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FACULTY OF SOCIAL AND HUMAN SCIENCES

Southampton Education School

An investigation into the clinical reasoning of cardiorespiratory physiotherapists using a simulated patient and simulated high dependency unit.

By

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FACULTY OF SOCIAL AND HUMAN SCIENCES

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Doctorate in Education

ABSTRACT

An investigation into the clinical reasoning of cardiorespiratory physiotherapists using a simulated patient and simulated high dependency unit

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The ability of physiotherapists to make clinical decisions is understood to be a vital component of achieving expertise and is part of being an autonomous practitioner, yet this complex phenomenon has been under-researched in cardiorespiratory physiotherapy. Educators in this field need to understand what method of clinical reasoning clinicians are using, so that educational strategies can be designed to facilitate the development of clinical reasoning by undergraduate physiotherapy students prior to them going on clinical placement.

This study explored the clinical reasoning of eight expert cardiorespiratory physiotherapists by observing their actions and behaviour whilst they assessed a simulated patient with respiratory complications in a simulated environment. The assessments were video-recorded. The physiotherapists were encouraged to think-aloud to verbalise their thought processes and had a debrief interview afterwards. The videos and the verbal transcripts from the assessment were analysed using a framework analysis and compared to other models of clinical reasoning.

The study has confirmed that clinical reasoning is a complex, multi-dimensional phenomenon and the model produced shares some similarities with other models of clinical reasoning. Four key concepts have been identified as requirements for clinical reasoning development: knowledge acquisition; knowledge storage and retrieval; information processing and cognitive skill development; and metacognition and reflection. These concepts have been incorporated into a new conceptual model of clinical reasoning and embedded into a simulation learning strategy to facilitate clinical reasoning across all three years of the undergraduate physiotherapy programme.

List of Contents

List of Figures

List of Tables

Declaration of Authorship

I, Debbie Thackray, declare that this thesis entitled: “An investigation into the clinical reasoning of cardiorespiratory physiotherapists using a simulated patient in a simulated environment” and the work presented in the thesis are both my own work and have been generated by me as the result of my own original research. I confirm that: This work was done wholly or mainly while in candidature for a Research degree at this University; Where any part of this thesis has been previously submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated; Where I consulted the published work of others, this is always clearly attributed; 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;

I have acknowledged all main sources of help; 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; None of this work has been published before submission.

Signed: ....

Date: ....

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Lastly, I would like to dedicate this thesis to the memory of my parents.

Presentations

Thackray, D: Exploring the clinical reasoning of cardiorespiratory physiotherapists using a simulated patient and a simulated environment.

- Work futures Digital Economy Symposium, Chilworth, March 2012
- Physiotherapy UK conference, October 2012
- 3rd European Congress on Physiotherapy Education, Vienna, November 2012

Thackray, D: Simulation and its use within the undergraduate physiotherapy curriculum, at CSP Education forum in November 2012

Future presentations

- Planned submission of abstract for the ASPiH National Meeting, Harrogate, November 2013.
- Planned submission of abstract for the WCPT Congress Singapore 2015

Papers in preparation

- Physiotherapy Research Foundation PRF final report submitted July 2013

Suggested papers:

- The clinical reasoning process in cardiorespiratory physiotherapy: Physiotherapy Journal
- Using simulation for observational research: Nursing Education
- A simulation pedagogy for teaching clinical reasoning in the undergraduate physiotherapy curriculum: Physiotherapy Journal

Operational Definitions and Abbreviations

- **ABCDE** An Acronym used as a systematic method of examining Airway, Breathing, Circulation, Disability and Exposure
- **ABGs** An arterial blood gas is a blood test that is performed using blood from an artery to measure the level of arterial oxygen tension, carbon dioxide tension, and acidity,
- **ACBT** Active Cycle Of Breathing Technique: breathing exercises involving different levels of breathing and huffing to clear secretions from the chest and increase lung volume
- **ACPRC** Association of Physiotherapists in Respiratory Care
- **ASPiH** Association of Simulated Practice in Healthcare
- **Auscultation** using a stethoscope to listen to the breath sounds made when breathing
- **B-Cell Lymphoma** a type of blood cancer affecting the white blood cells specifically the B Lymphocyte cells which are a vital part of the immune system.
- **Bird** trade name for Intermittent Positive Pressure Breathing IPPB machine, which uses positive pressure to support a patients' breathing and help clear removal of secretions
- **BiPAP** Bi Level Positive Airway Pressure, a machine that uses two levels of positive pressure to support breathing
- **BP** Blood pressure, sometimes referred to as arterial blood pressure, is the arterial pressure exerted by the circulating blood upon the arterial walls. Blood pressure varies between a maximum systolic and minimum diastolic pressure.

- **Breathing exercises** deep breathing to help re-expand collapsed lung
- **CPD** Continuous Professional Development
- **CR** Clinical reasoning
- **CSP** Chartered Society of Physiotherapy
- **Crackles** are clicking sounds heard on auscultation during inspiration. These are caused by opening and closing of alveoli and small airways and localised crackles can indicate lung collapse and sputum retention
- **CPAP** Continuous Positive Airway Pressure – a machine that assists breathing by using positive pressure
- **Cyanosis** blue or purple colouration of the skin or mucous membranes due to the tissues near the skin surface being low in oxygen; when signs of cyanosis appears, i) the airway should be checked for obstruction and cleared ii) supplementary oxygen should be commenced within 3-5 minutes to avoid respiratory arrest.
- **CXR** Chest x-ray, a radiograph of the lungs used when any abnormality is suspected
- **Deontology** duty of care of the patient
- **Desaturation** a drop in the oxygen saturation levels in the blood below the normal saturation value of 96-98%
- **DH** Drug History i.e. list of current medication
- **DH** Department of health
- **ECG** Electrocardiography is a recording of the electrical activity of the heart over a period of time as detected by electrodes attached to the

surface of the skin of the chest. The recording produced can be transmitted to a monitor at the patient's bedside for constant observation in certain clinical situations.

- **FH** Family history includes a list of any major diseases experienced by members of the immediate family.
- **HDU** Surgical High Dependency Unit a small ward usually 4 beds, for patients requiring a high level of care following surgery
- **HEA** Higher Education Academy
- **HFHS** High Fidelity Human Simulator that can be programmed with basic physiological parameters that replicate a human for example: heart-rate, blood –pressure, breathing, sweating, and a pulse.
- **HPC** History of present condition; summarises the patients' current symptoms.
- **HR** Heart rate, the speed of the heart beat, specifically the number of heart beats per unit of time, usually recorded as beats per minute. The normal rate is between 60-100 beats per minute. **Bradycardia** is a heart beat below 60 beats per min and **Tachycardia** is a heart rate above 120 beats per min.
- **Huff** a manoeuvre used to clear secretions that may be used instead of a cough
- **iCSP** Interactive Chartered Society of Physiotherapy discussion forum
- **IPPB** Intermittent Positive Pressure Breathing often referred to as the Bird. This delivers positive pressure on inspiration and is used to assist with breathing and the removal of secretions

- **Laparotomy** a midline incision used for surgery on the abdomen
- **LTM** Long-term memory, relatively permanent storage of information
- **Nebuliser**- a drug that is delivered by compressed air that causes very small droplets to be formed which enables the drug to be inhaled into the lungs
- **NMC** National Midwifery Council
- **Oxygen re-breathe bag** – an oxygen face mask with a reservoir bag so that the patient receives 100% oxygen
- **PCA** Patient controlled analgesia. Self-administration of small doses of analgesics by patients when they feel pain.
- **PEP bottle** Bubble PEP delivers Positive Expiratory Pressure by using a column of water approximately 10 cm in a bottle with a straw or tubing for the patient to blow through into the water. The water provides some resistance and encourages the patient to take a deeper breath.
- **PMH** a patient's previous medical history summarises the entire list of medical and surgical conditions that the patient has experienced to date.
- **RR** Respiratory rate is the number of breaths taken within a set amount of time, usually 60 seconds. A normal rate is between 12-18 breaths per minute.
- **SH** Social history provides a picture of the patient's social situation.
- **SimMan 3G Laerdale** TM a High Fidelity Human Simulator

- **SaO_2** the arterial oxygen saturation of blood, measurement is obtained from a sample of arterial blood and analysed using arterial blood gas analysis.
- **SpO_2** the measurement of oxygen saturation levels in arterial blood by wearing a probe on the finger that works by transcutaneous examination of the colour spectrum of haemoglobin that changes with its degree of saturation. The normal value is between 96-98%.
- **STM** Short-term memory, a working space for short computations
- **Temperature** body temperature maintained within a normal range of 36.5-37.5°C
- **TPN** Total Parenteral Nutrition or total peripheral nutrition, is when a liquid that contains nutrients such as glucose, amino acids and lipids with a very high calorific value, is fed intravenously when patients are unable to eat (as it bypasses normal process of eating and digestion).
- **UO** urine output, normal value is 0.5mls/kg/hr
- **VIP suite** Virtual Interactive Practice suite, Faculty of Health Sciences, University of Southampton
- **WCC** white cell count, white blood cells are the cells of the immune system involved in defending the body against infectious diseases and foreign material. There are approximately 7000 per microlitre of blood. The number is normally used as an indicator of disease, being less when there is an infection present.
- **Yankeur suction** a method used to clear secretions from the back of the mouth using a plastic tube.

Chapter 1: Introduction

1.1 Reasons for this study

In this research I set out to determine the clinical reasoning model used by expert cardiorespiratory physiotherapists for the reason that there is a dearth in the literature pertaining to this process in this specialised field of physiotherapy and therefore there is no clear method of how to approach teaching the subject. This study came about from my own personal experience of being a clinician, and educator. I have been teaching cardiorespiratory physiotherapy for the past fifteen years on the BSc and MSc programmes at the Faculty of Health Sciences and my teaching practice has evolved from my own clinical practice and educational experiences. Before embarking on my academic career, I studied for a master's degree in musculoskeletal physiotherapy and it was whilst undertaking this course that I became more aware of the importance of clinical reasoning and was introduced to strategies to enhance my reasoning skills. Over the years, I have integrated some of the concepts I learnt on the master's programme to facilitate the development of clinical reasoning within my current teaching practice. However, I had no evidence that these concepts were working, or if they were the most appropriate choice, given that these concepts were based on a different speciality within physiotherapy.

When I commenced this doctoral programme, I had also begun to use the High Fidelity Human Simulator (HFHS), SimMan (Laerdale TM) in my teaching practice. I thought this could help students learn some quite difficult concepts, for example, the examination of the chest could be conducted on the manikin as breath sounds can be created and manifested through the manikin's chest rather than using traditional didactic lectures or practical sessions. I had also thought that teaching with simulation could help develop clinical reasoning, as the simulation provided a contextual environment that mirrored clinical practice. My ideas emerged, and I decided that I would use this medium to explore the clinical reasoning of experts. My aim was to identify the actions, behaviour, knowledge and thought processes that constitute the clinical reasoning process in experts, and use the findings to help create an evidence-based teaching strategy. The study has clinical and educational relevance for the physiotherapy profession and also contributes to the growing area of research using simulation as a teaching strategy within the health care professions.

1.2 Cardiorespiratory physiotherapy

Cardiorespiratory physiotherapists specialise in the normal function of the lungs and aim to facilitate normal breathing. It is different to many other physiotherapy specialities, as physiotherapists are often dealing with seriously ill patients whom could possibly die if their breathing fails them. Therefore these physiotherapists require a specialist knowledge base, and complementary clinical skills. Furthermore, cardiorespiratory physiotherapists work in different settings, for example in the acute settings in the hospital such as the intensive care unit (ICU); medical or surgical high dependency unit (HDU); cardiothoracic intensive care unit; medical and surgical wards. They also work in the community, running pulmonary rehabilitation programmes and home oxygen services. The cardiorespiratory physiotherapist is often working autonomously with increasing accountability in decision-making and therefore clinical reasoning is an important concept to understand.

Equally important is the need to understand this process educationally, so that we can facilitate students to learn the right knowledge as best as we can and prepare them to work in this specialised area. The facilitation of clinical reasoning should be based on “an understanding of how competent individuals proceed in determining what observations to make, in identifying health problems from those observations, and in deciding on appropriate actions; and an understanding of the progression of such competence, from beginning level to the development of expertise” (Tanner, 1987, p.155). As an educator in this specialised field of cardiorespiratory physiotherapy, it is essential to explore this subject further to know which model of reasoning I should be encouraging my students to emulate, and to know how to approach teaching this subject so that students can frame their reasoning on models of practice that are compatible with clinical experts (Higgs and Loftus, 2008).

1.3 Problem statement

I recognised as part of this doctoral process, that an assumption had been made namely, that I could teach cardiorespiratory, based on my previous clinical experience. As Spencer (2003, p.591) recognised, assumptions like this are often made, that is: “if a person simply knows a lot about their subject, they will be able to teach it. In reality, of course, although subject expertise is important, it is not sufficient. Effective clinical teachers use several distinct, if overlapping, forms of knowledge”. However, I realised that without knowing what the model of clinical reasoning is in cardiorespiratory physiotherapy, I could not fully justify how I was teaching the subject and neither could I infer that simulation was an appropriate method for teaching the subject and that therefore I needed to explore both aspects further. The problem was that without understanding the model of clinical reasoning used by clinicians, it was difficult for me as an educator to frame the teaching so that it was comparable to the practitioners' frames of reference and hence students may not develop these skills when on clinical placement. Furthermore, I recognised that we currently do not specifically address teaching clinical reasoning and much of the way that we teach, can leave students unable to link the knowledge taught at the university to the clinical practice setting. To overcome this, I had introduced teaching cardiorespiratory with simulation but had no evidence to support my theory.

Effective teaching, and the strategies used, is tied to the curriculum base and philosophy that underpin the BSc and MSc programmes at the University of Southampton. The curriculum has been designed with the ultimate goal that on graduation, a student is ready to begin a preceptorship in physiotherapy. This means they have reached a level of competency required by the professional and regulatory bodies to begin clinical practice under supervision. During their time at university, they must acquire the appropriate knowledge and psychomotor skills required by the professional bodies: The Chartered Society of Physiotherapy who set the curriculum framework for qualifying programmes in physiotherapy and the Health and Care Professions Council who set the standards of gaining and maintaining registration to practise as a physiotherapist in the UK. The curriculum reflects this diversity and consists of many educational theories, which interweave to facilitate this final outcome. The physiotherapy curriculum at the Faculty of Health Sciences follows a constructivist educational philosophy - the "guided discovery learning" - a hybrid of problem based learning (Barrows and Tamblyn, 1980) that uses a combination of lectures, practical sessions, small group work, and clinical placements in which a total of 1,000 hours must be completed prior to graduation. Hence, clinical reasoning is not taught as a separate subject in the curriculum, but is an expected development as the student progresses through the course as they gain more knowledge and clinical experience.

1.4. The purpose of the study and the methodology

The purpose of this study was to explore the actions, behaviour, knowledge and cognitive thought processes that constitute the clinical reasoning of expert cardiorespiratory physiotherapists, in order that I could frame my teaching on the practice demonstrated. A qualitative design was chosen as the methodology for this study, as it would enable me to explore these different variables. The simulated environment was chosen so as to create consistency between the participants and also to establish whether simulation could be an appropriate strategy to teach clinical reasoning and create a simulation pedagogy.

1.5 Thesis Overview

This study has been an iterative process that has resulted in the identification of the actions, behaviour, knowledge and cognitive thought processes of eight expert cardiorespiratory physiotherapists as they undertook an assessment and treatment of a simulated post-operative patient with respiratory complications. The findings generated have been compared to other models of clinical reasoning and a new conceptual model of clinical reasoning has been designed specifically for cardiorespiratory. The findings have also given a greater insight into the underpinning requirements for teaching clinical reasoning and a new model for embedding clinical reasoning into simulated teaching sessions has been designed along with a learning trajectory across all three levels of the physiotherapy programme. Thus by creating an evidence base for clinical reasoning and using simulation as a learning strategy, this study contributes to the professional body of knowledge both clinically and educationally.

The thesis is organised into five chapters**:**

Following this introduction, Chapter 2 introduces the literature about clinical reasoning in medicine and the health professions. It discusses the different models of clinical reasoning and focuses on what is known in physiotherapy and what is currently known about clinical reasoning in cardiorespiratory, particularly, the differences between the novice and the expert. The chapter includes a discussion on how clinical reasoning is currently taught and introduces the concept of simulation as a teaching strategy and the supporting educational theories.

Chapter 3 describes how the methodology for the study was chosen and the justification for it. The pilot study and the main study are described and the iterative development of the analysis is explained.

Chapter 4 describes the main findings from a clinical perspective and reviews each of the stages observed in this study to other models. It concludes with a synthesis of the findings to produce a new conceptual model of clinical reasoning.

Chapter 5 discusses the findings from an educational perspective including synthesis of the findings to produce a conceptual model for integrating the clinical reasoning observed in this study into a simulated teaching session. A learning trajectory is proposed with a module plan for implementing simulated learning for cardiorespiratory modules across all three levels of the programme.

Chapter 6 assimilates the findings and draws together the conclusions from the study, discussing the implications of these findings for the profession clinically and educationally. This chapter discusses suggestions for future developments, makes recommendations, and reflects on what has been learnt from this educational doctorate.

Chapter 2: Literature review

Introduction

In this chapter, I begin by defining clinical reasoning in medicine and the health professions and the case for its importance. I then review the research into clinical reasoning and the different models and concepts that have been developed to explain this process. This review primarily focuses on the hypothetico-deductive model introduced in medicine by Elstein et al (1978) as this is widely used by many health professions, including physiotherapy. I discuss how this model has been adapted as the collaborative model in physiotherapy and used within most domains, but not cardiorespiratory. I consider what is known about clinical reasoning in cardiorespiratory physiotherapy, particularly the difference between the novice and expert practitioner and discuss how clinical reasoning can be taught in the undergraduate physiotherapy curriculum. I then introduce simulation as a teaching strategy and use the literature to explore both my underpinning pedagogical content knowledge and the underpinning educational philosophies of simulation, to support my proposal for using it as a teaching medium for developing clinical reasoning, prior to clinical experience. This chapter is divided into five main sections.

2.1.What is clinical reasoning?

Clinical reasoning is also known as critical thinking, clinical judgement, problem-solving and clinical decision-making and these terms are used interchangeably in the literature to describe a similar process. Clinical reasoning can be defined as “the cognitive thought processes, or thinking used in the evaluation and management of a patient” (Jones, 1992, p.876). Cervero (1988) and Harris (1993) state that clinical reasoning enables practitioners to take “wise action”, which means taking the best-judged action in a specific context. Clinical reasoning is seen as permeating clinical practice and as being the core of practice. Clinical reasoning has been a topic of interest for the past forty years in medicine, nursing, cognitive psychology, occupational therapy, dentistry and physiotherapy. Each profession has developed its own definition of the process. In physiotherapy, Higgs and Jones (2000, p.3) describe clinical reasoning as:

> ...the thinking and decision-making processes associated with clinical practice, it is a critical skill in the health professions, central to the practice of professional autonomy.

Higgs and Jones (2008, p.4) further defined clinical reasoning as:

> ...a context dependent way of thinking and decision-making in clinical practice to guide practice actions... It utilises core dimensions of practice knowledge, reasoning, and metacognition and draws on these capacities in others.

From these definitions, it would seem that clinical reasoning is primarily the thinking or cognitive thought processes involved when making a decision. However, research into this process has shown that this is only part of what is happening and that clinical reasoning is complex and multifactorial with many other variable factors occurring simultaneously (Edwards et al, 2004). This is because each patient presentation is unique, and each encounter has its own level of complexity and it is the skill of the clinician that unravels what is happening. Forde (1998) describes the processes as within a continuum: at one end is the strongly embedded scientific analytical approach while at the opposite end of the spectrum lays the humanistic, intuitive element. This helps us to understand why the medical line of research has followed a scientific enquiry of the analytical decision-making processes (Elstein et al, 1978; Neufield et al, 1981; Barrows and Feltovitch, 1987; Patel et al, 1991) whereas other health professions such as nursing (Benner, 1984; Carr, 2004), occupational therapy (Mattingly, 1991) and physiotherapy (Jensen et al, 1992; Higgs and Jones, 2000; Edwards et al, 2007; Smith et al, 2007) have explored clinical reasoning from the interpretive paradigm to investigate the variable professional factors and the more intuitive aspects of the reasoning process. These concepts are discussed further in section 2.3.

2.1.2 Why clinical reasoning is important

The medical and health professions' literature is replete with contentions about the importance of clinical reasoning for professional autonomy. In medicine, clinical reasoning means the physician gathers data about the patient and diagnoses what is wrong and decides what treatment is considered best, either by prescribing a medicine, treatment or further investigation or referral to another health professional. Therefore diagnostic reasoning is the most critical of a physician's skills to prevent misdiagnosis or error that could lead to patient morbidity (Croskerry, 2009). The effectiveness of clinical reasoning, therefore, determines how well the doctor's medical knowledge is translated into patient care. Despite this, errors in reasoning still occur and the rate at which doctors' fail in this critical aspect of clinical performance is surprisingly high: autopsy findings have consistently shown a 20-40% discrepancy with the ante-mortem diagnosis and a third of these autopsies would not have taken place if the true diagnosis had been known (Croskerry, 2009). The contribution of diagnostic error to patient morbidity and mortality is significant, but strategies for reducing it do not come easily (Croskerry, 2009). Hence, improving clinical decision-making is an important goal for the safety of patients and why there is an on-going interest in exploring this fundamental concept of clinical practice.

In other health professions, such as physiotherapy, clinical reasoning is not so much about forming a diagnosis, but rather it is about assessing the patient's problem(s), and deciding if the patient's problem is amenable to treatment that can effectively address the condition. Physiotherapy, in contrast to medicine, also gives a greater consideration to the perspective of the patient and their understanding of their condition, their social circumstances and the meaning they have associated with their problem. Patients' understanding of their problem has been shown to impact on their levels of pain tolerance, disability and eventual outcome (Borkan et al, 1991). Payton et al (1990), advocate client involvement in the decision-making about the management of their health and well-being, based on the process of client participation and recognition of the values of self-determination and the worth of the individual. "Mutual decision-making requires not only sharing of ownership of decisions, but also the development of skills in negotiation and explaining to facilitate two-way effective communication" (Higgs and Jones, 2000, p. 3). Often the physiotherapy treatment applied becomes part of the reasoning process too, as the effectiveness of the treatment given is evaluated immediately afterwards and this contributes to the on-going reasoning process. Hence, clinical reasoning is an essential skill that enables the therapist to perform as an autonomous practitioner, and make independent judgements tailored to the individual patient.

Physiotherapy became an autonomous profession over thirty years ago, following a Department of Health Circular in September 1977. Then, in the following year, the Chartered Society of Physiotherapy (CSP) altered its byelaws to allow physiotherapists to treat patients without referral from a doctor, and the profession effectively became autonomous. Today, the profession has changed significantly from the past, whereby the doctor referred the patient with a diagnosis and specified the treatment to administer. Physiotherapists can now accept referrals for assessment from a range of sources: from an individual themselves (self-referral) or from other people involved with that individual (CSP Scope of physiotherapy practice, 2008; Code of professional values and behaviour, CSP 2011). With this increase in autonomy, there is also an increase in accountability from within the profession. The demand is met by the profession’s on-going efforts to conduct scientific enquiry with the aim of providing evidence for physiotherapy treatment. The scientific paradigm is where enquiry is based on positivist philosophy. The randomised controlled trial has become the ‘gold standard’ for evidence because of the control of variables, the measurement of intervention and the subsequent prediction to populations from statistical analysis (Depoy and Gitlin, 1998). The scientific paradigm is the basis for the epistemology of current evidence-based medicine, which is:

> ... the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients (Sackett, 1997, p.3).

Sacket et al (1996, p.71), also acknowledge that the “proficiency and judgement that individual clinicians acquire through clinical experience” need to be used in conjunction with evidence-based medicine when considering how to optimise the care of the patient and evidence-based practice is the combination of both.

Evidence-based practice has been accepted in physiotherapy since the 1990s (Jones and Higgs, 2000; Ritchie, 1999). As a consequence of the change in professional autonomy, and the need for evidence-based practice, many conceptual models of clinical reasoning have been developed. These models have contributed to the epistemology of the respective health professions and have also contributed to helping educators understand what knowledge needs to be taught along with appropriate cognitive, communication and reflective skills so as to develop an effective autonomous practitioner. The next section presents the scientific and interpretative research paradigms that have been used by the different professions to explore clinical reasoning and how this research has contributed to the different models and concepts.

2.2 A Variety of models of clinical reasoning

Research, using a variety of approaches, has been undertaken for nearly three decades to try to understand the clinical reasoning process in the different health professions (Norman, 2005; Croskerry, 2009). Clinical reasoning has been investigated from both a scientific and interpretive paradigm and as a result of this research in medicine and the health professions, different conceptual models have emerged that enable clinicians and educators to understand the process. Clinical reasoning is now understood to be more than the cognitive thought processes used to form a diagnosis; it is a contextualised interactive phenomenon (Higgs and Jones, 2008). In this section, I discuss the main models evident in the literature.

2.2.1 Medical research:

Early medical education has predominantly investigated clinical reasoning using the scientific paradigm to explore three main themes: problem-solving or decision analysis; differences between the novice and expert; and the relationship of knowledge organisation such as memory recall and mental representations. As a result of this research, the hypothetico-deductive model was developed and further to this, the concepts of pattern-recognition, illness scripts, and forward and backward reasoning were proposed. This model and these concepts developed in medicine have subsequently influenced and underpinned much of the research in clinical reasoning in the other health professions and are now discussed.

