making errors and learning to improve performance understanding how errors occur.

Debrief: Is a collective examination of the simulation experience.

Divergers: An experiential learning theory learning style relating to those who learn better when allowed to observe and collect a wide range of information.

Ethical Engagement: Relates to a more profound understanding of the ethical and moral dimensions of clinical practice

Experiential Learning: Learning through direct experience.

Fidelity: Ubiquitous term in simulation education and refers to the extent to which a simulation replicates clinical practice.

Focal Attention: Process of focusing attention between stimuli or tasks with different cognitive requirements.

Heuristics: Heuristics are systematic biases, mental shortcuts or rules of thumb which simplify decision-making processes.

Human Factors Approach: Systematic analysis of organisations to determine how they can be altered to support workers to work effectively and safely.

Individual Causes of Medication Error: Range of causes of medication error which are classed to be directly caused by the individual who made the error.

Knowledge-Based Errors: Errors due to lack of general, specific or expert knowledge.

Lapse: A non-observable action, where the original intention was correct, but the action did not result as intended.

Latent Errors: Range of causes of error which origin from the structure or environment within an organisation which result in active failures and error.

Locus of control: Refers to people's general cross-situational beliefs and defined as internal and external. Individuals with high internal locus of control attribute outcomes due to their own efforts whereas those with high external locus of control tend to attribute outcomes to external forces, for example, luck.

Long-Term Memory: Long-term memory is the stage of the memory processes where information and knowledge can be stored and retrieved over a long period of time.

Medication Administration Error: Patient safety incident that occurs administration stage of medication management

Medication Error: Patient safety incident that occurs at any point during the prescription, transcription, dispensing or administration of medication management.

Medication Management: Full pathway of medication process including prescription, transcription, dispensing, administration. The administration phase is a central part of the for the student nurse pre-qualification education programme

Medication Related Incident: Any Patient-related safety incident that result in “any unintended or unexpected incident involving medication which could have or did lead to harm for one or more patients

Memory-Based Errors: When an individual forgets to do something.

Mistake: When an action proceeds as planned but the intended action was incorrect.

Narrative Analysis / Narrative Research: A form of qualitative research which uses stories or narratives as a method to gain insight into a phenomenon.

National Health Service (NHS): Municipal health service provider in the United Kingdom

National Institute for Health Care Excellence (NICE): A special health authority within the United Kingdom which provides national guidance and advice to improve health and social care to reduce variation in the availability and quality of NHS treatments and care.

National Patient Safety Agency (NPSA): Satellite body of the United Kingdom's Department of Health which analyses the state of healthcare to improve safe patient care by informing, supporting and influencing organisations and people working in the health sector.

National Reporting and Learning System (NRLS): Central database that records incident reports with the National Health Service in the United Kingdom

Nursing and Midwifery Council (NMC): Nurse and midwife regulatory body within the United Kingdom

Patient-Related Safety Incident: Any incident within a healthcare related environment that result in any unintended or unexpected incident which could have or did lead to harm for one or more patients.

Pedagogy: Method and practice of teaching.

Person Approach to Error: Approach to examining error which focuses on the person who made the error. It prioritises who and not why.

Realism: How realistic students / participants consider the simulation to be.

Reflection: A purposeful activity that enables practitioners to think, feel and imagine while learning from an event.

Reflective observation: Second subcomponent of iterative experiential learning theory where the learner reflects on the experience, (c) abstract conceptualization where the learner considers thoughts and reflections to identify the significance of the learning experience and considers alterations to improve outcomes and (d) active experimentation which involves using what was learned to direct future practice.

Rights: (Protocolised medication administration checks or 'right's) utilised within nurse education internationally to support nurses to administer medications safely, including the five rights, the eight rights, the nine rights and the ten rights.

Rule-Based Errors: Errors due to the misapplication or failure to apply a good rule, or the application of a bad / inappropriate rule.

Saliency: A psychological concept related to attention and distinctiveness and centres ability of a target or feature to dominate the attention of the perceiver

Schema: Represents a mental model or organized pattern of relationships and chunks of information concerning an area of knowledge

Selective Attention: the capacity for or process of attending to certain stimuli selectively when several occur simultaneously.

Simulation: education tool which replicates some form of clinical practice, predominantly in a non-clinical practice environment.

Situational Awareness: Relates to an individuals' awareness of the current environment, or perceptions of the perceived relevant aspects of the environment

Slip: An observable act in which the original intention was correct, but the action did not result as intended.

Systemic Factors: Factors within the organisation that give rise to certain conditions, for example error to occur

Social Constructivism: Learning theory in which the learner develops and 'constructs' new ideas and learning through interaction with others.

Task Analysis: Diagrammatical representation of a task and its composite subtasks.

Technical Errors: A subset of action-based errors. This occurs when the desired result fails to occur or because there was an error in the implementation of an action.

Social Learning Theory: Based on Bandura (1971) in which learning occurs through direct observation of others

Thematic Analysis: Widely used qualitative analytic method embedded within many qualitative approaches and provides a method in which to identify, organise, analyse and report themes derived from participant reports.

Theory-Practice Gap: Is the gap or dissonance between what is taught as evidence-based theory and what is practiced

Titration Theory: Process to in which small amounts of a solution are incrementally added to determine a given or desired concentration of a solution

Vicarious Learning: Based on Bandura's social learning theory (1971) in which learning occurs through direct observation of others.

Working Memory: Working memory has a finite span of information that can be retained at one time and is believed to be limited.

Social Learning Theory: Used in Bandura's (1971) theory of vicarious learning in which learning occurs through direct observation of others.

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