2.2.2 The hypothetico-deductive model

Elstein et al (1978) and his colleagues investigated the process of diagnostic reasoning by observational and experimental studies. The aim was to explain the complex reasoning process in medicine in terms of simpler elements to gain an understanding that would help medical students and their teachers improve their reasoning and decision-making. Twenty-four internists, (who had been identified by their peers as highly skilled clinicians), examined three, actor-simulator patients to present consistent history, symptoms and signs. Each internist, examined the patients, which began with a brief verbal description of the patient's problem (five to fifteen lines and a minimum amount of information about the case) so that the examinee then had to decide how to approach the patient, reach a diagnosis and develop a treatment plan. The clinicians were encouraged to think-aloud or subsequently review a videotape of their interactions as a "simulated recall of their thought processes" (Norman, 2005, p.419).

These studies showed that within a few minutes of the beginning of the encounter, clinicians generated several diagnostic hypotheses and gathered subsequent data to test these hypotheses. The findings suggested that all physicians approach medical problems by generating hypotheses and testing them, hence the model of clinical problem-solving was known as the hypothetico-deductive model. Barrows and Feltovitch (1987) endorsed the hypothetico-deductive model but also recognised that the process was a "temporal unfolding of information" (p.86) as clinical problems are ill-structured and reasoning is built around similar sequential events seen in experts and novices alike. Moreover, experts were able to reach a hypothesis more quickly than novices as a result of having more knowledge or having a better way of accessing their knowledge more readily. This led to subsequent research into knowledge organisation, and how recognising patterns contributes to a more nuanced account of the clinical reasoning process. These concepts are now discussed.

2.2.3 Pattern-recognition and illness scripts

Subsequent medical research into clinical reasoning explored memory recall and mental representations. Groen and Patel (1985) proposed the concept of ‘pattern-recognition’ (also referred to as ‘inductive reasoning or ‘direct automatic retrieval’), a process that occurs in experts when dealing with non-problematic situations for example, a broken leg. Pattern-recognition is characterised by speed and efficiency (Arocha et al, 1993; Ridderrikhoff, 1989) and uses direct automatic retrieval of information from a well-structured knowledge base. Explanations of pattern-recognition include categorisation and the use of prototypes. Categorisation involves grouping together objects or events. It can be related to the process of recognising similarity between a set of signs and symptoms or treatment options from a previously experienced clinical case. The new case is placed in the same category as the past case and is given the same label. An important aspect is that the clinician makes a link between the context of the condition, events or situation and previous cases.

However, Barrows and Feltovitch (1987), dismissed suggestions that experts use pattern-recognition, arguing that in order to recognise a pattern, a hypothesis still had to be made. They postulated that the reasoning abilities of the medical expert rely on extensive and well-organised bodies of knowledge. In the medical expert, this includes memory clustering of logical alternative diagnoses, clinical expectancies that are highly tuned to the particulars of the case and multiple variations of disease that enable the expert to adjust expectancies and interpretations to the clinical context. Boshuizen and Schmidt (1992) later confirmed this concept and corroborated the parallel development of knowledge acquisition and clinical reasoning expertise. They proposed a model of 'illness scripts' being developed as the novice undergoes transition to an expert. Illness scripts are the synthesis of biomedical knowledge and experience that become instantiated scripts and so enable the clinician to deal with problems more expediently than a novice. An important concept in the development of these illness scripts is the link the clinician makes between the context of the condition, events or situation, and previous cases.

Patel and Groen (1986) and Arocha et al (1993) have used the terms 'forward reasoning' and 'backward reasoning' and asserted these processes take place in the clinical reasoning process. They observed that experts tended to use the faster process of forward reasoning or inductive reasoning, in which data analysis results in hypothesis generation or diagnosis, utilising their sound knowledge base. Forward reasoning is most likely to occur in familiar cases with experienced clinicians, whereas backward reasoning (or the re-interpretation of data, or the new acquisition of new data), is required to test a hypothesis and occurs with in-experienced clinicians or when experts are dealing with atypical difficult cases. Pattern-recognition/interpretation is characterised by speed and efficiency and is a fast-forward process. By comparison, the hypothetico-deductive reasoning, particularly the phase of backward reasoning, is regarded as being a slower, more-demanding and more-detailed process (Arocha et al, 1993).

From this early medical research, I conclude there is agreement that both novices and experts are using the hypothetico-deductive reasoning model. There is recognition that clinical reasoning development is closely linked to the attainment of knowledge and the organisation of that knowledge, as illness scripts or patterns. However, this has been debated. This does seem a plausible explanation for why an expert can reason quickly in non-problematic cases, yet when confronted with a difficult situation, they still use the deductive process. Meanwhile, novices with limited experiences, have not yet developed illness scripts, and so use the more deductive, slower process most of the time (Elstein et al, 1978; Arocha et al, 1993). This is an important insight educationally and I return to it when considering educational strategies for teaching clinical reasoning in section 2.5.1. Despite the research in medicine and the development of the hypothetico-deductive model, there is still much debate about clinical reasoning also being intuitive and there is a call for clinical educators to stress the importance of intuitive and analytical reasoning, thereby enabling students to “marshal reasoning processes in flexible and context specific manner” (Eva, 2004, p. 98).

Recently the ‘dual process theory’ has emerged from psychological research and Croskerry (2009) proposes a schematic model using the theory to provide a basic framework that incorporates both the intuitive and the analytical hypothetico-deductive processes. Croskerry recognises that this system is probably not a dichotomy, but is more like a cognitive continuum (Hammond, 2000) between intuitive and analytical approaches. Thinking is affected by our thinking processes and by external factors. We may think intuitively ‘on our feet’, which may then let in cognitive bias and heuristics or we may think analytically weighing up all the science and evidence before acting. The cognitive continuum model (Hamm, 1988) is a model to explain or predict what sort of thinking the clinician will engage in, based on the situation they find themselves. The argument here is that the major determinant of whether a clinician uses intuitive or analytical thinking is the position of the decision task on a continuum. This depends on the structure of the task and number of information cues and the time available to make judgements. Goodman and Ley (2012) suggest that most healthcare interventions fall in the middle of the continuum, so a system-aided judgement is the most appropriate form of cognition. Thus a poorly-structured task, with many information cues and little time, suggests intuition as the most usual mode of cognition (Goodman and Ley, 2012). See Table 2.1 The cognitive continuum theory adapted from Hamm (1988).

Well structured							High
						1.Scientific experiment	
					2. Controlled trial		1.Visibility of process
The task structure				3.Quasi experiment			2.Possibility of manipulation
			4.System-aided judgement				
Poorly		5.Peer aided judgement					3.Time required
structured	6.Intuitive judgement						Low

Table 2.1: The cognitive continuum theory adapted from Hamm (1988).

2.2.4 Dual Process Theory

The dual process theory (Croskerry, 2009) can explain both the intuitive and analytical aspects of clinical reasoning. It is a framework that consists of two systems. System 1 incorporates the intuitive aspect and is highly context bound. This system relies upon the experience of the decision maker and therefore uses reasoning that depends on inductive logic and proves effective much of the time (Croskerry, 2009). It matches the work by Boshuizen and Schmidt (1992) in that experienced decision makers recognise overall patterns in the information presented, and act accordingly. Action is taken following recognition; physicians may be consciously or subconsciously influenced by a variety of factors including patient characteristics, illness presentation and other issues in the medical environment. System 1 is characterised by heuristics and other mental shortcuts and many diagnostic decisions in medicine are based on this type of pattern-recognition of how the disease is presenting itself. System 1 may also be using a form of tacit knowledge or intuitive aspect as suggested by Eva (2004). It must be recognised, however, that occasionally the method fails, as “it misses the patient who presents atypically or when the pattern is mistaken for something else” (Croskerry, 2009, p.1023). “It is this inherent vulnerability of intuitive thinking and the use of (problem-solving by trial and error) that account for the error in system 1” (Croskerry, 2009, p.1024). Croskerry illustrates this with the study by Breiger et al, (2004), a major study of acute coronary syndrome (ACS) that demonstrated the error rate in diagnosis of ACS increased tenfold when patients presented without the cardinal symptoms of chest pain. These patients experienced greater morbidity and a higher mortality, as they were frequently misdiagnosed and undertreated across the spectrum of ACS.

System 2 is the analytical systematic approach, and in contrast to system 1, takes place under more ideal conditions whereby all the relevant variables and parameters are known. The Bayesian method, a method used for estimating the probability of a particular diagnosis given the appearance of some symptoms, sign or test result in a specific patient (Last, 1995), is used to form a diagnosis. This form of thinking uses hypothesis testing (Elstein et al, 1978; Barrows and Feltovitch, 1987) and deductive reasoning (Arocha et al, 1993) as previously discussed. “It is engaged when the patients’ signs and symptoms are not readily recognised as belonging to a specific illness category, or do not follow a particular script” (Croskerry, 2009, p.1023). System 2 is logical; it requires “conscious activation and is a linear system that is built through learning...it becomes increasingly competent as we mature, socialise and go through formal education” (Croskerry, 2009, p.1024). Thus the hypothetico-deductive and the dual process theory are important models when considering how to teach clinical reasoning and will be discussed further after reviewing some models that have been developed in the health professions.

2.2.5 Health professional research and clinical reasoning models

The literature shows that the medical lines of investigation were very focused on finding a general method of problem-solving that was a separate skill that could be learnt independently of relevant professional knowledge or clinical skills. In contrast, health professional research has explored clinical reasoning from the interpretive research paradigm, which:

> ...acknowledges relativism and local, multiple, and specific constructed realities as the researcher seeks to interpret phenomena, particularly human phenomena... The various approaches do not look for cause-effect relationships or use the experimental method; rather they look at the whole phenomenon under investigation and take account of the context of the situation, the timings, the subjective meanings and intentions within the particular situation (Higgs and Titchen, 2000, p.26).

Interpretative research, such as hermeneutics (the theory and practice of interpretation), ethnography (which describes a phenomenon from a societal or cultural focus), and phenomenology (which tries to understand lived experiences), have been used to explore clinical reasoning by health professionals and this has led to other models of clinical reasoning being developed. I next discuss three prominent models from nursing, occupational therapy and physiotherapy.

2.2.6 The novice to expert model in nursing

In nursing, Benner, (1984) used hermeneutic enquiry to understand the behaviour of the expert and the context. Her approach was based upon there being a difference between practical and theoretical knowledge. She asserted that formal models, textbook descriptions and theory were inadequate to explain practical situations and their complexities. Benner postulated the notion of intuition as part of the reasoning process, which she felt nurses developed. The model involves six components: intuitive thought, pattern-recognition, similarity recognition, common-sense understanding, skilled know-how, senses of salience, and deliberative rationality. The work of Benner expanded upon the Dreyfus and Dreyfus (1986) model of skill acquisition. The Dreyfus model posits that in acquisition and development of a skill, a student passes through five levels of proficiency: novice, advanced beginner, competent, proficient and expert. There is a move from a reliance on abstract principles to the use of past concrete experiences with a change in viewing a situation as multiple fragments to seeing a more holistic picture.

2.2.7 Narrative reasoning model in occupational therapy

Mattingly (1991) developed the narrative model as the central mode of clinical reasoning in occupational therapy. She maintains that therapists reason by story-telling and story creation. Story-telling describes the therapist's understanding of the patient's way of dealing with disability and includes puzzling about how to handle the patient's problems. Story creation is the process of envisaging or imagining the future. This theory is based on the work of Bruner (1986, 1990), who argued from a cognitive psychology perspective that humans think in two fundamentally different ways. The first type of thinking is paradigmatic, that is, thinking through propositional argument, and the second type of thinking is by story-telling. The difference between these two kinds of thinking involves how to make sense of, and explain what humans see. When a clinician thinks paradigmatically, it means that they see a patient with a set of symptoms and link these to a general disease category. In contrast, if thinking narratively, the clinician tries to understand that person's experience of their disease. "Narrative thinking especially guides therapists when they treat the phenomenological body; that is, when they are concerned with their patients' illness experience and how the disability is affecting their lives" (Mattingly, 1991, p. 1004).

2.3 The collaborative hypothetico-deductive clinical reasoning model in physiotherapy

Similarities with the medically developed model of reasoning (Elstein et al, 1978) have been shown to exist at a broad level within physiotherapy and have described reasoning in terms of being primarily a diagnostic process (Payton, 1985). Subsequent research (Jensen et al, 1992; Jones, 1995; Jones et al, 2000; Edwards et al, 2004, and Edwards et al, 2007) has recognised other contributing factors and shown that reasoning is not only about diagnosis. Hence the medical hypothetico-deductive model has been expanded further to include what is happening between the patient and the physiotherapist and is known as the "collaborative clinical reasoning process" (Jones et al, 2000, p.119). The model is intended to provide a simple pictorial representation of clinical reasoning in physiotherapy and incorporates the interactions that occur at each stage (see Figure 2.2).

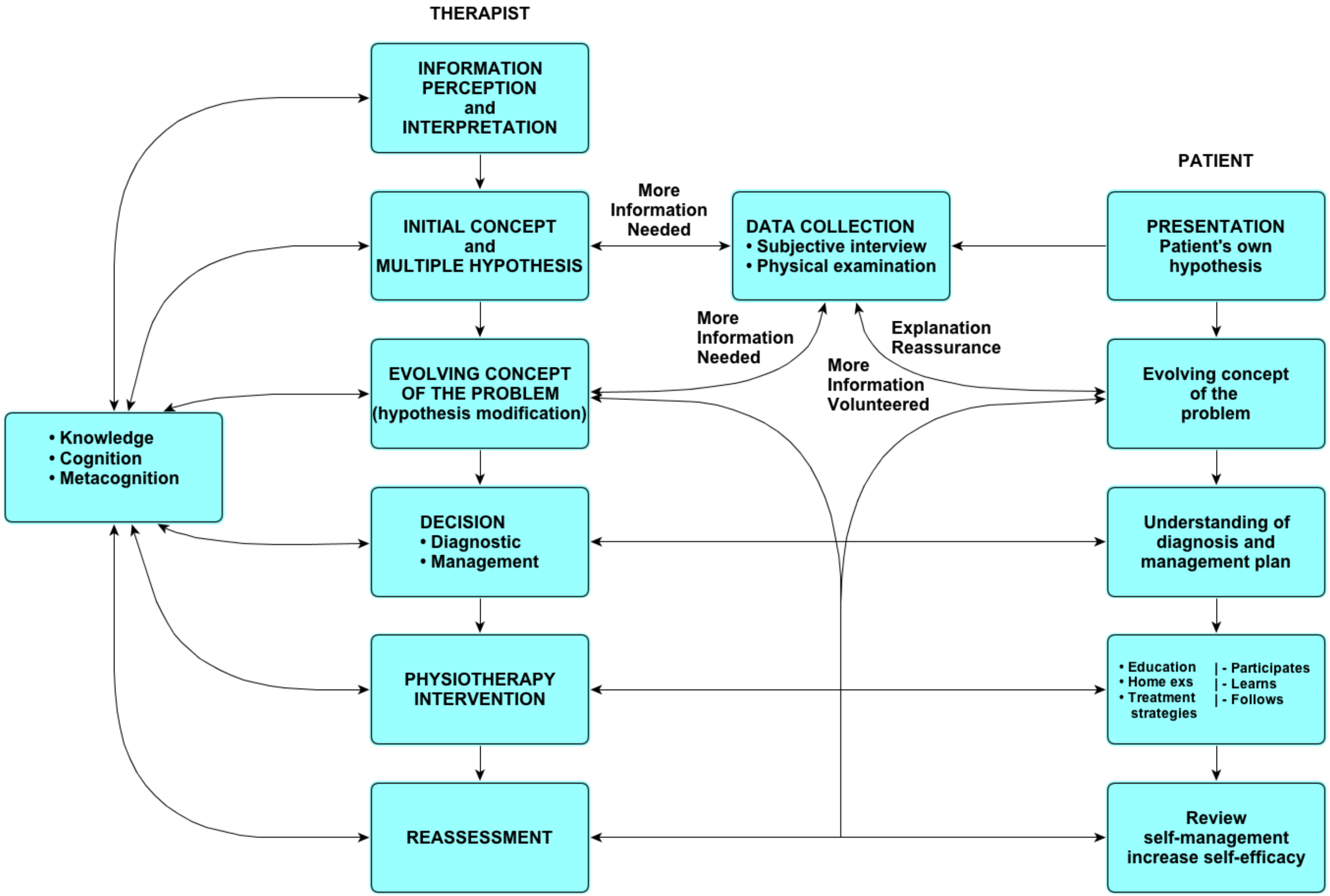


Figure 2.2: The collaborative clinical reasoning process (adapted from Jones et al, 2000, p.119).

The essential elements are cognition, a strong underpinning of discipline specific knowledge and metacognition, which provides the interaction between cognition and knowledge. The model has also been represented as an upward and outward spiral to demonstrate that clinical reasoning is cyclical and a developing process. Each loop of the spiral incorporates data input, data interpretation/re-interpretation and problem formulation/re-formulation to achieve a progressively broader and deeper understanding of the clinical problem (Higgs and Jones, 2000). Based on this deepening understanding, decisions are made concerning intervention and actions are taken (see Figure 2.3 the clinical reasoning spiral adapted from Higgs and Jones, 2000, p.11).

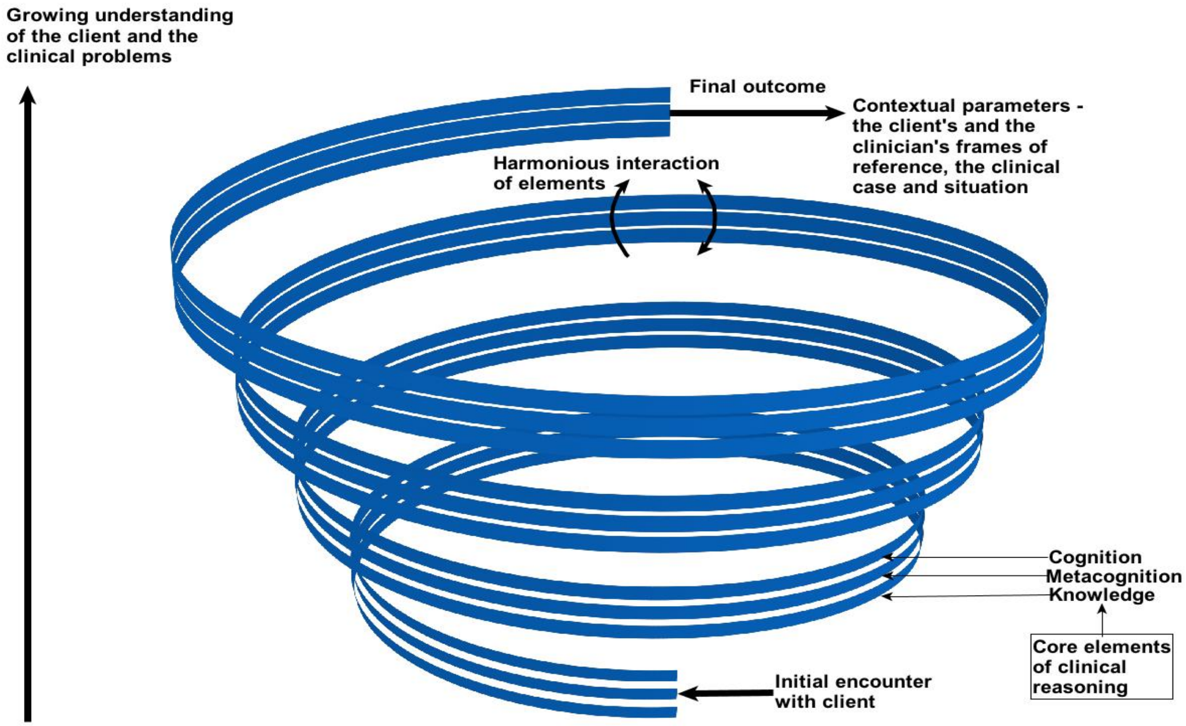


Figure 2.3: Clinical reasoning - an upward and outward spiral (adapted from Higgs and Jones, 2000, p.11).

Analysis of the literature indicates that the collaborative hypothetico-deductive model is comprised of multiple components. As this model is fundamental to my research study, I discuss the chronological stages and the components of the process.

2.3.1 Stages in the collaborative hypothetico-deductive clinical reasoning model

In all physiotherapy settings, the physiotherapist's reasoning begins with the initial data/cues obtained. This can be from a variety of resources for example, the patient, the environment, and the medical notes and often by communication with another health professional. This preliminary information will evoke a range of impressions or working interpretations. Whilst typically not thought of as such, these can be considered hypotheses. The cognition involved in hypothesis generation includes a combination of specific data interpretations or inductions and the synthesis of multiple clues or deductions. This is quite possibly 'pattern-recognition' (Groen and Patel, 1985) or the 'intuitive inductive approach" (Croskerry, 2009). In most settings, the initial hypothesis will be quite broad, and may be physical, psychological or socially related with, or without, a diagnostic implication. All physiotherapists have an element of routine to their examination and will then gather more information usually by conducting an interview and patient examination. Specific inquiries and tests are tailored to each patient's unique presentation. The cognitive activity of hypothesis testing includes the search for both supporting and negating evidence. The resulting data are interpreted for their fit with previously obtained data and the hypotheses considered. This could be the analytical stage as described by (Croskerry, 2009), or the deductive backward reasoning stage described by (Arocha et al, 1993). In this way, the physiotherapist acquires an evolving understanding of the patient and their problem. Initial hypotheses will be modified and new hypotheses considered. This hypothesis generation and testing process continue until sufficient information is obtained to make a diagnosis and management decision.

The clinical reasoning process continues throughout on-going patient management. Physiotherapy intervention is evaluated and used to either support or negate the initial hypotheses and this may lead to hypothesis modification/generation, further data collection and problem clarification or referral to another specialist. At the micro level, therapists are constantly reading patient responses (listening, observing, feeling) and using these to build on their understanding and guide clinical decisions to modify and improve their interventions. At a macro level, whole treatment sessions or even multiple treatments will be used to test management hypotheses (Higgs and Jones, 2000). Thus reasoning in physiotherapy has some similarities with the medical models but is different, as it goes beyond ‘making a diagnosis’, and is a constant process of reviewing information, re-assessing and re-evaluating during a treatment session. Another difference is that this process may continue over several treatment sessions, which allows the physiotherapist time to reflect.

2.3.2 Strategies used by physiotherapists in clinical reasoning

Further research has been carried out to a) verify this model, and b) identify if any other distinctive features occur. Edwards et al (2004) undertook an observational study of six experts, two from each field in musculoskeletal/out-patient, neurology and domiciliary care and interviewed six other experts representing each of the same fields. The study used a grounded theory approach (Glaser and Strauss

1967) and demonstrated that all the physiotherapists used a range of clinical reasoning strategies representing a diversity of thinking and actions in a variety of tasks. These clinical reasoning strategies ranged from making a diagnosis through to management issues. The findings support the use of the hypothetico-deductive model in physiotherapy, but also illustrated the interplay between different reasoning processes in every task of clinical practice, suggesting both a complexity and scope of reasoning activity not previously understood. Eight strategies were identified (see Table 2.2). Many of these clinical reasoning strategies have been previously identified in the clinical reasoning literature: diagnostic reasoning (Fleming, 1991); procedural reasoning (Jones, 1988; Payton, 1985); interactive reasoning (Fleming, 1991); collaborative reasoning (Jensen et al, 1992); teaching as reasoning (Sluijs, 1991); predictive reasoning (Fleming, 1991); ethical /pragmatic reasoning (Barnitt and Partridge, 1997); and narrative reasoning (Mattingly, 1991). Edwards et al, (2004) proposed that two or more of these reasoning strategies may be in operation concurrently and there may be an overlap occurring in practice. It seems that “different combinations of these strategies are used at different times and on different occasions according to the particular patient or context of care” (Edwards et al, 2004 p. 315).

Diagnostic reasoning	The formation of a diagnosis related to physical disability or impairment with consideration of the underlying pathophysiology and potential contributing factors
Narrative reasoning	The apprehension and understanding of patients illness experiences, Stories, contexts, beliefs and cultures
Procedural reasoning	The determination and implementation of treatment procedures
Interactive reasoning	The purposeful establishment and on-going management of therapist patient rapport
Collaborative reasoning	The nurturing of a consensual approach towards the interpretation of examination findings, the setting of goals and priorities, and the implementation and progression of treatment
Reasoning about Teaching	The activity of individualised and context sensitive teaching
Predictive reasoning	The active envisioning of future scenarios with patients including the exploration of their choices and the implications of those choices
Ethical reasoning	The apprehension of ethical and practical dilemmas that impinge on both conduct of treatment and its desired goals, and the resultant action towards their resolution.

Table 2.2: Clinical reasoning strategies (adapted from Edwards et al, 2004, p. 73).

2.3.3 The patient and clinical reasoning

The collaborative hypothetico-deductive model also recognises that the patient’s thoughts about his/her problem are equally important to the therapist’s thinking and so should be taken into account. Patients begin their physiotherapy encounter with their own idea of the nature of their problem, as shaped by personal experience and medical advice from medical practitioners, family and friends. Borkan et al (1991), examined the narratives of eighty elderly subjects after a hip fracture and found that the patients who had perceived their problem in a more external way, showed greater improvement in ambulation at three and six months compared with those who perceived it as an internal problem. It would seem that dysfunctional beliefs could be counterproductive and impact on the level of pain tolerance, disability and eventual outcome.

> Patients' self-efficacy and the responsibility they take for their management can be maximised through a collaborative reasoning process with their therapist. ... through explanation, reassurance and shared decision-making, the patient and the therapist jointly develop an evolving understanding of the problem and its management...(Jones et al, 2000, p.118).

A primary outcome sought in the collaborative reasoning approach is patient learning (i.e. altered understanding and improved health behaviour). To achieve this, the therapist must recognise the patient as a source of knowledge and give patients the opportunity to tell their story rather than simply answer questions. Reflective therapists, who attend to individual patient presentations noting features that appear to be linked, will learn the variety of ways in which patients' health; cognition, behaviour, movement and pain can interact (Higgs and Jones, 2000). Thus the patient contributes to the reasoning process, providing the physiotherapist is receptive to the information the patient is giving and that the physiotherapist is able to interpret what they are saying appropriately. Again this will depend upon their knowledge and perhaps this is where the intuitive knowledge or life experience of the physiotherapist is important. This concurs with the theory of Barrows and Feltovitch (1987) that there is a 'temporal unfolding" that occurs with each new patient encounter and relates to the "narrative model"

(Mattingly, 1991). Again, an important difference in physiotherapy compared to medicine, is that the patient-therapist encounter may occur over a period of time, and therefore the reasoning does not all have to occur at the initial consultation and the therapist maintains an on-going rapport with the patient (Edwards et al, 2004). For this complex interaction to take place with the patient, there is interplay between the physiotherapist's knowledge, cognition (e.g. data analysis and synthesis processes) and metacognition (i.e. awareness, self-monitoring, reflective processes). It is important to consider each of these components as they influence all aspects of the reasoning process and in turn are strengthened by experience and these are discussed next.

2.3.4 The physiotherapists' knowledge in clinical reasoning

Both propositional knowledge (which is discipline-specific knowledge, derived from theory and research) and non-propositional knowledge (which is derived from professional and personal experience, including tacit knowledge) are necessary for sound and responsible clinical reasoning (Higgs and Jones, 2000). Procedural knowledge is not just recall of information but also transformation of information; it requires critical analysis and deliberate action (Cevero, 1988). The clinician must be able to recognise the situation in order to arrive at and apply the appropriate 'if /then' guides to action, different patient encounters can add to the individual's repertoire. Knowledge of life and social interactions, for example good communication skills, are also vital to guide practice along with an understanding of professional autonomy and knowing the professional rules of conduct. Hislop, (1985, p.29) concurred, "clinical decisions are based on knowledge readily understood, readily recalled and commonly encountered" thus confirming the importance of context. The clinician needs to activate the relevant knowledge according to the situation, and this distinguishes the experienced from the inexperienced clinician. As previously mentioned, Boshuizen and Schmidt (1992) and Patel and Groen (1986) showed that it is not only the amount of knowledge, but it is how the knowledge is organised, that is important and this distinguishes the expert from the novice. So educationally, there is a need not only to develop these types of knowledge but also to facilitate their storage for easy retrieval when in the appropriate context.

Jones (1992) studied knowledge organisation in musculoskeletal physiotherapy and he proposed that inquiries and clinical decisions could be broadly categorised into discrete but related areas of information, termed hypothesis categories. While diagnostic hypotheses are most easily recognised, other categories have also been proposed (Gifford, 1997; Gifford and Butler, 1997; Jones et al, 1994; Higgs and Jones, 2000). These include dysfunction, disability, patho-biological mechanism, source of symptoms or dysfunction, contributing factors, precautions and contraindications, and prognosis and management (Higgs and Jones, 2000). Knowledge organisation has not been explored in a similar way in any other field of physiotherapy. In my own teaching experience, I have tried modifying these hypothesis categories to create a simple ‘analysis tool’ to assist students when they are discussing a case study in the classroom. The hypothesis categories include signs and symptoms, pathophysiology, background, dysfunction, precautions and contraindications and medical management. Although this work is not based on any research, anecdotally the students have found this method very useful. I think that this simple tool enables the students to organise their knowledge and also aids the development of their cognitive skills.

2.3.5 Expertise

The characteristics of expertise have been critically examined in a variety of fields including medicine, nursing, teaching, psychology, and physiotherapy and it has been found that experts in these different fields share some common characteristics. Experts mainly excel in one domain, therefore experience is a fundamental quality of expertise, but it is not just experience that makes them an expert (Jensen et al 1992). It is recognised that the expert has a combination of experience and subject knowledge which is more extensive and better organised in the long term memory (Boshuizen and Schmidt 1992; Patel and Groen 1986), which is easily recalled and transformed, meaning experts can solve problems more quickly and perform the necessary clinical skills faster than novices with little error. Therefore one of the most critical and complex dimensions of expertise is clinical reasoning and decision-making (Jensen et al 2008).

May and Dennis (1991) have shown that experts form hypotheses faster and earlier and test these until a fit is found with the cues from the clinical data and that they use selective data gathering. This means they demonstrate a skilful application that is adapted to the needs of the patient and the context. In addition, experts have strong regulatory metacognitive skills so that they can evaluate the effectiveness of their treatment during and after each intervention. According to Dreyfus and Dreyfus (1986) the expert uses their intuition or tacit knowledge as well as their analytical skills to reason (Hamm, 1998).

Communication skills are stronger and the expert can maintain dialogue with the patient both verbally and non-verbally (May et al 2008). They can teach patients during the consultation so that they assume responsibility for their own health care. Jensen et al (1992) have investigated the attribute dimensions of expert physiotherapists and have found that ‘master clinicians’ are able to fully control the treatment session and make efficient use of time yet maintain an intense focus on the patient: master clinicians consistently used an evaluation framework that included the patient’s history and physical examination. They place an emphasis on documentation coupled with a strong tie between the physical examination data and information gathered about the patient’s perception of their condition. Master clinicians keep an intensely focused connection with their patients. Teaching was one of their most important clinical skills and they were confident in predicting outcomes.

For me a question that arises from this brief review of the characteristics of expertise is: “how do ‘experts’ experienced clinicians apply their knowledge and cognitive skills in clinical practice and is this linked to knowledge storage and retrieval?” To answer this question, the cognitive skills used by expert physiotherapists are now considered.

2.4.8 The cognitive skills used in clinical reasoning

Cognitive or thinking skills, such as inquiry strategies, data analysis, synthesis and evaluation of data collected are utilised to process clinical data against the clinician’s existing discipline specific and personal knowledge base in consideration of the patient’s needs and the clinical problem (Higgs and Jones, 2000). Practitioners must be able to identify and solve problems in ambiguous and uncertain situations (Barrows and Feltovitch, 1987; Kennedy, 1987). While clinical-expertise has been linked more to clinicians’ organisation of knowledge than the process of clinical reasoning, cognitive skills and knowledge are interdependent. Inquiry strategy of hypothesis testing plays a significant role in the acquisition of knowledge (Lawson et al, 1991). While the expert may not need to engage in hypothesis testing with all problems, it provides the means by which textbook patterns can be tested refined and new patterns learned (Barrows and Feltovitch, 1987). Novices who lack sufficient knowledge to recognise clinical patterns, will rely on the slower deductive hypothesis testing approach to work through a problem, whereas experienced clinicians are able to function more on inductive pattern-recognition. When confronted with a complex unfamiliar problem, the expert, like the novice will rely more on the hypothetico-deductive model (Patel and Groen, 1991).

The research literature indicates that errors in clinical reasoning are frequently related to errors in cognition. Examples of these include over emphasis on findings which support existing hypotheses and misinterpretation of non-contributory information as confirming a hypothesis, rejection of findings which do not support a hypothesis and incorrect interpretation related to inappropriately applied inductive and deductive logic (Elstein et al, 1978; Jones, 1992; Ramsden, 1985). In 1992, Norman et al, demonstrated an example of a cognitive error in data analysis and synthesis. These researchers demonstrated that both expert and resident radiologists could be biased to alter their disease probability ratings and reports of symptomatic features identified in both normal and abnormal films when the history was manipulated to bias a positive result. Bordage and colleagues suggest "diagnostic errors are not the result of inadequate medical knowledge as much as an inability to retrieve relevant knowledge already stored in memory" (Bordage and Allen, 1982; Bordage and Lemieux, 1991). Cognitive errors may contribute to the development of poorly organised knowledge. Higgs and Jones (2008) argue that metacognition, or the thinking about thinking, serves to bridge knowledge and cognition. It enables clinicians to identify limitations in the quality of information obtained, inconsistencies or unexpected findings; it enables them to monitor their reasoning and practice, seeking errors and credibility; it prompts them to recognize when their knowledge or skills are insufficient and if remedial action is needed.

This connection of knowledge and cognition could be enhanced through reflective practice. What seems vital for the process is that clinicians have the ability to think or reflect about what they do during an encounter, reflection-in-action or after a clinical encounter (Schön, 1983 and 1987). However, Higgs and Jones (2000) argue that many clinicians will be unaware of these processes, and they may reason through a problem without recognising the various aspects of their thinking. They may have also reached a stage where a systematic process of reasoning is no longer used for many problems, because experience has enabled them to identify problems and treatment quickly. The reason for a lack of reflection needs to be considered. It could be that the physiotherapist has not been taught and is therefore unaware of the reflective process, or they may know about it, but they choose not to use it and instead, only activate their intuitive, fast-forward system as proposed in the dual processing theory. Therefore, as an educator, I think it is important to overtly recognise and use these components of knowledge, cognition and metacognition and build these into the teaching strategies, so as to facilitate the development of clinical reasoning in students, in order that they become more self-aware and can continue to build their clinical reasoning skills. This is discussed further in section 2.4 in relation to possible methods of teaching clinical reasoning.

From the literature review so far, I have highlighted that clinical reasoning is an important skill for an autonomous independent practitioner, yet there have been different interpretations of what it actually is by the different health professions. Within physiotherapy, I have established that the collaborative hypothetico-deductive model is a complex multidimensional interactive phenomenon that has been accepted to occur widely within the different specialities of physiotherapy. This model has been modified and is now described as the " biopsychosocial model" (Jones et al, 2008, p.247). However, this model is not essentially altered from the earlier model by Jones et al (2000) but does situate the physiotherapists' clinical reasoning within a broader framework of health and disability. In summary clinical reasoning in physiotherapy is now thought to be a contextualised interactive phenomenon that:

> ...involves the construction of narratives to make sense of multiple factors ... it occurs within a set of problem spaces informed by the practitioner's unique frames of reference, workplace context and practice models, as well as the patients'. It utilises knowledge, reasoning, metacognition ...and maybe individually or collaboratively conducted. It involves skills of critical conversations, knowledge generation, practice model authenticity and reflexivity (Higgs and Jones, 2008, p.4).

Jones et al (2008) propose that this collaborative hypothetico-deductive model is appropriate in all fields of physiotherapy whether working in musculoskeletal/sports, neurological, oncological or cardiorespiratory, from infants through to old age. However, there has been limited research into the clinical reasoning model used within the speciality of cardiorespiratory physiotherapy. In the next section, I follow up this proposition and explore the research into clinical reasoning within the speciality of cardiorespiratory to see whether this is prevalent.

2.4 Clinical reasoning in cardiorespiratory physiotherapy

Most of the research into clinical reasoning in physiotherapy to date has focused on areas of clinical practice such as musculoskeletal/orthopaedics, neurology and community practice and it is difficult to know if the research is transferrable to cardiorespiratory. This is because cardiorespiratory physiotherapy is a specialised area of work that can often involve life-threatening situations that require immediate action, such as a patient in respiratory failure (which can then lead to cardiac arrest and death) and the physiotherapist having to decide the best treatment at the time to improve the patient’s condition. In some areas of work, such as intensive care, patients may be intubated and unconscious and therefore the collaboration is lost with the patient, which raises the question of ‘by whom, what, or how is the patients' voice in the process substituted?’ Because of the unique differences in this speciality, it is essential to review the literature on clinical reasoning in cardiorespiratory and consider whether the hypothetico-deductive model is applicable.

2.4.1 The context of clinical reasoning

To date, there have only been three studies that have explored the concept of clinical reasoning in cardiorespiratory physiotherapy. Smith et al (2007) conducted a qualitative study using observation and semi-structured interviews with fourteen physiotherapists working in acute cardiorespiratory care to explore what factors influence decision-making. This study found that cardiorespiratory decision-making was affected by three factors. Firstly, the nature of the decision itself; such as the complexity and difficulty of the decision, secondly, the context in which the decision occurred; such as physical, organisational and socio-professional factors and thirdly, the physiotherapists themselves; such as decision-making capabilities, physiotherapy frames of reference and level of clinical experience. The authors concluded that optimising the quality of decision-making in the current context of healthcare requires an awareness and consideration of a range of factors influencing decision-making.

Whilst Smith et al (2007) identified the complex interactions of the decision-making process, which concur with elements of the biopsychosocial model; the model of clinical reasoning was not identified. Neither has this study identified the types of knowledge used by the physiotherapists, the cognitive processes involved, or what reflection or metacognition is undertaken during the decision-making that have previously been identified as key components in clinical reasoning and therefore I wish to look at the novice expert distinction for further insight.

2.4.2 Differences between the novice and expert

Case et al (2000) conducted a qualitative study in which fifteen junior physiotherapists, with approximately one year of clinical experience, were compared with fifteen physiotherapists, of approximately twelve years clinical experience. Both groups were sent a paper case study of a critical care patient and were asked to read the information from history-taking and then answer specific questions relating to the case study. This was to extract the thought processes that came into their minds, after reading the account and to speculate on what they thought the likely hypothesis or provisional explanation was for the patient. Participants were also asked to comment on what they expected to find on examination of the patient. They were then given the information from the patient’s physical examination and asked to give a more definite hypothesis or explanation of what was wrong with the patient. They were asked to construct a problem list, and devise a treatment plan and list any other treatments they could use for the patient and indicate why they had chosen these treatments.

The answers were analysed using content thematic analysis and emerging patterns were developed into theoretical categories. Seven main themes emerged from this study: conciseness, vagueness, terminology, general approach, tacit knowledge, degree of consensus and clinical reasoning process. The more experienced therapists had a tendency to express themselves more concisely than the junior therapists in their reasoning. Juniors were sometimes vague in their responses compared to those given by the senior group, whereas the experienced group tended to use a more comprehensive approach and were able to identify salient points. The overall consensus was higher between the more experienced group compared with the novices, and there was a higher degree of knowledge organisation and logic among the experienced therapists. The authors believed this finding to be consistent with previous research. The increased amount of clinical experience of a senior physiotherapist in comparison to the junior was eleven years, and the interpretation was: that they had created a more organised knowledge base and had also integrated their theoretical knowledge with their experiential knowledge (Boshuizen et al, 1997). The authors suggest that those in the less-experienced group are still in the process of organising their knowledge, suggesting that this group had not yet achieved ‘knowledge encapsulation’ as described by Boshuizen and Schmidt (1992). In contrast, the senior group already have relevant components interrelated which maximises the use of their cognitive strategies to solve context specific clinical problems. The findings from this study provide evidence that a “crucial relationship exists between a clinician’s knowledge base, cognitive skills and metacognitive skills” (Case et al, 2000, p. 20) and concur with Jones' (1995) claim that the success of one's clinical reasoning can be attributed to a combination of thinking, interpersonal and clinical skills combined with an organised and accessible knowledge base.

Roskell and Cross (2001), further explored expertise in cardiorespiratory physiotherapy using a Delphi technique (Walker and Selfe, 1996) to elicit clinicians' perceptions of expert cardiorespiratory practice. There was good consensus within and between groups but this study did not allude to what the clinical reasoning process is or address how to progress the student from novice to expert. The lack of research on clinical reasoning in cardiorespiratory physiotherapy highlights the need for research to identify what the model is and the subsequent development of appropriate educational activities for students.

From this review of the literature on clinical reasoning it can be seen that the process is complex and multidimensional and needs to consider many variable factors. Research has highlighted different aspects of the process and various models have been used as a guide for clinicians and educators to understand the process further. The various models proposed however leave the educator with the challenge of deciding which model to use to teach a process that also develops when students are on clinical placement as their clinical experience increases. It is clear from existing research that the hypothetico-deductive model is the most widely accepted model and is used in musculoskeletal, orthopaedics, and neurology physiotherapy (Edwards et al, 2004). This model however, has not yet been identified within cardiorespiratory physiotherapy. The research into clinical reasoning in this speciality has only given us insight that differences exist between the expert and the novice (Case et al, 2000; Roskell and Cross, 2001) and that clinical reasoning is context-specific (Smith et al, 2007).

As there is limited literature about clinical reasoning in cardiorespiratory physiotherapy, I have extended the literature search into the same field within nursing. The five-rights of clinical reasoning (Levett-Jones et al, 2010) is used as an educational model to enhance nursing students' ability to identify and manage clinically at risk patients in the acute-care settings. This model suggests that the nurse should follow five-rights of reasoning: that is they should have "the ability to collect the right cues and take the right action for the right patient at the right time and for the right reason" (Levett-Jones et al, 2010, p.517). The model goes through the following sequential stages: consider the patient situation; collect cues/ information; process information; identify problems/ issues; establish goal/s; take action; evaluate outcomes; reflect on process and new learning (See Figure 2.4)

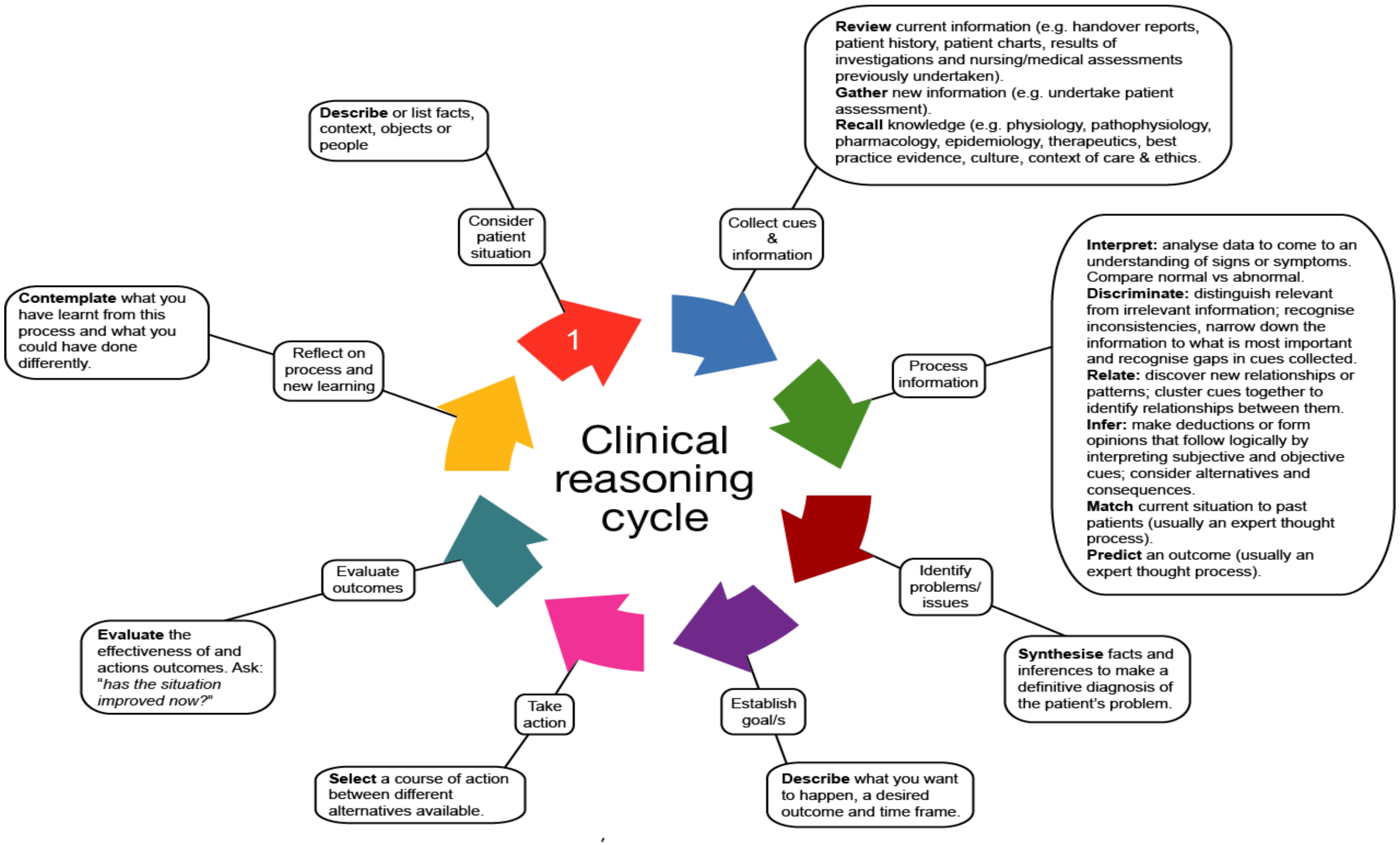


Figure 2.4: The five rights model, (adapted from Levett Jones et al, 2010, p.517).

These stages are similar to the hypothetico-deductive model, which suggests that this model could be extrapolated to physiotherapy, but we have no evidence for this. The challenge therefore remains as an educator in cardiorespiratory physiotherapy, to know which model of clinical reasoning to use from these reviewed and how to teach this complex phenomenon to undergraduate physiotherapists prior to any clinical experience. Case et al (2000) suggested that undergraduate students could be exposed to on-call scenarios as part of their undergraduate education to prepare them for on-call (out of hours working on graduation) to aid their clinical reasoning development. However, they did not address how this could be implemented in the undergraduate curriculum. Therefore the clinical reasoning models discussed so far only guide educators in what is required for effective clinical reasoning to occur. I have identified that there is a gap in the literature about which model of clinical reasoning is being used in cardiorespiratory physiotherapy and also how we teach it. This indicates that the practice of expert cardiorespiratory physiotherapists must first be explored to find out what they are doing. Thus the review of the literature has informed the development of two clinical research questions:

(1a) What model(s) of clinical reasoning are used within cardiorespiratory physiotherapy?

(1b) What are the similarities and differences in this reasoning to the collaborative hypothetico-deductive model?

Research exploring these questions would be needed to shed light on and generate understanding of what knowledge is required, the cognitive processes that cardiorespiratory physiotherapists use, and how they communicate and interact with the patient. The aim would be to use the insights gained from this inquiry to guide educators seeking to develop pedagogical activities that are suitable and relevant prior to clinical practice. From my own experience of clinical practice and previous educational experience of using simulation, I propose that simulation could be a medium that can provide the context of the clinical situation to answer the first research questions without any harm coming to a patient and that simulation may also have benefits for teaching cardiorespiratory clinical reasoning in the future, thus leading to the subsequent educational research questions:

> 2a) How can simulation be used to explore the clinical reasoning process in expert cardiorespiratory physiotherapists?
>
> 2b) In what way can the findings contribute to an evidence-based teaching strategy to facilitate the development of clinical reasoning in undergraduate physiotherapists prior to clinical practice?

In the next section of the literature review, I discuss known methods of teaching clinical reasoning and discuss the reasons why simulation may be an appropriate method, to consider in the pedagogical development of teaching cardiorespiratory to the undergraduate physiotherapists on the BSc and MSc programmes of the future.

2.5. How to facilitate clinical reasoning

From the literature reviewed so far, my conclusion is that even though there is not a clear model for clinical reasoning in cardiorespiratory, there are four key concepts that are required for clinical reasoning development that can be applied to whatever speciality the individual is working in. Firstly, the individual must acquire a comprehensive knowledge base that consists of different types of knowledge such as domain-specific knowledge, procedural and tacit knowledge. Secondly, this knowledge must also be stored in the memory in a way that it can easily be retrieved; clinical experience appears to assist with this and helps theoretical knowledge to become encapsulated. Thirdly, the individual must develop cognitive skills so that they can process information to identify, recognise, and analyse a clinical presentation, to decide if / and what action is appropriate. Fourthly, the individual must develop skills of metacognition (as this has been shown to bridge knowledge and cognition (Higgs and Jones, 2008) and reflective skills so that they can reflect in-action and after-action and learn from an experience. This insight about clinical reasoning has further challenged me to consider how to best facilitate these four concepts and the most appropriate learning strategies to employ as an educator. To answer these questions, I have first considered my own pedagogical content knowledge (PCK) (Shulman, 1986). Pedagogical content knowledge is defined as:

> a second kind of content knowledge ... which goes beyond knowledge of subject matter per se to the dimension of subject matter knowledge for teaching ... it includes the most regularly taught topics in one’s subject area, the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples explanations and demonstrations...ways of representing and formulating the subject that make it comprehensible to others...

Pedagogical knowledge also includes an:

> ... understanding of what makes the learning of specific topics easy or difficult; the conceptions and pre-conceptions that students bring with them to the learning of those most frequently taught topics and lessons. If those pre-conceptions are misconceptions teachers need knowledge of the strategies likely to be most fruitful in re-organising understanding of learners. (Shulman,1986, p.9).

When I commenced this study, I thought simulation could be a method to explore clinical reasoning in cardiorespiratory, based on my experience of using it for teaching and valuing how well it related to my own previous clinical experience. By reflecting on my PCK, I realise that I was seeking to understand my own domain-specific knowledge of cardiorespiratory (which is based on my clinical experience from several years ago), my knowledge of clinical reasoning (which was developed whilst studying for a master’s degree in musculoskeletal physiotherapy) and my current knowledge about teaching my subject. I had intuitively started to use concepts from my own clinical experience of clinical reasoning in musculoskeletal physiotherapy and I had applied these concepts to cardiorespiratory, but I realised that these methods had not been evaluated and may not be transferable to cardiorespiratory. I had also started to teach cardiorespiratory by using simulation, which related well to my previous clinical experience in cardiorespiratory before entering an academic career and thought this teaching strategy could develop clinical reasoning in students, but I had no evidence for this.

I came to recognise that my knowledge and experience had all culminated in this study, which could ultimately lead to improving my teaching practice. In order to make evidence-based change in my teaching practice, I first needed to establish what model of clinical reasoning cardiorespiratory experts use, so that I could choose the most appropriate teaching strategy to deliver the subject. By considering my own PCK, I was able to recognise that I also needed to consider the curriculum design. As previously mentioned in the introduction to this thesis (see section 1.3), the undergraduate physiotherapy curriculum is based on the constructivist educational philosophy (Dewey, 1938) using guided discovery learning and incorporates an integrative approach using a mixture of didactic lectures, practical sessions, tutorials and clinical placements. While it is beyond the scope of this section of literature review to discuss how the curriculum was designed, I acknowledge that the cardiorespiratory module is part of this curriculum and hence also follows the principles of the constructivist learning theory. I begin the next section by discussing other recommendations from the literature about how to teach clinical reasoning and the different learning theories, to support and justify my own recommendation for teaching clinical reasoning in cardiorespiratory by using simulation.

2.5.1 Learning theories that support clinical reasoning development

Terry and Higgs (1993) and Refshauge and Higgs (2000), suggest that adult learning theory (Knowles, 1990) is applicable for physiotherapists' learning clinical reasoning. This theory is based on five assumptions:

adults are independent and self-directing;

they have accumulated a great deal of experience, which is a rich resource for learning;

> they value learning that integrates with the demands of their everyday life;
>
> they are more interested in immediate, problem centred approaches than in subject centred ones;
>
> they are more motivated to learn by internal drives than by external ones (Kaufman, 2003, p.2)

Similarly, for clinical reasoning development, the learner must have: good motivation; a relevant and sound knowledge base; a willingness to take responsibility for decisions and actions; the ability to use cognitive learning and reasoning processes; the ability to seek information and knowledge as required and the additional capacity to engage in self-monitoring and self-evaluation and to take responsibility for self-development (Higgs and Titchen, 2000; Refshauge and Higgs, 2000). These authors further suggest that problem-based learning (PBL) maybe a suitable teaching method to develop clinical reasoning. The PBL approach in medical education began at McMaster University in the mid-1970s. It is defined by Barrows and Tamblyn (1980, p.18) “as the learning that results from the process of working toward the understanding or resolution of a problem”. The essence of the PBL method involves three steps: confronting the problem, engaging in independent study, and returning to the problem (Kaufman, 1998). PBL can be used in many formats such as small group tutorials, problem-based lectures, large group method discussion and problem-based laboratories (Kaufman, 2003) however it is mostly used in small groups with a facilitator. Medical literature is supportive of PBL and its effectiveness in clinical reasoning development, however despite PBL being adopted by some physiotherapy programmes, there is limited evidence of it developing clinical reasoning in physiotherapy (Barr, 1977; Perry, 1981) and there is limited evidence of PBL developing clinical reasoning in nursing (Jones, 1988; Yuan et al, 2008). The underpinning educational theory of PBL is constructivism, and there is an overlap here with the adult learning theory, which may be why Terry and Higgs (1993) recommended PBL as a suitable teaching method for clinical reasoning. Constructivism and inquiry learning methods are such that when the learner encounters new information, it is assimilated with existing knowledge that has been developed through experience. Learners construct knowledge themselves: each learner individually and socially constructs meaning as they learn. Learners are self-directed; creative and innovative, they learn by being hands on and by experimentation, and are left to make their own inferences, discoveries and conclusions. The aim of the educator is to guide the student through the process by being a facilitator, and develops the learner, rather than providing information as in the didactic approach.

A common approach used in PBL is the case study. In PBL, students start to learn with problem scenarios that stimulate their learning process (Davis and Harden, 1999). These case studies can be used to develop knowledge, foster analytical or critical thinking, and by receiving feedback from an expert, their knowledge and skills can be verified thus increasing their confidence (Kaufman, 1998). A very simple model of clinical reasoning is introduced as students begin to work with a set of presenting cues (situation prime). These cues may consist of the patient’s medical diagnosis, the topic of the practise case study or the hypothetical patient’s chief complaint (Prion, 2000). Students activate newly stored knowledge about the subject or have to seek new knowledge, and they begin to gather clinical signs and symptoms, and start to piece together and form problem identification. They begin to use cognitive/ analytical skills to recognise, group and/or prioritise cues. Once these cues are gathered, they form possible hypotheses that might explain the patient's presentation. A hypothesis is either retained or rejected depending on its alignment with grouping of the relevant cues or more data is required. The students can then identify what intervention(s) are the most appropriate and possible outcomes from that treatment. The evidence base for the effectiveness of these treatments can be researched; this further helps to strengthen knowledge connections and the accessibility of the information again by establishing a related knowledge system. The educator acts as a facilitator, to check the students' thinking and questions their thought process either throughout the process or at the end in a plenary. Case studies have been used successfully as an educational method in medicine, law and business and nursing education (Prion, 2000) and are used within the physiotherapy programmes at the Faculty of Health Sciences.

Another teaching method thought to specifically develop the cognitive skills and metacognitive skills (Cahill and Fonteyn, 2000) of clinical reasoning is the "mind-map" or "concept map" which is a graphic representation of information or the thought processes of an individual (Buzan and Buzan, 1996). Mind-maps assimilate new information in circles or boxes, creating archical arrangements between concepts and sub-concepts that can be connected with lines or linking words (Rochmawati and Wiechula, 2010), to connect information and form associations between the different components of a case study. This is believed to help students be more creative as it is a less reductionist type of reasoning that allows students to understand how they link related data for meaning and understanding and is based in the Ausubelian learning theory (Ausubel, 1963a). This theory states that human thinking and understanding are based not only on understanding concepts, but also on relationships between concepts and this creates an opportunity for meaningful learning. This occurs when learners are able to take new concepts and incorporate them into concepts or knowledge structure already possessed so there is some transference and learners are able to widen and enhance their existing knowledge domains. “Students who employ meaningful learning are expected to retain knowledge over an extensive time span and find new related learning progressively easier” (Heinze-Fry and Novak 1990, p. 461). Cahill and Fonteyn (2000) conducted a pilot study using mind-maps with nine nursing students during a clinical placement. They found that the students perceived the mind-maps as improving their thinking more than care plans and more than clinical logs. They concluded that the mind-mapping provided students with a learning technique that helps their minds perceive and connect information in a more creative and efficient way. However, in my own experience, I have found that some students like the method, but also have found that some find it hard to do and prefer the more logical structured ‘analysis tool’ I suggested in section 2.3.4 as this method breaks the case study into smaller hypothesis categories.

A major contributor to the students’ clinical reasoning development is their clinical experience. For the students I teach, this occurs throughout the course and students must complete 1,000 hours to meet the requirements of the professional bodies (Chartered Society of Physiotherapy and the Health and Care Professions Council) prior to graduation. Clinical placement education is based on the experiential learning theory (Kolb, 1984), which grew from constructivism, and essentially involves a cycle of four key stages: concrete experience, observations and reflections, formation of abstract concepts, followed by testing implications and concepts in a new situation. Students work under supervision from an experienced clinician and their knowledge and clinical reasoning develops by exposure to different patients. However, there is diversity in clinical placements and each student's experience of clinical placement differs. I agree with Harper et al (2013) that there are several observable weaknesses in the allocation of placement learning and this style of "apprenticeship education" means that exposure to adequate experience cannot be guaranteed for all, also the meaning developed by the individual may not be the same, hence challenging the idea that clinical reasoning develops whilst on clinical placement. It can therefore be argued, that it is necessary to provide an equal opportunity to all the students when they are in university prior to placement, to help develop their clinical reasoning skills. Simulation, although relatively new to medicine and health professions, is becoming increasingly prevalent as an educational tool to fulfil this requirement (Harder, 2010). Simulation is described as:

> ...an educational technique that allows interactive, and at times immersive, activity by recreating all or part of a clinical experience without exposing patients to the associated risks. Simulation produces a risk free environment in which learners can successfully master the skills relevant to clinical practice. It also permits errors of either diagnosis or management to be allowed to develop and followed through to their natural conclusion (Maran and Glavin, 2003, p.22).

2.5.2 Simulation as a teaching strategy for clinical reasoning

Simulation is increasingly being used to replace or supplement clinical experience. Harper et al (2013) replaced a twelve-week placement for operating-department students with a twelve-week study block of simulated learning and video. The outcomes from this study support two concepts: 1) Self-confidence and self-belief improved which increased the desire for learning; and 2) Multi-professional learning enhances a professional approach in terms of communication, care intervention and thinking processes. The results infer specific advantages of this method as a supplement to traditional teaching methods and address some of the inequity of placement experiential learning. Simulation has replaced 300 hours of clinical placement in the undergraduate-nursing curriculum (Nursing and Midwifery Council Circular, 2007). I draw upon this, as an example of how relevant simulation is for learning clinical skills, including reasoning and that it has become an established pedagogy. The educational processes that underpin simulator training are “deliberate practice, reflection, and feedback” (Maran and Glavin, 2003, p.22). Bradley and Postlethwaite (2003a) and Bland et al (2011), suggest that simulation uses a combination of the adult learning theory (Knowles, 1990), constructivism and social constructivism (Dewey, 1938) and experiential learning (Kolb, 1984), cognitivism (Bandura, 2001), situated learning (Lave and Wenger, 1991), behaviourism (Skinner, 1974, 1989) and reflective practice (Schön, 1987). It is beyond the scope of this literature review to discuss how these theories relate to simulation and clinical reasoning and a summary is provided in appendix 2.1 and 2.2.

My suggestion for using simulation to teach clinical reasoning, begins with the presentation of a case study (in similar manner to PBL), which can facilitate either self-directed learning or didactic teaching sessions specific to the content. Following this, the students have the case study delivered as a simulated scenario, and they assess the simulated patient. Hence they go through an active process of acquiring the information, interpreting it based on what they already know and then recognising the information to give new insights or understanding.

In doing this, they will be strengthening associations between their current knowledge and the new experience. The responsibility of learning is with the learner, as the educator acts as a facilitator. The educator can scaffold (Vygotsky, 1978; Greening, 1998) the level of complexity of the case study, to suit the learner and ensure they are only working within their area of current knowledge and are not being taken out of their zone. This is the principle suggested originally by Vygotsky, in 1935, as “the zone of proximal development”, whereby opportunities are given to students to advance the boundaries of their knowledge and then that support is slowly withdrawn in an appropriate manner so as to encourage independence. Therefore a simulated case scenario may enable their confidence to develop prior to clinical experience as they have had an opportunity to practice parts of complex practice (without any harm coming to a real patient), so that less intense, less complex, less vital tasks are learned before more central aspects of practice (Bradley and Postlethwaite, 2003a). For example, at first, a simplified case scenario, which includes key learning issues, can be introduced by the educator with explanations of what is being done and why; the students can practice their assessment and discuss their findings with the educator afterwards. After the simulation, students have the opportunity for reflection as described by Schön (1987). By undertaking this reflective process with the educator, the students are developing their metacognitive skills. The reflection immediately after the simulation (reflection-after-action) is an opportunity to develop the students’ skills of reflective practice, which unfortunately, so often gets overlooked if delivering a lecture or practical teaching session. Thus the suggestion by Terry and Higgs (1993) of PBL and the constructivist learning theory (Bandura, 2001) can easily be applied to the simulated environment.

Because simulation incorporates these underpinning educational theories, I propose that simulation is a relevant and suitable medium to teach clinical reasoning as it can facilitate the four key components I have identified as being necessary for clinical reasoning development: knowledge acquisition, knowledge storage; information processing and cognitive skill development, metacognition and reflection. In addition, if the simulation is made ‘psychologically authentic’ by including an actor’s voice, this may encourage the display of empathy. This may facilitate the development of the cognitive emotional perspective of clinical reasoning, which can so often be overlooked when using paper case studies but important in the context of clinical reasoning in accordance with Smith et al (2007).

There is a growing interest in the use of simulation within medicine and the health professions and there is an expanding field of research. Simulation has also been reported to increase self-efficacy and perceived ability in operating-department students by allowing students the opportunity for individual psychomotor rehearsal (Harper et al, 2013). In physiotherapy, Shoemaker et al (2009, p.17) state that “one session using High Fidelity Human Simulators (HFHS) as a laboratory activity may have substantial impact on students perceptions and confidence prior to entering acute care clinical experience” and “ Physiotherapy programs should consider the incorporation into cardiopulmonary or acute care content”. Bland et al (2011) undertook a critical appraisal of simulation as a learning strategy. They identified five critical attributes: creating a hypothetical opportunity, authentic representation, integration, repetition and reflection. This resonates with my understanding that it is the combination of the constructivist, experiential and reflective educational theories together that suggest simulation could be an appropriate teaching strategy for the development of clinical reasoning in cardiorespiratory. Although this has not been validated in physiotherapy, there is evidence to support this theory in nursing (Garrett and Callear, 2001; Lapkin et al, 2010).

Summary

In this chapter I have described how important clinical reasoning is for the autonomous physiotherapist, how complex the process is, and therefore, how difficult it has been to define. I have described some of the main conceptual models, particularly the hypothetico-deductive model as this has been adapted and widely used within physiotherapy. I have identified that there is little evidence for this model being used in cardiorespiratory and hence the need to investigate the process further by conducting this observational study of experts. By reviewing my PCK I also recognised that this study could develop appropriate and relevant teaching strategies for facilitating the development of clinical reasoning. I have proposed that simulation is a suitable teaching method as it integrates the relevant educational theories for the development of clinical reasoning. In the next chapter I outline my methodology.

Chapter 3: Methods

Introduction

The literature review shows how complex the clinical reasoning process is and how research into this field needs to be cognisant of this complexity and use research methods that can help to identify the key components of the clinical reasoning process. To address the gap in the research regarding clinical reasoning in cardiorespiratory physiotherapy, I designed a study using a simulated patient and simulated environment to investigate the clinical reasoning of expert cardiorespiratory physiotherapists. This study is needed to support the development of effective teaching of this subject.

This chapter presents the purpose of the study and rationale for the methodology; the methods used for data collection are explained and the analysis is described. The chapter concludes with reflection on the methodology.

3.1. Purpose of the study and rationale for the methodology

The primary aim of this study was to explore the method of clinical reasoning that expert cardiorespiratory physiotherapists use. The educational purpose was to understand and identify what expert physiotherapists currently do, as there is no clear understanding of what model(s) of clinical reasoning is/are being used or how this should be taught at undergraduate level. I have proposed that simulation is a suitable medium to teach clinical reasoning, based on the underpinning educational principles it uses and I found it suitable to explore experts' clinical reasoning also. I recognise that as an educator in physiotherapy my educational facilitation needs to reflect clinical experience and that I need to: "frame clinical decision-making within models of practice that are compatible with practitioners' personal frames of reference, their professional codes of practice and the norms and regulations of their workplaces" (Higgs and Loftus, 2008, p.216) and that I also need to use the most appropriate methods to teach clinical reasoning. This has led to the following research questions:

Clinical:

(1a) What model(s) of clinical reasoning is/are used within cardiorespiratory physiotherapy?

(1b) What are the similarities and differences in this reasoning to the collaborative hypothetico-deductive model?

Educational:

2a) How can simulation be used to explore the clinical reasoning process in expert cardiorespiratory physiotherapists?

2b) In what way can the findings contribute to an evidence-based teaching strategy to facilitate the development of clinical reasoning in undergraduate physiotherapists?

Because clinical reasoning is a complex process, I selected a mixed qualitative method of video recording, think-aloud and debrief interviews to address these questions. An interpretive paradigm was most appropriate for exploring the complexity of clinical reasoning as it enables researchers "to understand, interpret, seek meaning, describe, illuminate and theorise about lived experiences and actions" (Higgs and Loftus, 2008, p.215). As the focus was on the behaviour and actions of expert cardiorespiratory physiotherapists these participants would be required to assess the same simulated patient in a clinical scenario. This would prevent the addition of uncontrollable variable factors that could occur in clinical practice, create consistency and enable the data from each participant to be compared. An interpretative approach would enable me to gain a representation of how clinical reasoning is conducted in a simulated context and can relate this to clinical practice. The anticipated outcome was to develop a conceptual educational model for the development of clinical reasoning in novice practitioners who would then be better prepared for the reality of practice (Loftus and Smith, 2008).

3.1.1. The simulated high dependency unit (HDU)

An observational ethnographic study could have been a suitable approach, however, this may have been challenging to conduct in a real High Dependency Unit (HDU) for ethical reasons. Use of a simulated patient in a simulated clinical environment would ensure that the physiotherapists could be the focus of the attention without any harm occurring to the patient due to neglect during the study.

This method would also enable the same scenario to be controlled and repeated thus giving consistency of experience between the physiotherapists.

A simulated HDU was set-up at the Virtual Interactive Practice Suite (VIP) suite, in the Faculty of Health Sciences. A four-bedded surgical HDU that mirrored an authentic HDU was established and three manikins were placed in the beds, leaving one bed space empty. A clinical educator was employed to act as the nurse looking after the patients on the unit and to interact with the physiotherapists about the care of the patient. This simulated environment gave a contextual and meaningful experience without risking harm to actual patients. The simulated scenario had clear objectives and provided fidelity and a sense of realism, an opportunity for real time problem-solving, support for the participant, and an opportunity for reflection (Gobbi et al, 2004; Jeffries, 2005; Jeffries and Rizzolo, 2006). The objectives of the simulation were for expert cardiorespiratory physiotherapists to**:**

1. Assess the simulated patient's clinical status and suitability for physiotherapy treatment;
2. Assess and respond to the patient's physiological responses;
3. Respond appropriately to any change in status and alarms;
4. Safely conduct physiotherapy treatment, based on findings;
5. Suggest additional interventions that may be beneficial to the patient and discuss these directly with the patient, and also the nurse and doctor as part of their management of the situation;
6. Write up their treatment notes after the treatment session and plan their next visit.

The Programme of Research and Education/ Ethics into Virtual Interactive Practice (PRE-VIP version 4, Gobbi and Monger, 2006) is an overarching protocol describing the ethical procedure and practices governing the VIP at the Faculty of Health Sciences, which was adhered to for this project (see appendix 3.1). Under this protocol, permission was granted to use a real case study from clinical practice. A clinician working in an NHS trust with cardiorespiratory knowledge identified a case study of a 54-year-old man who had developed respiratory complications on HDU following abdominal surgery. This patient was considered highly suitable as he had been on HDU for three days and had developed respiratory complications that were amenable to treatment from a cardiorespiratory physiotherapist. The case represented a fairly common presentation of respiratory complications after surgery and the participants would be familiar with this type of respiratory presentation.

The patient's notes were photocopied with his personal details obscured to preserve anonymity. A storyboard was written to summarise the history of his present condition (HPC), his past medical history (PMH), social history (SH), and present condition (PC) a review of his current condition over the past three days following his abdominal surgery in which his respiratory status had gradually deteriorated (see appendix 3.2 for the storyboard).

3.1.2 The Simulated Scenario

Simulation can be delivered through a variety of different methods including role-play, case studies, software-packages, high-fidelity human simulators (HFHS), virtual worlds and actors. For the purpose of this study a HFHS simulator SimMan 3G (Laerdale ™) was used (see Figure 3.1 photograph of SimMan 3G).

Figure 3.1: High Fidelity Human Simulator SimMan 3G Laerdale TM

SimMan can simulate real time changes in heart-rate and rhythm (HR), blood-pressure (BP), oxygen saturation (SpO_2), respiratory rate (RR), and pulmonary artery pressures. All these physiological variables can be manipulated during the scenario to replicate real-life changes as a scenario develops. Many clinical examination findings can be taught such as finding pulses, and listening to heart and lung sounds. The manikin can be set-up to have a number of invasive and non-invasive monitoring or interventional devices attached. Real patient data can be used and replicated though the manikin and students, or therapists, can then be allowed to interact dynamically with it (Shoemaker et al, 2009). I wrote a programme for the simulated scenario using the SimMan software, Laerdale TM. Technical support for developing the scenario and ensuring the manikin (SimMan 3G) worked was given by Laerdale to help address any technical challenges. A laptop computer was used to enable me to control the simulation from a separate room and a second laptop was set-up at the patient bedside as the patient monitor, to display an electrocardiogram (ECG) trace, saturation levels, HR and BP for the patient. I could alter these physiological variables remotely at any time during the simulation.

Additional equipment was used to make the simulated patient look as authentic as possible, including: an arterial line situated over the right brachial artery, a triple lumen line for drugs situated over the right subclavian vein, a nasogastric tube in the nose for drainage of secretions from the stomach as the patient was not eating, an oxygen mask delivering 60% oxygen with cold water humidification, a suction circuit, a urinary catheter situated in the patient’s groin with replica urine, and Ted stockings on each leg. A fake abdominal wound with a surgical dressing and wound drain with artificial blood was placed longitudinally over the manikin’s abdomen.

To further add to the authenticity of the simulation, all supporting data normally found at the patient’s bedside were included. The patient’s notes were re-written and put into a file, kept at the end of the patient’s bed. At the back of the notes was a section for all the tests and investigations such as arterial blood gases (ABG) results, nursing charts, documenting his care over the past three days and prior to his admission to the HDU. Observation charts were created for the past three days to display the monitoring of all his physiological variables HR, BP, saturation levels, oxygen requirements, position, and fluid balance status. Two chest x-rays were displayed on a computer monitor to the left hand side of the patient. A script was developed for the nurse looking after the patient and a script developed for the simulated patient. The purpose of the script was to ensure consistency of the simulated experience for the physiotherapists assessing the patient and help the nurse so as not to give any answers that would influence the thought processes of the physiotherapists. (See appendix 3.2 for full details of the simulated scenario and the script.)

3.1.3 Video-recording

Filming the physiotherapist whilst they assessed the simulated case study captured their decision-making process. The other advantage of the video-recording is that the video can be played back repeatedly by the researcher to identify the behaviour, actions and communication of the physiotherapists. Videotaping and video analysis are often considered essential methodological tools in interpretive approaches (Greeno, 1989; Jordan and Henderson, 1995). The analysis of the video-data would consist of watching and coding with the goal of transforming the video images into verifiable information as required because video-data can provide both quantitative and qualitative data (Jacobs et al, 1999). However, prior to undertaking the study, I was aware that some participants may have objected to being filmed, as cameras can often make people feel self-conscious, sometimes frightened or intimidated and they can prompt people to behave slightly unnaturally (Mason, 2002). Therefore to avoid any distress about being filmed, the participants were fully informed about the video-recording at the time of recruitment and prior to the study they were shown exactly where the cameras were situated so as to reassure them and make them feel less self-conscious. Following this explanation, all the participants were advised that they could withdraw at any time if they felt uncomfortable by the video-recording.

3.1.4 The think-aloud technique

The main focus of this study was to explore the clinical reasoning of the expert cardiorespiratory physiotherapists and, to capture their problem-solving as it took place, the think-aloud approach was used. This technique was founded in psychology in the 1930s and has gained acceptance as an indispensable method for studying thinking (Van Someren et al, 1994). The technique involves asking people to think-aloud while problem-solving and is based on the assumption that talking is a type of recordable behaviour that can be analysed like any other behaviour (Ericcson and Simon, 1993). Think-aloud is considered to be a direct verbalisation of cognitive processes as there are no interruptions or suggestive prompts or questions. Participants are encouraged to give a simultaneous account of their thoughts and avoid any interpretation or explanation of what they are doing; they just have to concentrate on the task and describe the cognitive thought processes as they occur, information being accessed from the short-term memory, and this is known as the concurrent think-aloud technique (Ericcson and Simon, 1993).

For most people, when speaking out loud, because almost all of their conscious effort is aimed at solving the problem, there is no room left for reflecting on what they are doing in general, and talking out loud does not interfere with the task performance. Think-aloud can also be used retrospectively; this is when the subject solves a problem and is questioned afterwards about their thought processes and this involves an element of reflection and accesses information from the long-term memory. This is known as the retrospective think-aloud technique (Ericcson and Simon, 1993).

The think-aloud technique has been used in conjunction with verbal protocol analysis (a line-by-line analysis of the think-aloud transcript) to investigate the decision-making of nurses. Fonteyn et al (1993) state that think-aloud studies can contribute to an understanding of the reasoning processes used to problem-solve in a variety of situations. Fonteyn et al, propose that concurrent think-aloud data, coupled with retrospective think-aloud data obtained in a follow-up interview, provides a fairly complete and detailed description of participants reasoning during a problem-solving task. Lundgrén-Laine and Salanterä (2010) conclude that think-aloud reveals information that is in the working memory and provides rich extensive data for analysis. The systematic use of the verbal protocol analysis makes it easier and adds credibility to study findings because the results obtained can be retraced and explained (Fonteyn et al, 1993).

Aitken and Mardegan (2000) conducted two studies using think-aloud and verbal protocol analysis to examine the decision-making of expert critical care practitioners in the natural setting. In the first study, they used the concurrent think-aloud technique to explore eight expert critical care nurses' haemodynamic assessment and management during a two-hour period of care of a critically-ill patient. Each participant was asked to think-aloud and explain how they were assessing and managing the patient. The think-aloud was transcribed and the participants had a follow-up interview three-four days later; they were asked questions about their experience and they were allowed to read their transcripts. The second study conducted a concurrent think-aloud technique of three cardiothoracic intensive care nurses and three nurses from the step down ward as they assessed a patient about their post-operative pain. Both groups were asked to think-aloud whilst attending to the patient. The tape recordings were replayed to the nurses afterwards and they were asked again to think-aloud and explain how they had been managing the patient (retrospective) and they were allowed to add anything else they thought contributed. The authors concluded that the think-aloud technique could be used in the natural setting without any compromise of patient care. They also suggested that using both the concurrent and retrospective data collection has benefits over the concurrent method alone.

Fonteyn et al (1993) have also suggested that think-aloud can be used with simulation (either written or audio-visual) rather than the natural setting, as the basis for the problem-solving task and client simulation has been used extensively in the studies of clinical problem-solving because “it allows investigators to approximate the clinical environment while controlling the other variables found in real-life scenarios” (p.433). So, in this simulation, I used the concurrent think-aloud technique to capture as much of the thought processes of the participant as possible. The particular strategy followed was that of Ericcson and Simon (1980), where participants are asked to verbalise the number of windows in their houses as a warm-up technique prior to the data collection.

My justification for using the concurrent think-aloud technique was that I wanted to know more about the participants’ thinking processes whilst they undertook the assessment and relate this to their actions, from which a comparison could be made to other clinical reasoning models. For this reason, I did not follow the verbal protocol analysis, but instead, I undertook an analysis of the transcripts from the participants’ think-aloud to look for themes that related to the hypothetico-deductive clinical reasoning model or other models illuminated in the process. This is discussed further in section 3.3.2 and a sample of the analysis of transcript can be seen in appendix 3.3.

3.1.5 Debrief Interviews

Immediately after the simulation, the participants were given the opportunity to watch their video-recording (if they wanted to) and to answer some questions about their experience of the simulation and comment on why they chose a particular course of action. The questions were developed following the pilot study (see section 3.2.1 and see appendix 3.4 for the questions used in the debrief interview). This gave the participants an opportunity to comment on their actions with some reflection. It was not used as a true retrospective think-aloud method as recommended by Fonteyn et al (1993) as there had been no prior analysis of their assessment, but instead, the debrief interview was used to gain their reflections about their experience rather than asking them to confirm or suggest alternative ideas. Debrief interviews are normal procedure after using simulation for teaching purposes and thought to be the “heart and soul” (Fanning and Gaba, 2007, p.10) of the experience as they give learners the opportunity to make sense of the events experienced in terms of their own world and an opportunity for reflection. Elements of a good debrief include the use of open-ended questions, positive reinforcement, cognitive aids, and good use of audio-visual capabilities (Fanning and Gaba, 2007). Paterson and Higgs (2008) recognise that clinical reasoning is a reflective process and the debrief interview would give the clinicians an opportunity to clarify and explain their actions further and thus give me more insight into the participants’ reasoning. This information could be used as part of the overall analysis to investigate other cognitive aspects associated with reasoning such as comprehension, metacognitive activities and the use of knowledge (Arocha and Patel, 2008). Similarly the debrief interviews in this study were transcribed and analysed samples can be seen in appendix 3.5.

3.1.6 Ethical considerations: sample selection and recruitment

As highlighted in section 3.1.1, ethical considerations for this study were guided by the “pre-vip protocol” (Gobbi and Monger, 2006, see appendix 3.1). This provided an overarching framework under which research is undertaken in the VIP suite. The primary purpose of the protocol is to protect the participants involved in the research programme. In addition, I considered confidence and boundaries, informed consent, harm and risk, honesty and trust, privacy, confidentiality and anonymity, research integrity and quality, ownership of data use, the use of results and conflicts, and dilemmas and trade-offs as suggested by Miles and Huberman (1994).

The main focus of ethical concern was the participating physiotherapists as there were no risks to any real patients. As the main aim of this study was to “get inside the heads of practitioners in order to see the world as they see it and understand the manner in which professionals think about construct and solve clinical problems” (Jensen et al, 1992, p. 712) it was important to recruit suitable participants. For this reason, the inclusion criteria were carefully considered so that a purposive sample of physiotherapists could be enrolled. The inclusion criteria were initially based on the number of years of experience as defined in an Australian study of decision making in acute cardiorespiratory care, by Smith et al (2007) who defined the levels of experience of cardiorespiratory physiotherapists as follows: low experience less than 2 years of rotating positions that involved some cardiorespiratory, intermediate: 3.5-5 years of non-rotational cardiorespiratory physiotherapy and high-level: 8-12 years of non-rotating senior designated cardiorespiratory physiotherapy. These inclusion criteria were discussed with the research representative at the Association of Chartered Physiotherapists in Respiratory Care (ACPRC) who considered that some ‘expert attributes’ such as: working independently, undertaking on-call duties and the supervision of students and junior staff will also be exhibited by physiotherapists in this country with only 2-3 years of experience. Therefore from this discussion my thinking was that if participants were undertaking these tasks, then they would have sufficient domain specific knowledge, the ability to problem solve independently and the ability to explain what they were thinking and be able to perform the think-aloud technique. Hence the inclusion criteria for this study, considered that these ‘expert attributes’ may also be found in staff with a lower level of clinical experience than in the Smith et al study and that the key factor for this study was that the participant could make their own clinical decisions, as this was the attribute of expertise that was being studied.

The inclusion criteria were:

- At least 2-3 years clinical experience and working independently in an adult cardiorespiratory specialty such as surgical, medical, or intensive care ICU;
- At least 24 hours experience of working in a cardiorespiratory speciality area per week;
- At least 6 weeks recent experience in adult cardiorespiratory care;
- Familiarity with working out-of-hours (twilight, on-call, weekend rotas);
- Being independently managing their own caseload and making their own clinical decisions;
- A willingness and ability to discuss their clinical decision-making.

The exclusion criteria were:

- Physiotherapy student status - not yet working independently in this field;
- Not having practised within the last 6 months in adult cardiorespiratory physiotherapy.

Participants were sought by circulating flyers about the study at an annual general meeting of the ACPRC, requesting participants who lived within a 50-mile radius of Southampton (chosen for pragmatic reasons) to take part in the study and local therapy managers were contacted directly by email to ask if staff that fulfilled the inclusion criteria could be approached to take part in the study.

Nine participants came forward from the local hospitals in Southampton and Winchester, London, Wales and Leicester. This was greater than my original radius but beneficial in bringing a greater diversity of experience. These physiotherapists met the inclusion criteria and worked within this specialised field of physiotherapy. Their experience ranged from a mean post-qualifying experience of seven years (range 3.5 -16 years). They were all capable of making independent clinical decisions and had experience of working across a range of areas within sub-specialities of cardiorespiratory such as surgical, medical, HDU, ICU, cardiothoracic and were familiar with on-call duties that is, working out of hours to attend to patients with acute respiratory complications requiring urgent physiotherapy. The physiotherapists were also supervising junior and student physiotherapists and so were familiar with explaining their decision-making and hence were capable of undertaking the think-aloud methodology required for the study.

An information sheet was sent out on initial enquiry. I explained my role as a university lecturer and the purpose of the study and that it was part of my doctorate in education. The participants were reassured that their practice was not being scrutinised, but their clinical reasoning was being explored so as to develop a new teaching strategy and they might gain an insight to their own practice from the experience which may benefit their Continuing Professional Development (CPD). I invited participants to discuss the project with me further by email or telephone before making any commitment so that there were no misunderstandings. From the nine willing participants who met my inclusion criteria, eight took part, as one had to withdraw due to personal circumstances.

Prior to the data collection, participants were briefed again and a further explanation of how the video-data were going to be used for the analysis was explained, as the trust of the participant was vital for participation. I explained that they would not be anonymous and there was a risk that they could be identified if I were to share the video material with students and/or other health professionals such as a conference presentation. This was slightly controversial as, according to the British Educational Research Association (BERA), 2004, it is the confidential and anonymous treatment of participants' data that is considered the norm. "Researchers must recognise the participants' entitlement to privacy and must accord them their rights to confidentiality and anonymity" (Walford, 2005, p.84). Another issue for this study was confidentiality as this implies information that is private or secret and that what was being said during the video would not be passed on to others, which again could not be the case as the purpose was to potentially re-use some video clips for teaching purposes. This is why the Pre-vip protocol (Gobbi and Monger, 2006) was used for guidance and the consent form carefully worded to address both these issues and participants were fully aware that the information gathered would be used in some form afterwards and be made public in research publications. Again reassurance was given that their practice of physiotherapy was not being scrutinised and that if I shared any of their video material publicly, it would not be used for professional scrutiny.

The participants were invited to go into the simulated HDU prior to the study and see where the video cameras were situated and again given the opportunity to ask any questions. A potential risk of hurting themselves if they tried to move the manikin was explained and the participants were advised not to do so. There were no risks from any infection from the simulation, but they were asked to adhere to their normal procedure for hand-washing and gowning when seeing a patient on HDU so as to minimise the risk of infection. They were also reminded of the think-aloud method and rehearsed the technique. Again, each participant was given the opportunity to ask questions and they were reminded that they could withdraw from the study at anytime. Thus by being transparent about the whole research study, I gained the participants' trust. Providing they were absolutely clear and happy about the whole procedure, the participants gave their informed consent (see appendix 3.6 for a copy of the consent sheet). This was a contract drawn up between myself and the participant for permission to video, store and use the data for research and educational purposes and that this contract meant that both parties would keep to the agreement but participants could withdraw at any time if they so wished, which gave the participant an element of autonomy. Overall, the participants agreed to take part because they could see the potential contribution to the evidence base in this particular field and they would also be benefiting in gaining an insight to their own clinical reasoning, which would contribute to their CPD and make the study mutually beneficial.

Steps were taken to protect the video-data by storing the data on a separate server specific to the VIP suite that was password protected. Following data collection, copies of the videos were made for the participants so that they could have a record of the experience. The videos were also uploaded to Synote, which also has a separate server that is password protected. The participants were able to veto the storage of all or part of the data at anytime if they chose to. In these ways, the study was constructed carefully and thoughtfully and adhered to a reasonable set of standards. Research ethics is, in large part, about being clear about the nature of the agreement one enters with the research participants (Blaxter et al, 2001). This study was given favourable ethical review by the Ethics committee at the School of Education, University of Southampton, in September 2008. The University of Southampton gave research governance and sponsorship, September 2008. The study was registered with the "Controlled Trials Register" ISRCTN77334588 (See appendix 3.7 for risk assessment, and 3.8 participant information sheet). The next section describes the pilot study in which all the methods were rehearsed.

3.2 Data collection

3.2.1 The Pilot Study

A pilot study was conducted to test the authenticity of the scenario and ensure all the technical aspects of the study worked. A technician set up the cameras in the VIP suite for video-recording and monitored the cameras ensuring they were in the correct position for the bed space and for filming the debrief interview. The technician monitored the video-recording and the camera angle was occasionally altered to capture the best view of the bed space and the interactions taking place. A two-way microphone was piloted to test the patient's voice so that the actor could hear the conversation at the bedside and then interact as required during the assessment. A physiotherapy lecturer volunteered to act as the patient's voice and was briefed about the patient and how to respond and shown how to apply the technology.

The simulated patient was set-up (as previously described in section 3.1.1) at the VIP suite in the Faculty of Health Sciences. The patient was given the pseudonym Mr Alan Day; he had developed respiratory complications following abdominal surgery. He was now day three after surgery and was sitting up in bed, not feeling very well due to abdominal pain from the surgery, he had difficulty with his breathing, and secretions which he was unable to clear. As a result, his oxygen had to be increased to 60% overnight and for these reasons the nurse asked the physiotherapist to assess the patient's chest and provide advice about his management.

The simulated scenario was organised with all the supporting peripheral equipment, notes and charts. The staff nurse was at the patient's bedside to support to assist the physiotherapist if required (see figure 3.2 photograph of Mr Day and the staff nurse at the bedside). I remained out of the HDU to operate the simulated scenario in the adjoining room.

Figure 3.2: The simulated patient "Mr Day" in the simulated HDU with the staff nurse.

A fellow respiratory lecturer in physiotherapy (pseudonym: Mary) assessed the patient and underwent the debrief interview. There was also an opportunity for a general discussion between myself and my colleagues on any important adjustments they thought were needed. Mary's feedback was very useful. Overall, Mary said that she had enjoyed her experience and thought it was "Brilliant*".* In her debrief interview Mary commented that:

> *She started to look at her own practice and felt she really got into role as a physiotherapist assessing the patient and felt really immersed in the scenario.*

Some of her criticisms of the scenario set-up were that she found the manikin heavy to move and suggested an actor could be in the next bay to demonstrate the next stage of the management e.g. treatment. She thought there could have been other patients in the unit to make the environment more authentic and perhaps could also include smell e.g. disinfectant smell and some background noise from other monitors with alarms beeping and other patients. Mary had found some of the notes confusing as there were so many included and these needed to be in chronological order. Also some of the patient’s data did not match, which was probably due to setting the parameters slightly differently in the SimMan software programme and easily corrected. Mary found the addition of the patient’s voice useful and appreciated his comments as this feedback enabled her to interact as if this was a real patient. Mary also found the rehearsal of the think-aloud technique, as recommended by Ericcson and Simon (1980), very useful and therefore verbalising the number of windows in the participant’s house was kept for the main study.

Based on Mary’s feedback, some minor modifications were made: the medical notes were reorganised into chronological order and separate medical, physiotherapy and nursing sections to make it easier to find the information; any disparities in information between what was being used on the patient monitor and the charts were clarified; a male lecturing colleague was employed to be the patient voice and by using a two-way microphone, he could listen to what the physiotherapists were saying and reply appropriately with the physiotherapist during the assessment process; a patient script was written for consistency between the participants (see appendix 3.2). Three other bays were included into the HDU environment and two other manikins were set-up to be patients with peripheral monitor noise added. The nurse moved between the three patients to create more authenticity of a staff nurse working on an HDU. To further add to the authenticity of the simulated environment, I was available to act as the doctor of the unit, as, in clinical practice, a doctor would either be working on the unit or be available by bleep, to discuss any concerns that the physiotherapist or nurse might have about the patient. Other minor modifications were required with the peripheral equipment and it was agreed with the nurse to set-up total parenteral nutrition fluid (TPN) and a patient controlled analgesia (PCA) pump for pain-relief.

Another aspect of the study that Mary helped to develop was the debrief interview. The purpose of the debrief interview was to give participants an opportunity to reflect on their experience and also an opportunity for them to add to my overall understanding of the decisions they had made and what their clinical reasoning was based on. Mary made some suggestions regarding the sort of questions to ask and a semi-structured interview schedule was designed taking these ideas into consideration. The debrief questions were developed to gather information about participants' clinical experience, if they had received any training about clinical reasoning and if so, what type, how they found the overall simulation experience, specific questions about their assessment and, finally, an opportunity to add anything about the assessment process (see appendix 3.4 for a summary of debrief questions).

3.2.2 The Study

Eight physiotherapists took part in the study over a one-week period. Each participant was met individually and taken to the VIP suite. If they had travelled a long way they were given the opportunity to have refreshment and change into their uniform. They were given the opportunity to ask any questions about the research study. The participants were asked to sign a consent form (see appendix 3.6 informed consent). Once the paperwork was complete, they were instructed on and rehearsed the think-aloud technique. Following this, the participant was taken through to the simulated HDU, where the staff nurse introduced herself; gave a handover about Mr Day and requested the physiotherapist to assess.

The scenario started with the manikin upright in the bed and the patient actor making loud breathing noises to simulate a patient with breathing difficulty. The physiotherapist began her assessment process by either talking to the nurse and/ or patient, or by reading the notes and looking at the charts and x-rays. A desaturation (a drop in oxygen levels seen in the blood) occurred at the time participants started to examine the manikin’s chest with their stethoscope. This was set-up to observe the physiotherapist’s response to an acute deterioration of the patient, an event that might occur in clinical practice. The interaction between the physiotherapist, the patient, the nurse and sometimes a doctor (who could be called to the unit if required), proceeded with each physiotherapist deciding their own course of action and treatment ideas, each participant took as long as they felt necessary. Treatment continued until the physiotherapist believed they had exhausted all possibilities and/ or the patient’s condition improved. This marked the end of the assessment and the physiotherapist was taken through to an adjacent room to have a debrief interview with the researcher.

3.3 Data Analysis

This study was designed to generate rich observational data and each physiotherapist's assessment/treatment video was set to last between forty and sixty minutes and the debrief interviews between twenty and thirty minutes. The video provides a sequential record of the actions and behaviour of the physiotherapist and a verbal record of their communication during the assessment with the nurse, patient and sometimes also the doctor. The video-recording also provides a verbal record of the physiotherapists' thoughts, if they used the think-aloud technique. The debrief interviews give a reflective account of their experiences and similarly these were video recorded so that the audio data could be transcribed. The rationale for the analysis was to observe the video-data in conjunction with the verbal data to see if there were any patterns emerging and compare this to the hypothetico-deductive model for similarities and/or differences.

The next section presents the principles of the interpretative process used during the analysis and is based on the qualitative data analysis steps from Creswell (2003) to make sense out of the text and image data, thematic analysis by Burnard (1991) to look for any themes of clinical reasoning, and a framework approach by Spencer et al (2003) to identify specific clinical reasoning themes taken from previous models within the data and also identify any new themes. The analysis was an iterative process that evolved as the data were repeatedly reviewed and categories were refined, dimensions clarified and explanations developed. This followed the observation by Spencer et al (2003), that there is a constant need to revisit original or synthesised data to search for new clues, to check assumptions or to identify underlying factors. To illustrate the iterative process undertaken, the initial data management and synthesis of the data to establish themes are described.

3.3.1 Data management

The first step was to organise the video-data. The videos were recorded digitally in windows “wmv” format and these files were uploaded onto the web-based computer programme Synote (Electronics and Computer Science, University of Southampton). This computer programme was selected, as it is a free, on-line resource, meaning that the video material can be shared and viewed by others who have permission to do so for example the participants or other colleagues with an interest in the research.

The other reason for choosing Synote was that the software enabled editing of the video and annotation into smaller chunks known as “Synmarks”. By repeatedly watching the embedded videos, I could observe and make field observations and organise and sort the data into initial themes. These synmarks acted as bookmarks and enabled me to find a precise place in the video without difficulty or having to watch the whole video again. I watched the videos several times which enabled me to identify common actions and these became the initial themes. Headings or labels were given to each synmark to describe what activity was happening for example: “handover from the nurse to the physiotherapist” (see Figure 3.3 for an example of a screen shot displaying video, transcript and Synmarks and appendix 3.9 for an example of a worked extract in synote).

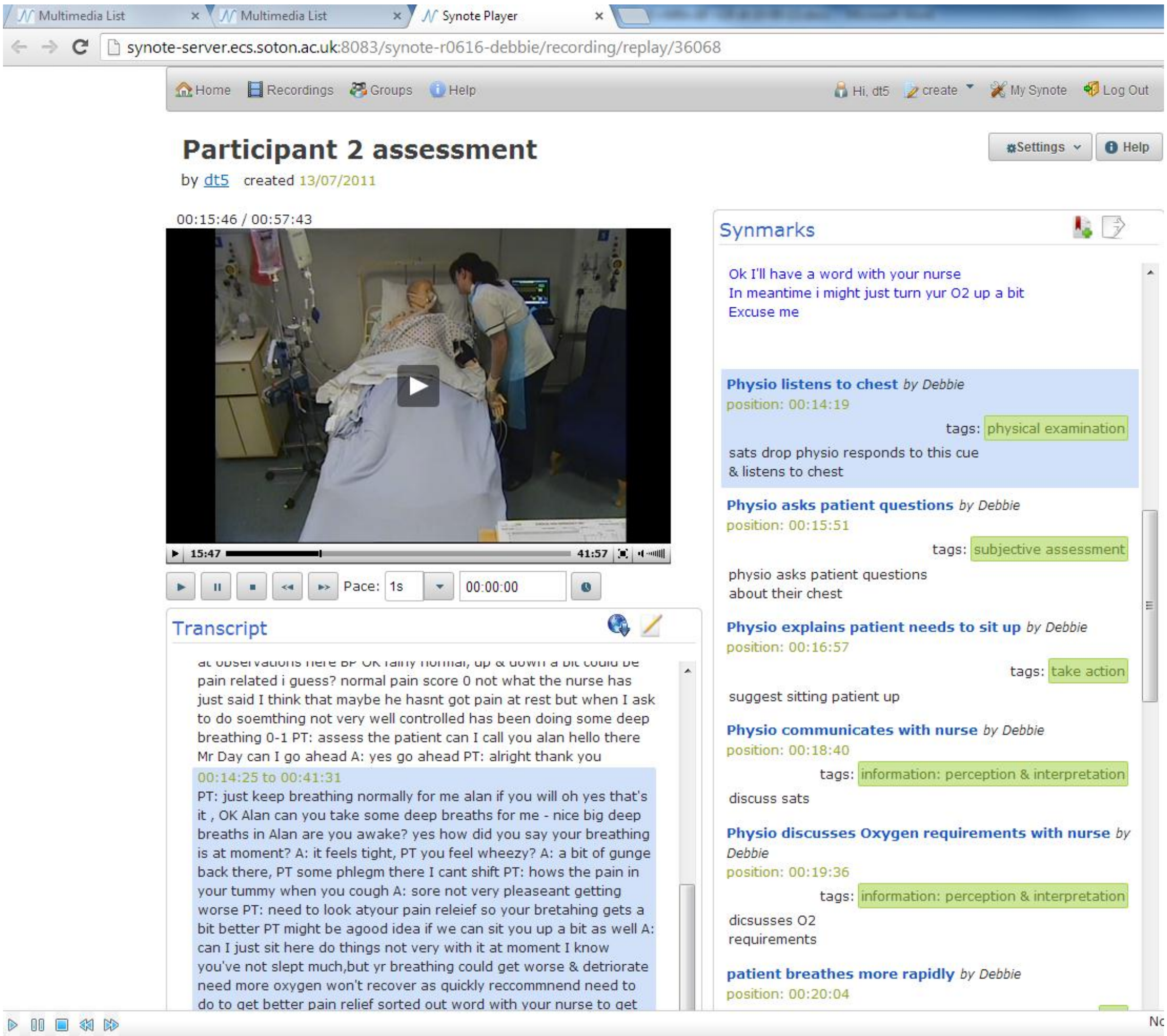


Figure 3.3: Synote screen shot

A further sub-heading called a “Tag” was used to describe the activity or process occurring, as can be seen in Figure 3.4 the tags were: “physical examination, subjective examination, take action, information perception and interpretation”. The next step in synthesising was to try to make sense of the synmarks by sorting the headings and the tags that had been used, thus “organising the material into chunks before bringing meaning to those chunks” (Cresswell, 2003, p.192).

Another feature within synote was the production of a "tag cloud", which gave a visual representation of the similar tags clustered together. The size of the word in the cloud suggests the frequency that it has been used. This is a form of content analysis and is a partially quantitative method, as it is determining the frequency of the occurrence of particular categories (Marks and Yardley, 2003). Hence the tag cloud was used as a primary method of organising the data into preliminary codes to enable the categories to emerge (see Figure 3.4).

Figure 3.4: An example of a Tag cloud produced in Synote.

I re-watched the videos of all eight participants and listened carefully to the conversations to create written transcripts of the whole assessment process. In doing this, I became fully immersed in the data and this is believed to enrich the analysis (Howitt and Cramer, 2008). I produced written transcripts of the audio data manually and I then carried out a thematic analysis as I considered this to be the most appropriate method to analyse the written transcripts. Thematic analysis shares many of the principles and procedures of content analysis as codes and themes are used interchangeably. A theme refers to a specific pattern found in the data. The theme can be deductive, whereby the researcher brings to the data themes from theory or prior research or the theme can be generated inductively from the raw information (Boyzatzis, 1998). From watching the videos several times, I had already become quite familiar with the data and had seen some similarities with the hypothetico-deductive clinical reasoning model. However, I recognised that this could be quite limiting in only looking for the same themes as in the hypothetico-deductive model and so I also included another clinical reasoning model which is used for educating undergraduate nurses in critical care: "the five-rights of clinical reasoning" (Levett-Jones et al, 2010, see Figure 2.4 p. 46). I used this model because I thought that similarities might exist between the two professions when working in this speciality. The model also shares many similarities to the hypothetico-deductive model but expands further on the cognitive skills required in the reasoning process and hence I thought this would help illustrate the cognitive skills used by the physiotherapists in this study. These themes, which had emerged from the video data, and themes from the two clinical reasoning models were synthesised and a coding matrix was developed and a framework approach (Ritchie and Lewis, 2003) to the analysis of the transcripts was undertaken. The framework approach shares similarities with thematic analysis, but allows transparency in data analysis and the links between the stages of the analysis in a series of interconnected stages that enables the researcher to move back and forth across data until a coherent account emerges. This results in constant refinement of themes that may aid the development of a conceptual framework (Smith and Firth, 2011).

This framework was applied to all the transcripts to look for similarities and differences between the participants. (See Table 3.1 for an example of the coding framework and appendix 3.3 for a sample of transcript).

Table 3.1: Coding framework with example data from Anne's transcript. Colour coding: Pink =theme from clinical reasoning models, Orange= Action of Participant, Blue= Cues from nurse, Green= cues from patient, Yellow= Participants' cognitive processes, Hypothesis formation = Pink & orange, Mauve= Emergent themes.

Sequential stages from hypothetico deductive model & five rights model **[Pink]**	**Behaviour/ activity of participant** **[Orange]**	**Cues from nurse** **[Blue]**	**Cues from patient** **[Green]**	**Cognitive processes** **[Yellow]**	**Hypothesis Formation** **[Pink and orange]**	**Emergent themes** **[Mauve]**
Information perception/ consider patient situation/collect clues/ nurse handover	Communication with patient Communication with nurse questions in response to handover Reads notes, Looks at charts, X rays Assesses patient	Had a poor night... He's in quite a bit of pain, had his PCA changed from morphine to Fentanyl overnight...	Patient breathing heavily	Recognition Questioning in response to cues from nurse about pain and saturations dropping	I'm already thinking if you smoke prior to surgery can make you more likely to have respiratory complications post-operatively	Some Pattern recognition

3.3.2 Establishing themes from the data

This coding matrix was applied to each transcript and confirmed the similarities between each participant and the two aforementioned models. The application of the Levett-Jones et al (2010) model was particularly useful to help identify the cognitive skills each physiotherapist used. Having identified that these and other cognitive skills were evident, I decided that, given this was a new insight into the clinical reasoning of cardiorespiratory physiotherapists, I would analyse this theme further. I thus developed a second coding matrix using the Levett-Jones et al (2010) themes and findings from my first analysis. The framework included the following cognitive skills: *Recognise*: the ability to identify abnormal signs and symptoms, *Discriminate:* to distinguish relevant from irrelevant information, *Match:* compare current situation, signs and symptoms to normal physiological values and past values and/or patients. *Relate*: connect information, cluster clues together to identify relationships between them, *Infer*: make deductions consider alternatives and consequences. *Synthesis:* bring together all the information gathered so as to *identify problems* and *hypothesise or predict* an outcome. Each participant's transcript was analysed using this framework. Table 3.2. is an example of the analysis of Sarah's transcript.

Table 3.2: Framework for analysis for cognitive skills-based on the Levett-Jones et al (2010) model the five-rights of clinical reasoning

Participant	Recognise acknowledge	Discriminate distinguish	Match compare	Relate connect	Infer imply	Synthesis	Identifies problems	Hypothesise Predict- foresee
			[Pattern-recognition]					
Sarah	Smoker 6 cigars per day Left lower lobe collapse p.4 and right middle and lower lobe collapse p.4 +ive fluid balance p.6 sats dropping p.7 needs more pain control p.7 sats dropping fast may need to suction not enough time to wait for nebuliserp.8 HR increase p.10 Need so increase his O2 use the rebreathe bag p.11	Questions nurse about pain relief p.1 Questions if he has sat out of bed yet p.1 Asks pt how he is feeling p.2 Asks pt about his pain? What level is it score 0-10 p.3 Asks if he is coughing phlegm up? P.2 What colour is it? p.3 Asks if using his PCA	Auscultation Breathe sounds to normal CXR to normal Observations from monitor matches to normal in head Looks at sats on monitor p.7 ABG results to normal values p.9 HR to normal p.10 Watches monitor constantly p.13	Difficulty with clearing secretions asks if nurse has had to suction p.5 Thick secretions asks if h has had nebs p.5	Smoking with patency of lungs Not enough pain relief p.4	Pain is an issue Secretions are thickp.5 Collapse consolidation/respiratory distress Lots of secretions	Pain Secretions Causing collapse and consolidation	Needs more pain control to comply with Rx p.7 Predicts effect of nebs and sitting out in chair p.9 Plans Use CPAP or bird p.19

3.3.3 The debrief interviews

The debrief interviews gave an opportunity for demographic data to be collected and also gave participants an opportunity to reflect on their experience of the simulation, as many advocates of simulation affirm that a satisfactory debriefing session is requisite to an effective simulation experience (Campbell and Daley, 2013).

A semi-structured interview approach was undertaken and the questions were designed based on feedback from the pilot interview. The opening questions ascertained the number of years the participant had been qualified and the areas of cardiorespiratory they had worked in and in what speciality they were currently practising. They were asked to comment about their experience of the simulated scenario and their assessment. They were also asked about their background knowledge of clinical reasoning and how this had been learnt.

The debrief interview videos were observed and transcripts produced from the verbal data in the same way as the assessment videos. Using the framework analysis (Spencer et al, 2003) the transcripts were analysed primarily to assist with developing the themes that had been identified from the assessment videos. The framework included: the participants’ experience of the simulation; what they thought went well; what they thought had not gone so well; the assessment process they used; any ‘triggers’ “clues’ they had identified; their hypotheses; their background knowledge and their previous experience of simulation (see appendix 3.5 for an example of the framework analysis of a transcript). Thus the debrief interviews augmented and helped give validity to the verbal data from the think aloud gathered from the assessment video of the participant.

3.4 Reflection on the methodology

My personal reflection on the methodology is that the objectives of the scenario were achieved: a realistic four-bedded HDU environment was created; and authenticity was reinforced by using the actor as the patient's voice; the nurse and the doctor, so that participants were able to engage in the scenario. The desaturation event added another dimension to the problem-solving and brought realism to the scenario, as this can occur in clinical practice. However, there were limitations in that the study did not include the respiratory adjuncts such as the Continuous Positive Airways Pressure (CPAP) or Intermittent Positive Pressure Breathing (IPPB) machines that the participants may have chosen to treat the patient, so a full picture of what they might do in real practice was not captured.

The video-recording was effective and the only technical difficulty was the quality of the sound produced, which led to not being able to use the voice recognition software to produce written transcripts in the Synote programme and why the analysis of the video-data changed.

My original intention was to triangulate the observational and verbal data from the assessment with the debrief transcripts. Where the information in the debrief interview concurred with the analysis, this added further support to the interpretation of the data. Where the debrief data were less closely aligned to the video data, this prompted me to go back to the data and consider other possible interpretations, which was a helpful check. Due to the volume of material and the time taken in making sense of the data from the assessment videos, this was not carried out as extensively as it could have been. On reflection, I recognize now that I could have gone into more depth in my questioning of the participants and gained a greater insight about their own clinical reasoning and this may have added more robustness to my research methodology. As previously stated, I had used the debrief interview as suggested in the simulation literature for reflection about the experience and hence this occurred immediately after the assessment. From a research point of view, it may have been wise to give the participants a small break and ask them to view their video and then question them either during their own observation or afterwards about their actions and thought processes. The questions could have been framed more to ask why they were taking certain actions and what they were thinking at the time so as to validate their own 'think aloud' and hence explore their reasoning process more. This process is more like the 'retrospective think aloud technique' (Ericcson and Simon, 1993) and more similar to the way in which Fonteyn et al (1993) coupled the concurrent think-aloud with the retrospective think-aloud to provide a fairly complete and detailed description of participants reasoning during a problem solving task (see section 3.1.4). This may then have yielded more information about the actual thought processes they were using at the time and may have confirmed the analytical skills they were using rather than the data being my interpretation of the information from the verbal transcript. Therefore by cross-referencing the same information, this may have increased the credibility and validity of the study by providing a more comprehensive data analysis. If conducting a study of this type again, I would recommend using the debrief interview to support the research methodology and take these points into consideration.

The synote tool enabled me to create synmarks that synchronised the video-data of the participants' actions with their verbal data (thought processes) and make a provisional content analysis, which gave me insights to the reasoning, but it did not enable me to fully understand the process being used. I considered using the Transana software (Mavrou et al, 2007) as this allows synchronisation of both verbal and nonverbal transcripts (text) with the video itself. This, though, would have added further time delays in learning how to use the software. I therefore, decided to undertake the transcription of the verbal data manually by re-listening to the conversations from the videos and writing the conversations manually. I began to analyse the videos with the themes generated from the initial observations using a deductive thematic analysis, by synthesising the themes from the hypothetico-deductive model and the five-rights of clinical reasoning (Jones, 2000; Levett-Jones et al, 2010) with the data from the videos. This developed into the framework approach (Ritchie and Lewis 2003), which shares many similarities to thematic analysis, but this method allowed the initial themes to be extended and new themes to emerge so that the association between themes became clearer and the whole picture emerged. On reflection, I realise that I could have analysed the transcripts using the verbal protocol analysis as recommended by Fonteyn et al (1993) but instead I continued with the themes already generated and I did not start the analysis a fresh. However, I took every step to ensure that I was transparent in my analysis and in future studies; I would recommend using a second uninvolved analyst.

Summary

In this chapter, I have explained and justified the qualitative approaches I used to explore the clinical reasoning process used by eight expert cardiorespiratory physiotherapists. I have described how the simulation was set-up and how the data were collected. I have given an overview of how the data were managed and analysed. I have reflected on the strengths and weaknesses of the methodology. In the next chapter I discuss the findings from a clinical perspective.

Chapter 4: Findings

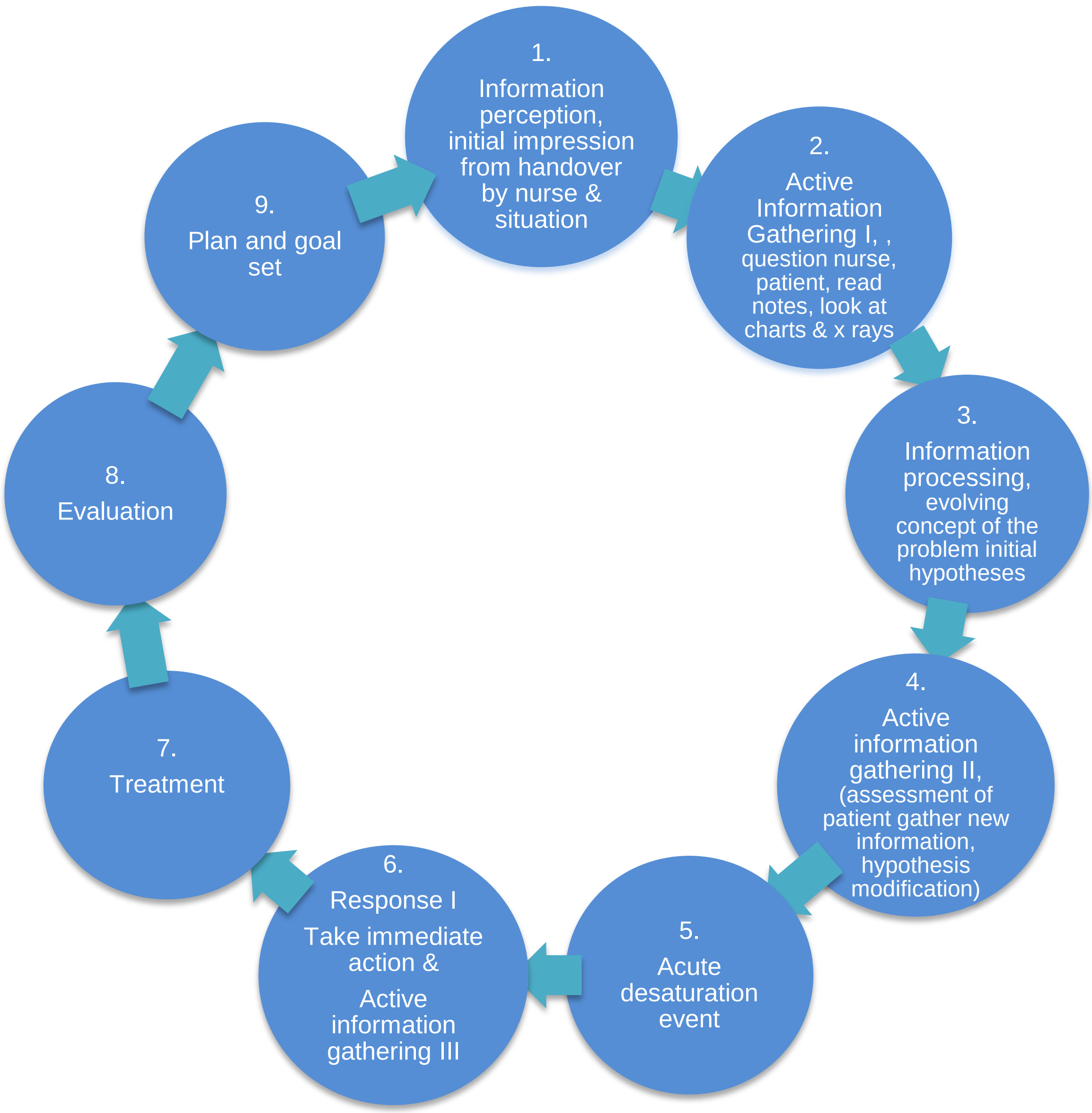
Introduction

This study explored the clinical reasoning of eight expert cardiorespiratory physiotherapists as they assessed and treated a simulated post-operative patient in a simulated HDU. Observational data from the videos and analysis of the written transcripts of the audio data of the assessment and debrief interviews (as described in chapter 3), have shown that there are similarities in the sequence of actions taken by the participants with the collaborative hypothetico-deductive model (Jones et al, 2000) and the five-rights clinical reasoning model (Levett-Jones et al, 2010). However the process would not appear to be as straightforward as these models suggest, but instead appears to be a complex, interactive, iterative process in which each action is interwoven with another. This chapter describes the findings in relation to the clinical aspects of the study. The findings are presented as the sequence of actions that occurred during the assessment of the simulated patient. The similarities and differences to the other clinical reasoning models are discussed under the subheadings of the events that took place and illustrated with examples from the participants and thus answer research questions 1a and 1b (p. 62). For anonymity, the participants have been given pseudonyms.

4.1 The clinical reasoning demonstrated by the participants in this study

From the observation of the video-data and the subsequent analysis, the evidence suggests that these eight physiotherapists with a mean post-qualifying experience of seven years (range 3.5 -16 years) demonstrated similarities with the collaborative hypothetico-deductive model (Jones et al, 2000) and the five-rights model (Levett-Jones et al, 2010). I begin this first section by presenting an overview of the sequence of events by the participants in this study in Figure 4.1. This is a simplified version as the data indicate that there were many iterative, interactive stages occurring throughout. I next describe the actions and themes identified at each stage and compare them with other clinical reasoning models.

Figure 4.1: Summary of the sequence of events that took place during the assessment of the simulated patient.



4.1.1 Information perception: initial impressions from the patient and the clinical context

The behaviour observed in the videos was that all the participants began by entering the HDU where the nurse greeted them and orientated them to the unit. This introduction of the patient and unit by the nurse set the scene and context of the simulation. The physiotherapists began to make initial impressions from the situation and the context of the patient ‘triggers’ the physiotherapists to process this information and this led them to actively seek further information. I observed that the physiotherapists all started in a similar way by listening to information from the nurse during the handover. This aligns with the first stage of clinical reasoning in the Jones et al (2000) and Levett-Jones et al (2010) clinical reasoning models. The ‘handover’ conformed to the norms of a professional conversation, in which the nurse gave a summary and specific details about the patient; sufficient information was given to act as a trigger of the physiotherapist’s memory and this may trigger pattern-recognition at this early stage. The physiotherapist was able to ask questions in response to gather more information or confirm any initial thoughts they have of the situation. The ‘cues’ or ‘triggers’, or ‘relevant facts’ about the patient that the physiotherapists may or may not have recognised are described in Table 4.2

Facts given during handover by nurse	**Interpretation**
A. An open laparotomy	Carried out when surgery is unplanned Following an open laparotomy the patient is more likely to experience abdominal pain as the major muscles have been cut through, and therefore patients can be reluctant to mobilise or slower at mobilising after surgery. This procedure may also cause respiratory complications due to the abdominal wound being painful and limiting the patient's ability to take deep breaths and cough to clear secretions.
B. A poor night due to the admission in the next bay	Suggests that the patient is tired and reluctant to co-operate
C. The change in the pain medication	Suggests that the patients' pain control has been inadequate. If the patient is in pain, he is unlikely to want to breathe deeply, mobilise or cough for the physiotherapist.
D. The desaturation overnight	The patient required an increase in his oxygen to 60% (the highest percentage possible with a high-flow face mask) to keep his saturations within the normal range 96-98% suggesting that his respiratory function is deteriorating.

Table 4.2: The 'cues' given by the nurse during handover.

4.1.2 Active information gathering

During and after the handover, the participants actively sought further information, the information given, prompted the physiotherapist to explore and question further. These initial cues may have stimulated a memory of a previous patient or pre-existing knowledge, thus the information was recognised and matched to their existing knowledge, from which they then actively sought more information by questioning the nurse. All the participants responded and asked questions about cue C – the change in the patient's pain medication from Diamorphine to Fentanyl overnight and cue D – the drop in his saturations at 2 am leading to an increase in his oxygen from 35% to 60%. However, only Jane responded to cue A and asked if the laparotomy had been elective or not. This information was however also given in the notes, so may have not needed to be clarified. The participants' questions reflect how they were beginning to process this initial information and may indicate a style of clinical reasoning that is based on 'pattern-recognition'. Sue confirmed this in her debrief interview and said that she has an idea of what a patient post-laparotomy should be like and she compared the patient to this "picture" during her assessment.

Pattern-recognition (Groen and Patel, 1985) has been widely accepted as a hallmark of expert practice (Case et al, 2000) and outlines that participants quickly move towards diagnosis via the recognition of clinical clues, which they have experienced before. This finding could also be a sign of the 'intuitive approach' part of the dual process theory (Croskerry, 2009), which relies heavily on the experience of the decision-maker and uses reasoning that depends on inductive logic. Table 4.3 summarises the cues the participants acknowledged and the questions they asked in response as part of their information gathering and processing.

Table 4.3: Active information gathering I – questions asked

Participant	Cue from Handover from nurse	Physiotherapists Questions
1 Anne	**Cue C** Changed from diamorphine to Fentanyl overnight **Cue D** Sats dropped at 2am increased O2 from 35-60%	Is he using the pain relief OK? Are his saturations within normal limits?
2 Sue	**Cue C** Changed from diamorphine to Fentanyl overnight **Cue D** Quite uncomfortable and he's on 60% humidified O2 that was turned up when he dropped his sats a bit he was on 35%	So he's still uncomfortable now? Is he on any other pain relief? Did you look after him yesterday? Have you noticed any difference in the change in the PCA? Is he more sleepy? Is he responding when you speak to him? Are you prompting to use his PCA quite regularly?
3 Jenny	**Cue C** Changed from diamorphine to Fentanyl overnight	Is it making him sleepy? Any plans for pain team to review him?
4 Kate	**Cue D** Dropped his sats overnight was on 35% now on 60%	His saturation did that occur previous to this admission? Did he get out of bed yesterday?

Participant	Cue from Handover from nurse	Physiotherapists Questions
5 Sarah	**Cue C** Changed from diamorphine to Fentanyl overnight **Cue D** Dropped his sats overnight was on 35% now on 60%	Is he still on that now? Pain score 0-10? Is he using his epidural? Has he sat out of bed yet? Goes to the patient and asks how he is feeling How his pain is What he has been coughing up Asks him to rate his pain on a scale of 0-10 Asks if he is using his PCA
6 Louise	**Cue C** Changed from diamorphine to Fentanyl overnight **Cue D** Dropped his sats overnight was on 35% now on 60%	Doesn't ask anything about pain control What was his resp rate doing at that time? Much the same? What time was CXR taken same time as change in Oxygenation?
7 Jane	**Cue A** Laparotomy **Cue D** Dropped his sats overnight was on 35% now on 60%	Was it elective surgery or not? Is that his most recent x ray?
8 Jo	**Cue C** Changed from diamorphine to Fentanyl overnight **Cue D** Dropped his sats overnight was on 35% now on 60%	Why did you change his PCA? What did his sats drop to? Do you have any concerns about his chest at the moment?

The table shows that the physiotherapists asked different questions in response to the same cues. This suggests that the participants were beginning to shape their thoughts at this early stage and this difference in questioning style reflects the different ways the physiotherapists were beginning to make sense of the information based on their own interpretation of the situation. The participants' questions, demonstrate that they were discriminating, matching and comparing this information with their stored knowledge. For example, Anne asked if the patient was using the PCA correctly, which suggested that this physiotherapist was not worried over the actual drug being given, but recognised that it was more important that he used the pump to administer the drug effectively. Similarly, Sue and Sarah checked he was using his PCA regularly as this is important for effective pain relief. The participants questioned if the patient was having any other pain relief, which also seemed to be about ascertaining if his pain was under control. Sue asked about sleepiness, which may have been asked to determine if the patient was sleepy as a result of the change in pain control or if it was due to another reason, such as the low oxygen saturation. All the participants asked about his saturation levels suggesting they were comparing this clinical sign with their stored knowledge of normal saturations and that they were taking into consideration the high level of oxygen required to maintain these normal levels. This demonstrates they were immediately recognising a respiratory problem. The difference in style of questioning between participants was probably because physiotherapists bring their own unique frames of reference and experiences to the situation (Smith et al, 2007). Following the questioning, the participants actively gathered more information in a variety of ways: most read the notes but Sarah immediately questioned the patient. There is evidence that they were simultaneously processing this information and some were forming hypotheses.

Reading the notes

Following on from the initial interaction with the nurse, four physiotherapists introduced themselves to the patient stating the purpose of their visit and that they would be at the end of his bed for a while reading his notes and looking at his charts and x-rays**.** These physiotherapists spent between twelve and twenty-eight minutes reading the notes. This is quite a long time to be reading notes and is perhaps longer than is normally spent in clinical practice with a high workload, this length of time may reflect the uniqueness of the simulation. It may also reflect that participants in this study were in an unfamiliar situation, quite similar to being on-call as they had to travel to the HDU, get changed and then they had to familiarise themselves with the patient as they had no prior knowledge and they did this by reading the notes. The time spent reading notes may also be a reflection of the speed of the participants' cognitive thought processes, some being quicker than others suggests that they could find relevant information much more quickly i.e. sort through the data and discriminate between the relevant and irrelevant data more quickly. Some participants asked the nurse for clarification about particular pieces of information or sequence of events so that they understood the patient's past medical history clearly. They also ascertained information about his social life and his level of fitness/activity prior to the surgery. Again they seemed to focus in on key facts that were 'cues' or 'triggers' that enabled them to recall their existing knowledge. An example was that the patient had presented with B Cell Lymphoma as his past medical history and had required radiology. Louise made an association between this fact and the current chest infection stating in her think-aloud "*they can get quite nasty chest infections with this"*. She then started to bring other facts together such as his raised white cell count, and his temperature rising to reach a provisional diagnosis that he was presenting with a chest infection.

Anne focused on the social history and that he smoked six cigars per day and grouped this with the other facts such as the anaesthetic causing paralysis of the cilia and retention of secretions leading to a chest infection. Jane picked up on low albumin and stated that this could be contributing to a muscle weakness and immobility.

These think-aloud comments made by Anne, Louise and Jane imply that the physiotherapists were actively processing and interpreting the information from the notes and had begun to assimilate the different clues and form initial hypotheses about the patient. Some participants stated they were forming an ‘initial hypothesis’, whereas others said they were ‘identifying his problems’ thus using different terminology.

Interaction with the patient

The collaborative clinical reasoning process proposed by Jones et al (2000) sees the patient as an integral participant in the information gathering process. In my study, Sarah asked the patient his perspective about his condition immediately after she had introduced herself at two minutes forty-two seconds and before she went on to read the notes. As a result, she gained a valuable insight into the patient’s condition directly from him. The individual physiotherapist, her interpretation of the situation, the context, her beliefs, and her previous experience (Smith et al, 2007) may explain why she approached the patient at this stage. This observation could have been the physiotherapist’s normal approach to her assessment of a patient on HDU. It may have also been part of her physical assessment, as by doing this she could check that the patient had a clear airway, and assess the severity of his breathlessness by his ability to speak in full sentences.

In contrast Anne, Sue, Jenny, Kate and Louise only briefly introduced themselves to the patient to explain the purpose of their visit before they started reading the notes. Jane and Jo did not introduce themselves or ask the patient any questions about his condition until after they had fully read the notes and looked at the charts. This observation that Jane and Jo did not communicate with the patient might be common to the setting as sometimes patients in HDU or critical care may be unable to speak, whereas the collaborative clinical reasoning model has been based on observing physiotherapists in outpatient settings where patients are fully conversant.

However, an interesting observation is that Sue, Jenny, Kate, Louise asked the patient his perspective when the desaturation event occurred. Jenny used the conversation to help inform her during the desaturation and said “he was not in too much respiratory distress because he is able to speak in full sentences”. Therefore, communicating with the patient at an early stage, even in an HDU setting, can contribute to the clinical reasoning process and should not be overlooked by the physiotherapist, as if the patient is able to communicate they can actively contribute to the decision-making process which may also lead to better adherence with treatment.

4.1.3 Information processing and evolving concept of the problem and initial hypothesis

The physiotherapists spent some time either reading the patient’s notes and/or discussing his condition with the nurse or patient. The think-aloud and conversations the physiotherapists had with the nurse and patient, illustrate how the physiotherapists were actively processing this information and forming initial hypotheses. According to the collaborative clinical reasoning model (Jones et al,

2000) the next stage after information perception and interpretation is that an initial concept and multiple hypotheses are formed. The preliminary information gathered evokes a range of impressions or working interpretations. While typically not thought of as such, these impressions can be considered hypotheses. The cognition involved in hypothesis generation includes a combination of specific data interpretations or inductions and the synthesis of multiple clues or deductions. The initial hypotheses are quite broad (Jones et al, 2000). This was evident with Anne, Kate and Sarah who expressed initial hypotheses in their think-aloud although the time this occurred varied.

Anne formed her initial hypothesis very early on at three minutes and thirty-nine seconds into the assessment following the handover form the nurse.

> *I'm already thinking that if pain is a problem and his PCA has been changed – not using properly, not ideal and respiratory function is going to be compromised after surgery if pain isn't well controlled. Looking at his sats although OK – 95% but it's not, because he's on 60% a lot of oxygen that concerns me and that his pain is not controlled. He says he's not feeling well and he's tired he didn't sleep much last night … I'm already thinking if you smoke prior to an operation, it can make you more likely to have respiratory complications post-operatively… So I'm thinking that he's had a laparotomy and anaesthetic, he's not been moving-can lead to a decreased lung volume and retained secretions and already smokes 5-10 cigars a day then cilia not working well and that he'll have secretions and pain all add up to him having decreased lung volume and infection.*

Sarah thought aloud about her hypothesis quite quickly after only eight minutes into the assessment, immediately after she had listened to the patient's perspective and before she read the notes:

> *Just had a quick chat with Mr Day and I want to find out a bit more about him, more of his background History. Just reading notes at moment... The type of op he had was a laparotomy procedure ... He's a smoker of 6 cigars a day so that will be taken into consideration for the patency of his lungs ... looked at the x-rays its showing a left lower lobe collapse and consolidation, today its showing right middle lobe collapse and consolidation there's also collapse of his right lower lobe. So from the chat with Mr Day his pain is an issue. He needs encouragement to use his PCA. I need to speak to him to get him to use that a bit more. I can see he's nil by mouth he's telling me his secretions are very thick and he's got a lot, but he can't get them up that indicates to me that he may need a bit more fluid, some saline. That's just what I'm thinking at moment; having had a look at the charts and everything I want to objectively assess Mr Day by auscultation and running through my assessment there.*

There is evidence that Sarah was using the information from the patient to guide her through the notes to find more information quickly and confirm her thoughts and next she would assess the patient to prove or disprove her initial hypotheses. Sarah processed the information she gathered directly from the patient suggesting that by communicating directly with the patient it could help to gleam pertinent information more quickly than reading the notes. These two examples, illustrate that there may have been an inductive reasoning process occurring (Croskerry, 2009).

In contrast, Kate thought aloud about her hypothesis after the desaturation event at thirty-two minutes fifty-five seconds:

> *...so in my head just thinking why he had this drop in sats maybe he had a plug of phlegm there, he's got a little bi-basal collapse because he's not getting up and moving about and taking deeper breaths after surgery, being laid down for a while in surgery and after – wasn't*

> *particularly mobile prior to surgery because of pain that's been going on. So now I'm just going to take a look.*

She proceeded to question the patient about how his breathing felt and went on to listen to examine his chest. In contrast to Anne and Sarah, Kate appears to have worked more slowly through the patient's notes deductively to reach her hypotheses and then she goes on to assess the patient.

The Levett-Jones et al (2010) model varies slightly from the Jones et al (2000) model, stating that after the information has been processed there is a synthesis of the facts to make a definitive diagnosis of the patient's problems and to establish goals. Sue, Jenny, and Jo did not think-aloud that they were forming a hypothesis, but I have interpreted from their transcript that they did gather all the information, process and synthesise to establish a problem list. This suggests that hypothesis formation and synthesis serve the same cognitive function but is expressed differently by the individual. This may also be evidence that these participants undertook a slower more deductive process of reasoning. Again this may reflect the individuals' preference or how they have been taught or may even have been an effect of the simulation exercise.

What is evident from this study is that there is a constant interpretation of the information and an evolution of the physiotherapists' understanding of the problem as the scenario progresses. Whether the participants formed a hypothesis or an initial problem list or a synthesis of all the information, the next stage in the process was to assess the patient by examining his chest to gather further information to prove or disprove the provisional hypotheses or problems identified.

4.1.4 Active information gathering II: Assessment of the patient

The physiotherapists next physically assessed the patient, thus enabling them to gather new information that either proved or disproved their initial hypotheses. There was an element of routine to their examination. Some of the participants used the A-B-C-D-E framework (McQuillan et al, 1998; Smith et al, 2002). The letters are acronyms for Airway, Breathing, Circulation, Disability and Exposure. Alternatively, they conducted their own style of assessing the respiratory, circulatory, renal and neurological systems. Regardless of the assessment process followed, all the participants proceeded to examine the patient first with auscultation to assess his breathing. This involved placing a stethoscope on the patients' chest to listen to breath sounds of the lungs and it gave an indication of the status and patency of the lungs at that moment in time. It is a skilled procedure and requires the physiotherapist to have a good understanding of normal breath sounds to be able to identify abnormal breath sounds.

The physiotherapists, who had not asked the patient any direct questions previously, now asked the patient how he was feeling, what his pain was like, and what his breathing was like. As commented previously, this indicates that this was their normal procedure and was based on their own experiences and preferences. The physiotherapists also asked for his consent to listen to his chest. At this moment in the scenario, the patient presented himself as being un-cooperative and asked the physiotherapist to go away. However, the physiotherapists did not accept that and continued to explain the purpose of their visit and persuaded him to allow them to continue with the examination of his chest. As they began their examination the patient's breathing became more distressed and he desaturated (the oxygen level in his blood dropped from 96% to 89%).

The clinical reasoning observed up to this point in the scenario shares similarities in stages to the hypothetico-deductive (Jones et al, 2000), and five-rights models (Levett-Jones et al, 2010). The think-aloud technique generated relevant evidence of hypothesis formation. The process observed up to this point was fairly straightforward however, this unexpected desaturation event, created an opportunity to observe how the participant responded to an acute situation.

4.1.5 The desaturation

Most of the participants responded immediately to the desaturation and took appropriate measures to ensure the patient was safe. There was further information gathering and processing which involved communication with the nurse and the patient (and for some participants also the doctor) about the most appropriate treatment for the patient. This part of the process represents a fast-forward approach rather than the slower deductive approach that was first observed.

Immediate action

The response by the participants to the patient's desaturation episode illustrated how the participant responded at that immediate moment, in a potentially life-threatening situation. All eight participants recognised the desaturation event but only six took immediate action, which suggests they were predicting and thinking ahead of how to prevent further deterioration. The speed of the recognition of the desaturation and the efficient use of the information to take appropriate action may indicate clinical reasoning based on advanced pattern-recognition seen in experts (Brooks et al, 1991; Schmidt et al, 1990) or an intuitive response (Croskerry, 2009). The participants may have had previous experience of a patient desaturation and this may have triggered their procedural knowledge and response. Kate firstly checked the SpO_2 probe was working correctly and then continued with deep breathing exercises. The other participants followed a similar approach. Table 4.4 summarises the response by the participants and the action taken to correct the desaturation event. Again, the differences in the way each participant responded may reflect a variation in their thought processes in the acute situation.

Table 4.4: Summary of the responses made by the participant at the time of desaturation

Response	**Participant**
Immediately looked at monitor	All except Anne
Checked the saturation probe	Kate
Immediately talked to the patient about his problem and management	All except Anne
Talked to the nurse about-patient's diagnosis and management	All
Talk to the doctor about-patient's diagnosis and management	Jenny, Louise, Jo
Treatment	
Deep breathing exercises	All
Re-breathe bag	Louise, Jane, Jo
Re-position	All except Anne
Nebuliser	Kate, Louise, Jo
Suction	Sue, Sarah,
Pain control	All
Circulation exercises	Sue, Sarah,
Treatment plan	
Pain team to review	Anne, Sue, Jenny, Kate, Sarah, Jane,
Mobilise out of bed and sit in a chair	All
"Bird" (IPPB)	Anne, Jenny, Sarah, Jane, Jo
Continuous Positive airway Pressure (CPAP)	Anne, Sarah,
Positive End Pressure (PEP)	Jane

As can be seen from the table, seven physiotherapists acknowledged the desaturation by looking at the monitor and they asked the patient how he was feeling and commenced deep breathing exercises. Jenny (one of these seven) was slightly slower in her response as she continued with her assessment before commencing deep breathing exercises. Her think-aloud at this moment reflects that she used the conversation with the patient to check the severity of the condition. However, Anne appeared not to notice the desaturation on the monitor and continued to discuss pain medication with the nurse before she started to do any deep breathing exercises so her response time to the desaturation compared with the others was much slower.

The immediate response by seven of the physiotherapists suggests that they quickly recognised the clinical sign of desaturation, interpreted the situation, and took some form of immediate action to counteract the desaturation. In a real-life scenario, the treatment administered would be to prevent further deterioration such as a respiratory arrest. The initial interpretation of the clinical reasoning in this acute phase is that the physiotherapists must first recognise the desaturation. Most did this by looking at the patient's monitor in response to the alarm and recognised that the saturations were lower than normal. Some of the physiotherapists also noticed that the patient was less responsive and sleepier. The physiotherapists compared the information on the monitor to their knowledge of normal saturation values; they also compared the appearance and conscious state of the patient to what he was like before. They made a very quick interpretation of the situation and responded appropriately with an action that would benefit the patient and restore the saturation levels to normal.

In this acute event, the physiotherapists demonstrated high-speed information processing which consisted of first comparing the information of the saturation levels to their knowledge of normal values. They then had to decide if this was a real reflection of the patient’s status, as Kate demonstrated when she immediately questioned if the probe was on correctly as this could give a false reading if not positioned correctly. Anne apparently did not immediately respond with treatment. However, her response was based on her thought process that the patient was in distress due to his pain and she discussed his pain relief with the nurse and an extra paracetamol suppository was given. She decided that deep breathing exercises would be ineffective and abandoned any further treatment until his pain was better controlled. This suggests her reasoning was different to the other participants and she was thinking that the underlying cause needed to be addressed first. This was confirmed in her debrief interview.

Jenny also seemed to have a slightly slower response rate to the desaturation episode and continued with her assessment. Both participants Anne and Jenny may have behaved in this way because they did not perceive the situation as real or life-threatening, as this was only a simulated patient. In contrast, the other physiotherapists appeared to be fully immersed in the simulation and decided that the patient had actually deteriorated as they immediately asked the patient how he was feeling and commenced deep breathing exercises. Sue, Kate, Sarah, Louise, Jane, and Jo appeared to predict that his condition would deteriorate and so started treatment straight away. The processing of the information and response rate to the desaturation was quicker than the earlier data gathering stage. These findings suggest that some of the participants began to synthesise during the desaturation stage and they started to reform their hypotheses and make inferences e.g. some inferred that he had a sputum plug and this was causing the desaturation episode. They were then able to share this information when they communicated with the patient, the nurse or the doctor and the subsequent discussions they had together appeared to create a collaborative decision-making process about suitable treatment goals.

In the following section, the communication between the physiotherapists, patient, nurse and doctor is discussed. These findings shed light on how the behaviour of the physiotherapist varied under the stress of the desaturation episode, and gives further insight to how and with whom the physiotherapists communicated to help inform their clinical decision-making.

Explanation

All the physiotherapists explained what was happening to the patient and why his saturations were dropping and what they needed to do to rectify the situation. According to Jones et al (2000) the hypothetico-deductive reasoning model is collaborative with the patient being an integral part of the decision-making process. All the participants showed some empathy and understanding of the situation, even Jenny, who had had a slightly delayed response to the desaturation, started to show some empathy and understanding as she conducted deep breathing exercises with him.

Sue, Kate and Sarah demonstrated a caring, empathic approach with the patient and discussed what was happening and how he was feeling all the way through. They were particularly good at creating rapport with the patient, showing a caring approach during this acute phase and continually informed the patient about what was happening. These participants focussed on patient care, for example they administered mouth care, suction at the back of the mouth to clear secretions and the patient responded positively to the intervention which then reinforced the approach the physiotherapist had undertaken. The way in which the patient responded clearly effected the next action the physiotherapist took so he influenced the decision-making process. Sarah reinforced this is in her debrief interview saying that "*getting feedback from the patient really helped my clinical reasoning".*

Most of the physiotherapists educated the patient and explained how important it was for him to press his PCA button to administer the painkiller. In one scenario, the patient said "...*oh, nobody had explained that to me before, that makes sense now".* Educating the patient can be just as important as actually administering an intervention and the positive outcome reinforced the physiotherapist's thought process that he had not been using his PCA correctly and that was also contributing to his deterioration.

Communication with the nurse during the desaturation event

The participants asked the nurse at the time of the desaturation for her help in the immediate management of the patient. However, for the purpose of this research she could not influence the physiotherapist's decision-making and therefore the physiotherapist had to decide and instruct her what to do. If she was unable to assist, then she called the doctor to the unit, for example: Kate, Louise and Jo wanted to give a nebuliser, which has to be prescribed by the doctor.

Communication with the doctor during the desaturation event

Jenny, Louise, and Jo communicated directly with the doctor. When the doctor arrived on the unit, the physiotherapist gave a synopsis of the patient's presenting clinical signs, his breath sounds, chest x-ray and how he had just de-saturated (a similar conversation to the handover the nurse had given to the physiotherapist). The doctor asked the physiotherapists to express their thoughts about what was happening with the patient and together they considered the treatment options and agreed on treatment goals. For the purpose of this research, the doctor could not be seen to influence the physiotherapist's decision-making and always allowed the physiotherapist to come up with the answers. Jo reflected on this in her debrief interview stating: *"today I was forced to make the decisions, normally the doctor would come in and take over".*

This observed communication between the physiotherapists, nurse and doctor during the desaturation event, shows that the decision-making in this particular context does not have to occur in isolation, but extends and includes other professionals. This finding concurs with Smith et al (2007, p.91) who recognised "that decision-making is situated within a broader contextual ethos, with dimensions particular to the practice in the specific workplace".

4.1.6 Treatment Selection

The clinical reasoning during the desaturation event was very quick, enabling the physiotherapist to respond immediately and take action. My interpretation of this almost immediate response is that either the participants were using pattern-recognition (Groen and Patel, 1985) in a sophisticated form as characterised by the speed and efficient use of information as seen in experts (Brooks et al 1991; Schmidt and Boshuizen, 1993), or it was an inductive intuitive response (Croskerry, 2009) or a procedural response (Edwards et al, 2004), which allowed them to respond quickly and appropriately to the situation. The cognitive skills used at this time appear to be recognition, matching, inference and prediction, which concur with Levett-Jones et al, 2010.

The choice of treatment selected varied between the participants and as mentioned previously, the actual treatment selected is not being analysed. However, variation in treatment choice between the physiotherapists was possibly due to their reasoning at that moment and may have been based on previous experience or procedural knowledge. Five of the participants immediately spoke to the patient and explained what was happening and asked him to press the patient controlled analgesia (PCA) buzzer for pain relief, which should make it easier when he took a deep breath. All of the participants encouraged the patient to take deep breaths, support the wound and cough to clear the secretions. Louise, Jane and Jo asked the nurse to replace his oxygen mask with a rebreathe mask as this gives a higher concentration of oxygen than the one he was wearing. Both these interventions should have helped to improve the oxygen and improve his saturation back to a normal range.

Once a treatment was started, the physiotherapists monitored the patient carefully; hence this feedback became part of the reasoning process. This was observed with Anne, who chose to stop the deep breathing exercises as the patient was still expressing he was in a lot of pain and she felt that his pain needed to be better controlled and requested he was reviewed by the medical team before she could do anything with him. Similarly, Jo chose to discontinue her treatment as the patient's heart-rate became elevated and she was concerned that he needed this to be managed before she could continue. In contrast, Sue, Jenny, Kate, Sarah, Louise, and Jane continued with the deep breathing exercises as they noticed that these exercises appeared to be having a positive effect. Hence the intervention chosen and the response to it, served as another test of the hypotheses (Jones et al, 2000). With these participants, the treatment session continued and evolved based on their perception of the situation. There were indications that during the treatment session the physiotherapists were continually processing information about the patient's condition and they were using their cognitive skills to evaluate the patient's response to treatment.

There was evidence that the physiotherapists did not work in isolation during the treatment session, but worked collaboratively with the patient, the nurse, and the doctor to reach clinical management decisions. Therefore the treatment session in this study was an interactive, reflexive, relational and a dynamic process, which required good communication skills with the patient as well as good cognitive skills.

Table 4.5 summarises each participant's treatment approach and the interactions between the nurse, the patient, and the doctor. The similarities in treatment approach taken i.e. pain control, followed by deep breathing exercises, with supported coughing and clearance of secretions either independently or using some suction to assist, suggests that the clinical decision-making in response to the desaturation was fairly similar between the physiotherapists in this study. The slight variation in the timing shows their individuality.

Table 4.5: Summary of the treatment approach each participant takes during the acute desaturation event (The colour coding is as follows: Yellow = the physiotherapist communicates with the nurse, Green = the physiotherapist, communicates with the Doctor, Blue = the physiotherapist communicates or treats the patient, Purple = the physiotherapist stops treatment in recognition of a problem)

Participant	Treatment
1 Anne	Communicates with the nurse and a Paracetamol suppository is given explains to patient the effect of the operation on his lungs, examines his chest, tries deep breaths and a cough. stops treatment as she recognises that his pain is limiting what she can do and she wants the Dr's to see him first to review his pain medication. Discusses a plan of treatment with nurse for later after his pain control has been reviewed of sitting out or moving on the spot, maybe using the Bird or CPAP to improve lung volume.
2 Sue	Communicates with the patient and examines his chest and explains why it's important to clear the phlegm. sits the patient up with the nurse. discusses pain control and an increase in Oxygen with nurse . does deep breathing exercises, coughing, gives mouth care and exercises for circulation There is some improvement in the patient's condition saturations improve and some phlegm is cleared. Discusses a plan with nurse of getting him sitting over edge of bed later if pain better controlled
3 Jenny	Re-positions the patient into left side lying with assistance from the nurse explains to patient about the pain from surgery and the need to use the pain control communicates with the dr, they discuss CXR, pain relief, oxygen requirements and if Bird can be used Does Deep breathing exs, huff and cough Pt Clears some phlegm discusses a plan with the nurse to come back in 2 hrs after a saline nebuliser to sit patient out of bed and Bird later. Suggests changing his oxygen from humidified oxygen to nasal specs
4 Kate	Checks probe is on, Explains the problem to the patient. Does deep breathing exs uses a towel for support of abdomen when coughing, discusses having a saline nebuliser with the nurse, discusses pain control with the patient discusses a plan with nurse of giving nebuliser first, get out of bed, have a bit of a walk around, see how he goes, see if he can get any phlegm up, make sure he takes nice deep breaths go back to bed this pm Discusses plan of treatment with patient
5 Sarah	Asks the patient to sit up in bed, asks patient to cough with towel over tummy. asks patient how his pain is and asks him to press PCA Discusses with nurse increasing his oxygen, giving a nebuliser, suctioning and pain control Gives Mouth care, Repeats Breathing exs and coughing and suction using yankeur suction, Circulatory exercises Discusses with patient the idea of using either Bird or CPAP and sitting out later requests Nurse gives a Saline Nebuliser whilst she sets up equipment discusses treatment plan with nurse of either Bird or CPAP (positive pressure adjuncts)
6 Louise	Requests nurse gives Oxygen via Rebreathe bag straight away, Explanation to patient, encourages patient to use PCA, Re - Position on to left hand side Deep breathing exs, huff and cough, manual technique of shaking given during breath out Discussion with nurse to bleep dr, communicates with dr about saline nebuliser Nebuliser given, breathing exs repeated after the nebuliser, discusses treatment plan

Participant	Treatment
	with nurse to sit patient up, deep breathing exercises, try to reduce his Oxygen
7 Jane	Encourages patient to press PCA to control his pain, Discusses with nurse additional paracetamol suppository, which the nurse gives and changes his oxygen to the rebreathe mask Deep breathing exs, with towel for support of abdominal wound Sits patient up, she discusses with nurse that he could be written up for regular saline nebs, that his pain needs to be reviewed by dr's; discusses a plan with the nurse of using the Bird, or a PEP bottle, sit out for short periods, or right side lying and deep breathing exercises
8 Jo	Discusses with nurse patient management and decides to sit patient up and change Oxygen to Rebreathe bag, Deep Breathing exercises, towel over incision to support wound when coughing, uses yankeur suction to clear secretions Communicates with Dr about CXR to rule out pneumothorax so that she can use Bird if she wants to, she requests another ABG Gives saline nebuliser communicates with nurse about his elevated HR and if it is pain related, P8 requests additional pain relief Nurse gives Paracetamol suppository stops treatment because of the patients increased heart-rate, explains to the nurse she would like the heart-rate to stabilize and she will review later.

Communication with the patient during the treatment session

Table 4.5 shows how the participants liaised with the patient, the nurse and in some cases the doctor, during the acute desaturation. It was also evident from watching the videos that all the participants showed some empathy and understanding with the patient and tried to explain why he had a problem with his lungs. However, there was variation in when they spoke to the patient and how much they included him in the decision-making process. The empathy and care given varied with each individual. In particular, Sue and Sarah stand out as having an excellent rapport with the patient and include him in the decision-making about his management continuously. This observation corresponds with the observations made by Smith et al (2007) that each physiotherapist brings their own unique character to the clinical situation.

Communication with the nurse and doctor

All the participants communicated with the nurse closely, and Jenny, Louise, and Jo also communicated with the doctor about the management of the patient. Whilst communicating their thoughts with the nurse or doctor, the physiotherapists seemed to synthesise their ideas, and identify the patient’s problems and how they would like to manage these. The outcome of this conversation was that an action was required to be taken by the nurse or doctor e.g. pain control or a nebuliser needed to be given before physiotherapy treatment could occur. This suggests that communication is vitally important between members of the multi-disciplinary team looking after a patient on HDU. The following extract of transcript illustrates this collaborative decision-making.

Jo asked the doctor to review the CXR and rule out a pneumothorax before she could commence treatment with the ‘Bird’ (Intermittent Positive Pressure breathing, IPPB), she also requested a repeat arterial blood gas to be taken to give up to date information on the level of oxygen in his blood.

> *Jo: I’m concerned his sats keep dropping 88-89%; he’s been on a re-breathe bag now for a few minutes. They went up and then dropped again. HR 120/130 a few minutes ago.*
>
> *Dr: What do you think is going on?*
>
> *Jo: Wondering if there’s some plugging going on there. We’re moving it but he’s quite tired.*
>
> *Dr: Kate what has his pain been like?*
>
> *NS: Pain has scored at zero, worse when moving not compliant with PCA.*
>
> *Dr: What would you like me to do then?*

Jo: Wonder whether you could review his last CXR to rule out any pneumothorax and do an ABG.

Dr: I'll take a listen to his chest as well.

Dr: looks at CXR no pneumothorax and discusses the CXR with physio.

NS: takes blood from the arterial line.

Dr Reviews the drugs; he can have saline or salbutamol that will help loosen up phlegm

Dr: A bit difficult isn't it?

Jo: Can hear a bit more with him on his right side

Dr: Yes I think we should try a nebuliser and see what that does alright Mr Day we'll sort out some extra medicine for you

4.1.7 Evaluation

Re-assessment is an opportunity to reflect and make decisions about how effective the actions have been, whether the patient has improved, and what could be done next, to improve the patient further. Evaluation influences the next stage of the decision-making process as, by evaluating whether the treatment has been effective, it can help to confirm or disprove if the initial hypothesis was correct and help inform what to do next. In this study, evaluation was a constant process during the treatment session evidenced by the physiotherapists checking the monitor for his observations of HR, RR and BP, asking the patient how he was feeling and by re-listening to his chest to evaluate the effectiveness of their treatment. This evaluation informed the physiotherapist and added to her perception of the situation. During the evaluation, the physiotherapists may also have questioned the nurse or doctor to further enhance their information processing and inform their clinical reasoning. Again, this finding indicated that the physiotherapists used evaluation throughout the desaturation stage rather than it being a discrete stage at the end of the treatment process as in the hypothetico-deductive model. Evaluation is another form of information processing, as it uses the cognitive skills of recognition, discriminating, matching, relating, and inferring. The physiotherapist gathered new information for evaluation constantly from the monitor, the patient and clinical tests.

4.1.8 Planning and goal setting

The stage of planning and goal setting is not considered in the hypothetico-deductive model (Jones et al, 2000) and in the five-rights model (Levett-Jones et al, 2010) it occurs after problems have been identified and before action is taken. In this study, planning occurred when treatment could no longer progress due to the patient tiring and so the physiotherapists planned what they wanted to happen next with the patient and nurse. They also planned when they would return to see the patient to attempt further treatment. This suggests there was a process of synthesis occurring at the end of the treatment session as most of the physiotherapists summarised their findings with the nurse, patient or both and document such in the notes. This was like a mirroring of the handover seen initially, but the roles were reversed with the physiotherapist leading the conversation. The following extracts from the transcripts illustrate the communication between the physiotherapist and nurse and how they planned the next treatment session.

Jenny discusses treatment goals with the nurse

Jenny: HR wise he's obviously elevated and is in tachycardia but is still within his BP are you happy for him to get out?

NS: Yeah

Jenny: Fine, I was wondering if we could either stretcher chair, or give him half hour breather then stretcher chair out? What do you reckon half an hour? Maybe come back in two-hours he can have saline neb whilst he's in chair maybe do some birding whilst he's in the chair

NS: Fantastic so you're happy about Oxygen he's on now?

Jenny: Currently would go for nasal specs rather than rebreathe. I think Birding a good idea even though he's doing his ACBT's he's getting quite tired so a little and often physiotherapy would be better so I'm going to walk away, in half an hour get him into the chair, come back when he's out he can have nebuliser as well.

NS: Fine

Sarah discusses treatment goals with nurse

Having communicated her treatment plan with the patient Sarah communicated her treatment plan with the nurse.

Sarah: His sats are 94% on 60% oxygen so he has dropped a little – his airway sounds a little clearer now I think the main issue we have is he's collapsed his right side and the consolidation. He has coughed up a bit of sputum, which was thick dark yellow at moment it sounds like its bit deeper down so I'd like to use some positive pressure with him that will hopefully clear airways and secretions. We can use the Bird, which I can get, do you use CPAP?

NS: Yep

Sarah: Do you set it up?

NS: Yep

Sarah: His gases are fine but I'm concerned about his sats decreasing and concerned that whilst his cough is effective because of the pain he's not participating much and we need to give him support. I think I *would go down the CPAP route because he's experienced some chest pain and his CXR quite considerable that we might go down the CPAP route.*

Do you do it by mask or helmet?

NS; Yeah by mask -that's fine- great Ok- would you like me to set it up straight away?

Sarah: Yeah I think that we should set it up straight away I can help you. I'm just going to speak to Mr Day I wasn't quite sure if you had CPAP so I'm going to tell him what's going on.

4.2 A new conceptual model of clinical reasoning in cardiorespiratory physiotherapy

This study has produced some rich and fascinating video and transcribed data which I have synthesised to create a model of clinical reasoning for each individual and an overall conceptual model. This has proved challenging as the clinical reasoning process observed was not a straightforward linear or cyclical process as suggested by previous models. This task of using data to produce a conceptual model actually highlighted how interactive, dynamic and iterative the process was for each individual and the importance of the context of the situation. Each action informed another, as illustrated by Higgs and Jones (2000), who used an upward and outward spiral (see Figure 2.3). Instead of trying to put all this information together into a complex diagram, or flow chart, or iterative spiral, I have used a simple diagram that interlinks the four key actions that take place during clinical reasoning and I have listed the activities/attributes of the physiotherapist associated with each action in adjacent text boxes. This simple conceptual model is easier to replicate and can be linked with the four key concepts required for clinical reasoning development as discussed in section 2.5: knowledge acquisition; knowledge storage and retrieval; information processing and cognitive skill development; metacognition and reflection. This simple conceptual model (see Figure 4.2) may help inform teaching strategies for developing clinical reasoning in the future which is discussed in the next chapter.

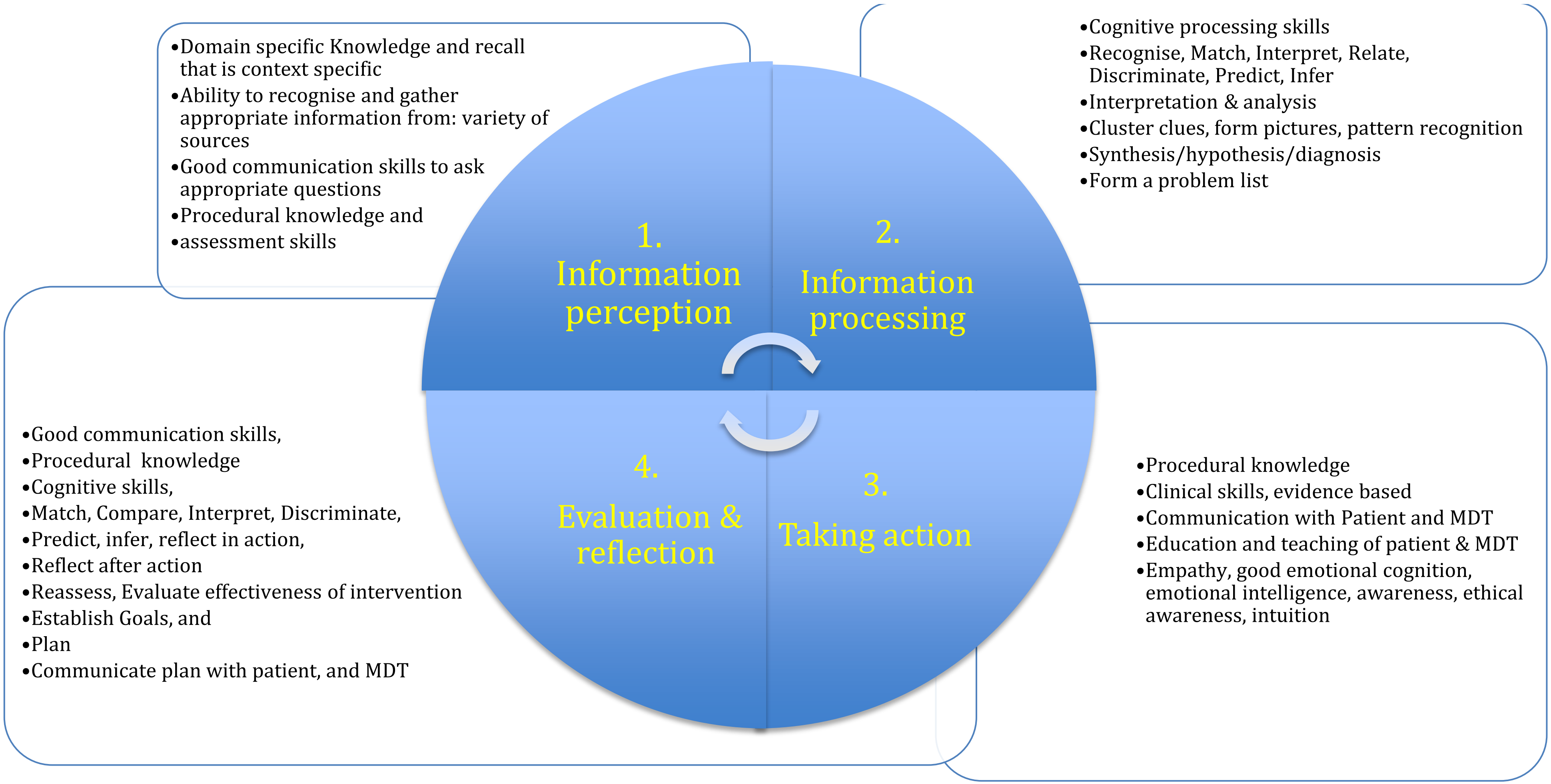


Figure 4.2: A conceptual framework of clinical reasoning in cardiorespiratory physiotherapy. I have synthesised the clinical reasoning observed into four key stages of 1. Information perception; 2. Information processing; 3. Taking action and 4. Evaluation and reflection. The text describes the attributes of the physiotherapist.

4.3 Summary of findings:

4.3.1 Similarities to other models

This study has used an innovative methodology of a simulated patient with an actor's voice, a simulated HDU setting with inclusion of the multi-professional team, and the inclusion of an acute desaturation event to explore the clinical reasoning of eight expert cardiorespiratory physiotherapists. The video footage has enabled the assessments to be watched repeatedly to identify the behaviour and actions of the physiotherapists. The framework analysis of the verbal transcripts has enabled the knowledge and cognitive thought processes to be identified and these data have been compared to the other models of clinical reasoning. The findings have shown that these physiotherapists' clinical reasoning was a complex, iterative, and dynamic process. This is particularly evident for information processing, which appears to occur simultaneously with information perception and occurs throughout the assessment process.

There is also evidence that some of the physiotherapists used pattern-recognition (Groen and Patel, 1985) and some were also using some of the reasoning strategies described by Edwards et al (2004). The acute desaturation event illustrated the different speed in processing information and this suggests that either the physiotherapists were using procedural reasoning, as identified by Edwards et al (2004), or they were using an inductive method of reasoning as in the dual process theory (Croskerry, 2009) rather than the slower more deductive process that had been observed before the acute desaturation event. Table 4.6 summarises the stages observed and compares these with the hypothetico-deductive and the five-rights models to illustrate the similarities and differences in the sequence of clinical reasoning. Table 4.6 summarises the similarities the findings share with other models of clinical reasoning.

Hypothetico-deductive Jones et al, (2000) (Linear model)	**Five-rights** Levett-Jones et al, (2010) (Cyclical Model)	**This study** (Iterative, dynamic, and interrelated)
Information perception and interpretation	Consider the patient situation	Information perception and initial interpretation
Initial concept and multiple hypotheses	Collect cues/information	Active information gathering Handover from nurse, read notes, speak to patient
Evolving concept of the problem and hypothesis modification	Process the information	Information processing Evolving concept of the problem and initial hypotheses
Decision Diagnostic Management	Identify problems /issues	Active information gathering II Assess patient, gather new information, hypothesis modification
Physiotherapy Intervention	Establish goals	Acute desaturation event
Re-assessment	Take action	Response I - take immediate appropriate action And Active information gathering III
	Evaluate outcomes	Response II give treatment
	Reflect on process and learn	Evaluate effectiveness of treatment

Table 4.6: The stages of the clinical reasoning process identified in this study compared with the hypothetico-deductive and five-rights models.

Analysis of the data indicates that each physiotherapist used more than one model of reasoning styles. This is summarised in Table 4.7 where each tick represents the style was evident.

Participant	Hypothetico deductive	Five-rights	Pattern recognition	Inductive	Deductive	Narrative
Anne	✓	✓			✓	
Sue	✓	✓	✓	✓	✓	✓
Jenny	✓	✓	✓		✓	
Kate	✓	✓			✓	✓
Sarah	✓	✓	✓	✓	✓	✓
Louise	✓	✓	✓	✓	✓	
Jane	✓	✓	✓	✓		✓
Jo	✓	✓			✓	

Table 4.7: Summary of the different clinical reasoning models demonstrated by the participants in this study.

4.3.2 Differences to other models

The analysis has particularly illustrated that information processing (recognised as a unique stage in the hypothetico-deductive and five-rights models) actually occurred throughout the whole interaction with the patient and this seems to be an essential part of clinical reasoning. It would seem that information processing is actually the cognitive part of the reasoning process and it starts simply with information perception, that is, a valid clinical sign or symptom is recognised as being significant. This then triggers either inductive pattern-recognition in which further data may be gathered to confirm an initial hypothesis, or a deductive method used from the onset to gather more information. To do this, further cognitive processing occurs and in this study, the cognitive processing appeared to occur in a sequential order of first recognition, and secondly discrimination, where inconsistencies were recognised and narrowed down, illustrated by the physiotherapists actively seeking more information from the nurse, patient or doctor. It would appear that pattern-recognition began when clues were clustered together and relationships were made between them, which were then compared to previously stored schemas. The physiotherapists inferred and made deductions or formed opinions that followed logically by interpreting cues; they also considered alternatives and consequences. Thus, cognitive processing requires knowledge that can be easily retrieved from the memory. The physiotherapist compared the new information obtained to pre-existing knowledge in their long-term memory and this determined the gaps in the information and the questions they needed to ask. Information was synthesised which was where the information was brought together to identify the patient’s problems and was used as an interim stage to reform hypotheses prior to commencing treatment. Then as treatment commenced there was an evaluative process that occurred and this again used the cognitive skills of recognition and comparison to see if the treatment had made a difference. The physiotherapists, in this study, constantly used this evaluative process.

In the first stage of the clinical reasoning when information was being gathered, the information processing appeared to be a slow deductive process whereby the physiotherapists were mainly collecting information and interpreting the information given in the handover, from the notes, charts and x-rays. When the desaturation event occurred, the information processing was seen as a fast-forward approach whereby the majority of the physiotherapists took immediate, appropriate action as they had quickly predicted the patient could deteriorate further and perhaps have a respiratory arrest. The evidence suggests that at the start, they used a slower deductive approach whereas at the time of the desaturation, the clinical sign prompts a fast-forwarding or more inductive response. This finding may be explained by the dual processing theory (Croskerry, 2009) in which the inductive fast-forward process occurs in response to a pattern that has been seen before which triggers the appropriate knowledge retrieval and action or a certain procedural response.

This study has also shown that clinical reasoning was dynamic and iterative with communication and exchanges occurring between the physiotherapist, the patient, the nurse and the doctor all contributing to the decision-making. Communication appeared to be a key feature and flowed right the way through the process from beginning to end. This study has shown that communication was multi-directional, occurring between the physiotherapist and patient, physiotherapist, nurse and patient, and the physiotherapist, doctor and patient. Communication formed part of the information-gathering process and was also part of the information processing cognitive activity. The differences observed in the communication between the participants with the patient, the nurse and the doctor were individual and highly specific to the context. The participants demonstrated individual variations but overall the physiotherapist must be able to converse with the patient and establish rapport. Sue, Jenny, Kate, Sarah, and Jane demonstrated empathy and they were sensitive to the patient’s problems and respectful of his wishes. Anne, Louise, and Jo demonstrated in their communication with the nurse, how they respected her knowledge of the patient and used her to verify their thought processes and clinical judgement. Jenny and Jo demonstrated how they used the doctor to help them confirm their clinical judgements. This communication with the patient validates the use of simulation for this study and the debrief interviews confirm how engaged the participants were during the simulation, which suggests that simulation is an effective medium for this kind of observational research and if used in a similar way, it will also have benefits for teaching if students are fully immersed in the scenario, thus aiding their memory storage for future clinical practise.

The findings indicate how complex clinical reasoning is and that the process may not be as straightforward as the hypothetico-deductive and the five-rights models suggest. The individual differences demonstrated by the participants during the assessment and treatment of the simulated patient can be compared to the strategies described by Edwards et al (2004). I have extended the collaboration to show the different emphasis given by the participant with the patient, nurse or doctor and these have been summarised in Table 4.8.

Table 4.8: Summary of the clinical reasoning strategies used by the physiotherapists (the tick represents that it was seen)

Participant	Diagnostic	Procedural	Interactive	Collaborative With patient	Collaborative With nurse	Collaborative with doctor	Teaching	Predictive	Ethical Pragmatic	Narrative
Anne	✓	✓	✓		✓		✓	✓	✓	
Sue	✓	✓	✓	✓	✓		✓	✓	✓	✓
Jenny	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Kate	✓	✓	✓	✓	✓		✓	✓	✓	✓
Sarah	✓	✓	✓	✓	✓		✓	✓	✓	✓
Louise	✓	✓	✓	✓		✓	✓	✓	✓	
Jane	✓	✓	✓	✓	✓		✓	✓	✓	
Jo	✓	✓	✓			✓		✓	✓	

Conclusions

This chapter has presented the findings from the analysis of the video data and written transcripts using the framework approach. I have shown that the clinical reasoning demonstrated by the eight participants shares some similarities with other clinical reasoning models (Jones et al, 2000; Levett-Jones et al, 2010; Groen and Patel, 1985; Croskerry, 2009). The main differences to these models have also been discussed and new insights into the clinical reasoning process have been presented. This study has helped me to understand more about the clinical reasoning being used by expert cardiorespiratory physiotherapists and in the next chapter I discuss the educational implications from these findings and how they contribute to the development of teaching clinical reasoning using simulation.

Chapter 5: Discussion

Introduction

In the previous chapter, I presented the findings from a clinical perspective and discussed their relevance to other models of clinical reasoning. From my interpretation and synthesis of these findings, I have developed a conceptual framework for clinical reasoning in cardiorespiratory physiotherapy (see section 4.2). Having gained greater insight into the clinical reasoning of experts, I draw out the educational implications and look at which of these concepts from the study may be facilitated. In this chapter, I relate the findings to the four key concepts that are required for clinical reasoning: knowledge development; knowledge storage and retrieval; information processing and cognitive skill development; metacognition and reflection. I propose a conceptual model of how clinical reasoning may be embedded into a simulated learning session and I propose a learning trajectory with a supporting module plan that will facilitate the development of clinical reasoning in undergraduate physiotherapists and thus answer research questions 2a and 2b (p.62, p.63).

5.1.Educational implications from the study and how simulation can support the development of clinical reasoning

5.1.1 Knowledge acquisition, storage and retrieval

As soon as the physiotherapists walked onto the HDU in this study, they began to seek information about the patient. They did this simply by observing the surroundings, discussing the patient with the nurse and looking at the patient's notes and charts. They appeared to process this information quickly, thereby comparing this scenario to their knowledge and previous clinical experiences. Certain information acted as 'triggers or cues' for this knowledge to be retrieved from their memory, which was evident in the think-aloud data and also in the debrief interviews when participants admitted they began to identify cues and triggers almost immediately.

It has been recognised that what distinguishes the novice from the expert is the ability to activate the relevant knowledge quickly and appropriately. Hislop (1985, p.29) states, "clinical decisions are based on knowledge readily understood, readily recalled and commonly encountered". The educational implication from this is that to prepare physiotherapists to be able to reason, educators must first ensure the students have the appropriate knowledge base to which they can refer and recall quickly at the right time. The participants in this study demonstrated that they had knowledge of: the cardiovascular and respiratory systems; the type of surgery; the effect that surgery and reduction of mobility can have on the lungs; pharmacology; and an ability to recognise the signs and symptoms of respiratory deterioration and cardiac compensation. Therefore, this is the essential knowledge for being able to reason through a case such as this. Further to teaching this knowledge, educators need to consider how it gets stored in a meaningful way so that it can be retrieved when exposed to a similar trigger again. Some theories of learning (see section 2.5.1) are based on the interaction among three memory systems and the processes that move information between them: the visual and auditory sensory memories; working or short-term memory (STM); and long-term memory (LTM) (Clark and Harrelson, 2002). The sensory memory retains an exact copy of what is seen or heard (visual and auditory) for a very short time interval, an average duration of 500 milliseconds and selective attention determines what information moves from sensory memory to short-term memory. The STM provides a working space for short computations; it is thought to be able to store seven pieces of information (Miller, 1956). The STM is vulnerable to interruption or interference and can only hold information for three to twenty seconds. STM is most often stored as sounds, especially in recalling words, but may be stored as images which it then transfers to other parts of the memory system or discards it. The LTM is relatively permanent storage. Information is stored on the basis of meaning and importance. The progress of information through these storage systems is often referred to as the Information Processing Model (Marzano, 1998).

The fact that the STM can last between three to twenty seconds (Miller, 1956) suggests the STM is the central processor for learning and thinking. For learning to occur, new sensory information from the visual and auditory systems must be integrated into the STM to form a coherent idea (Clark and Harrelson, 2002). These ideas must be rehearsed in STM in a way that integrates new ideas into existing memories, the so-called schemas in the LTM as encoding or knowledge encapsulation. Boshuizen and Schmidt (1992) first proposed knowledge encapsulation to explain how biomedical knowledge becomes incorporated into clinical knowledge as an outcome of experience and training. This process is essential for clinical reasoning as LTM has a large storage capacity. However encoding into LTM is not sufficient, as this information must also be retrieved into STM when needed to perform a skill or task. This final stage is the cognitive basis for the transfer of learning. Several critical processes can help the transformation of sensory data into retrieving knowledge into LTM. They include attention, rehearsal in STM, retrieval from LTM and metacognitive monitoring. Because STM has a limited capacity and accepts data from the environment and from the LTM, attention is the psychological mechanism used to narrow incoming information to accommodate limits of working memory (Clark and Harrelson 2002).

In this study, the simulated patient and simulated environment provided auditory and visual stimuli that appeared to enter the STM and trigger the retrieval of encapsulated knowledge from the LTM as was illustrated by the participants' immediate questioning in response to the nurse's handover. The educational implication from this finding is that we need to get the students' attention focused on the elements in the environment that are relevant to learning and filter out irrelevant elements (Clark and Harrelson, 2002). My proposal is that by using a simulated case study to replicate a patient's signs and symptoms, the visual and auditory memory of students could be facilitated. By encouraging them to think-aloud about what they are observing, the encoding from the STM to the LTM could also be facilitated. Then, through rehearsal and practice of simulated scenarios, the associations required for memory storage could be improved and this could also facilitate the development of pattern-recognition (Groen and Patel, 1985) or illness scripts (Boshuizen and Schmidt, 1992). Simulation, by creating a credible and meaningful learning experience, may therefore facilitate the storage of knowledge in the LTM in patterns, which can then later be retrieved, if triggered by cues when later exposed to a similar event (see Figure 5.1 information processing).

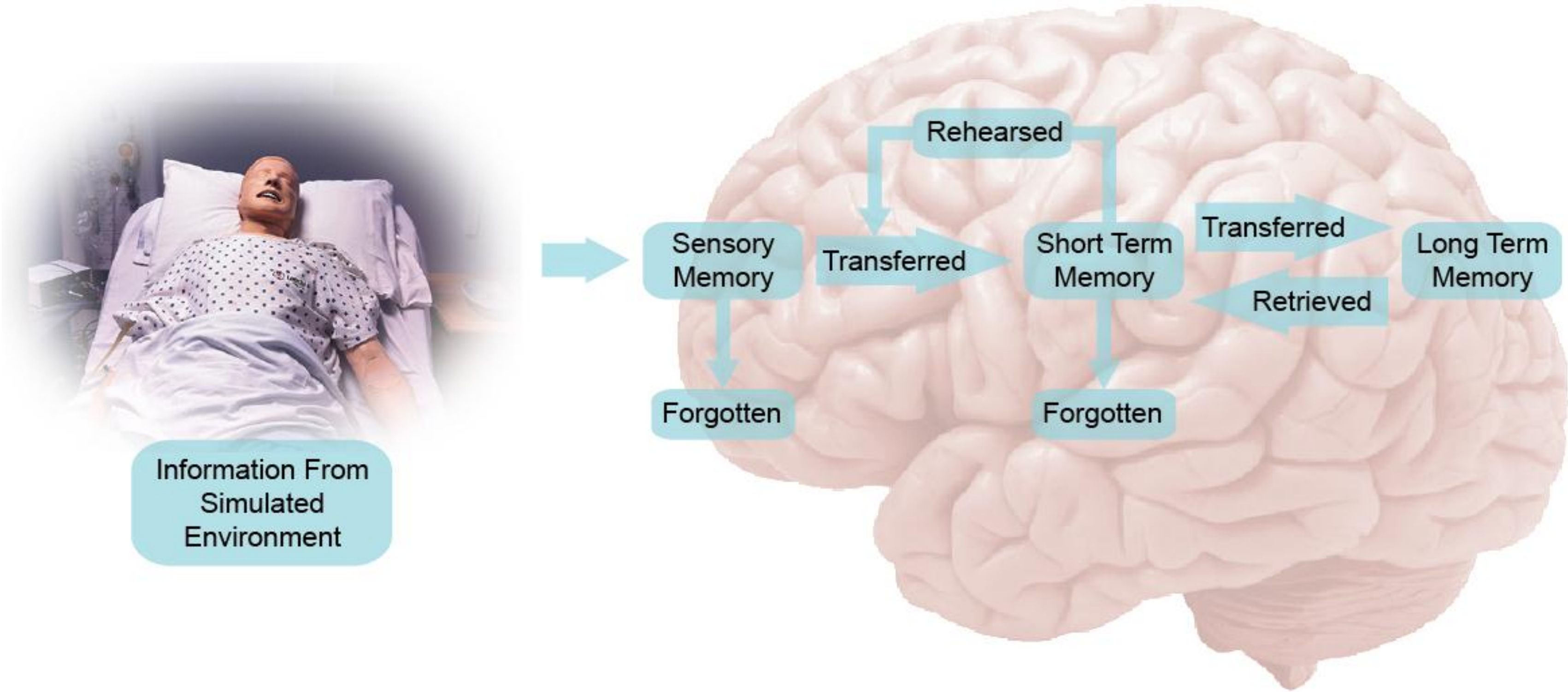


Figure 5.1: An adaptation of the Information processing model, (Marzano, 1998) to illustrate how the simulation may facilitate transfer of learning.

An example of the participants' information processing was illustrated in Table 4.3, whereby all the participants responded to similar cues given by the nurse and this caused them to question the nurse further, suggesting their cognitive thought processes were immediately 'triggered' upon exposure to these cues. This finding implies that knowledge was being transferred from their LTM into their STM as in the Marzano's (1998) information-processing model. As an educator, it is important to consider how this model may also help to develop cognitive skills used in information processing.

5.1.2 Information processing and cognitive skill development

Although described as a separate discrete stage in the hypothetico-deductive and five-rights clinical reasoning models (Jones et al, 2000; Levett-Jones et al, 2010), in this study it appeared that information processing occurred simultaneously with information perception and also occurred continuously throughout the assessment process. The think-aloud data illustrated how the participants were picking up on initial cues and triggers from the situation, the nurse, the patient and the notes and then they started to ask specific questions, thereby demonstrating how they began to process this information almost immediately. The educational question from this finding is: how can we facilitate the students' ability to process information more expediently and assist them to recognise cues or triggers when they have limited clinical experience? One important strategy for addressing this learning need is to support the development of students' cognitive processing. This study has shown that several common cognitive processes were being used: recognition or acknowledging; discrimination or distinguishing; matching or comparing; relating or connecting; inferring and implying (see section 3.3.2). The physiotherapists used these cognitive processes repeatedly throughout the assessment process (see Table 3.2). There also appeared to be an order in how these processes were being used so that once there had been recognition of a sign or symptom, it was followed with matching, relating and inferring to other information about the patient and to normal physiological values.

To develop their cognitive skills and processes, students must have knowledge of the normal physiological variables and understand their significance in monitoring a patient with a cardiorespiratory condition, for example, the colour of the patient's lips which may be blue due to a lack of oxygen (cyanosis), their respiratory rate, and their heart-rate which may be elevated and their oxygen saturations which may be lower than normal. These are key objective parameters that can indicate if a patient is deteriorating. In the current study, these variables were particularly evident at the time of the critical event (desaturation), and were used by the physiotherapists to determine the level of the patient's deterioration in order to predict and know-how to respond. To be able to do this, participants matched the values of oxygen saturation levels on the screen with known normal values. The speed and manner in which the participant responded, further suggests there is an element of predictive reasoning occurring as discussed by Edwards et al (2004).

In this study, the speed of the expert did vary, as Anne and Jenny were slower to respond to the desaturation event compared to the other participants (between three to five minutes respectively). Possible explanations could be that they did not perceive the desaturation to be that serious, as the drop in the oxygen saturation level was small and had occurred previously in the early hours of the morning. Alternatively, the variation may suggest that these two participants were not fully immersed in the simulation and did not perceive any threat to the patient, as he was not real or that their clinical reasoning was less well-refined. Whilst this may appear to be a shortcoming of these physiotherapists, it actually highlights the necessity to practice predictive reasoning and this too can be rehearsed and modelled when teaching students, if using a simulated patient. This finding suggests that if students are provided with opportunities to use these key cognitive processes of recognition, matching, discriminating, relating and inferring we will support the development of their cognitive processing skills. For example, if we use this case study again with the clinical signs of the drop in saturation, increased oxygen requirements, decreased breathe sounds and the altered chest x-ray image (which are all signs of reduced lung volume which can lead to a compromised respiratory function post-operatively), then it would enable them to rehearse their cognitive skills and be able to identify the patient's problems without any harm coming to a real patient. This experience will aid the development of cognitive processing skills and it will also reinforce their pattern-recognition, and LTM knowledge storage so that if they are then faced with a real situation in clinical practice, they will be able to respond quickly and appropriately to a real clinical situation. As Shoemaker et al (2009, p.17) purport: "it appears that even one session using a high fidelity human simulation (HFHS) as a laboratory activity can have substantial impact on students' perceptions and confidence prior to entering an acute clinical experience".

5.1.2.1 Synthesis and Hypothesis Formation

Following the initial information processing, in which the participants discussed the patient with the nurse, it was observed that some of the participants began to form an early hypothesis. This demonstrates how they were beginning to collate the information to create their own interpretation of what was happening. This early hypothesis formation could be evidence of how these physiotherapists began to create their own patterns that were later reinforced or modified as they gathered more information. Anne, Jenny, Kate, and Louise all acknowledged in their debrief interviews that they formed preliminary hypotheses prior to examining the patient. For example:

> *I guess I went in to assess physically knowing what I might expect, from the notes and by speaking with the nurse and the patient I had an idea but I might not be right. He [the patient] was breathing shallowly, some atelectasis, developing a chest infection; really uncomfortable if I could get him comfortable then I could reverse some of those. [Anne]*

Jenny used a combination of hypothesis formation and synthesis; stating:

> *... he had a respiratory problem probably a lower respiratory tract infection, there were more positives for this system e.g. Chest x-ray , auscultation, cough and productive cough. [Jenny]*

She further discussed how she had weighed up the different factors:

> *... the fluid balance had also been considered as very positive but the other facts swayed the diagnosis to be sputum retention secondary to his surgery".*

Jenny recognised that sometimes a hypothesis is formed very early:

> *... you know before you go in that the patient has had surgery and you know he's not moved and you walk on and you know it's a surgical unit you already have slightly coloured spectacles on [Jenny]*

This also suggests that some inductive reasoning was occurring (as previously mentioned in section 4.1.3) Louise said that she responded to initial information perception and recognised "triggers" which led her to form a hypothesis:

> *... he had chest infection, don't get a temp or white cell count increase, but get increased oxygen requirements with a chesty cough. [Louise]*

Louise demonstrated evidence of synthesizing information from the notes and his charts for further supporting evidence of his oxygen saturation drop and also what was also happening at that time with his heart-rate, temperature, oxygen, and what his arterial blood gases were like before and after the deterioration and she also checked the chest x-ray at the time. Her account indicates how she was synthesising all this information and starting to form a hypothesis of a chest infection.

> ... *his smoking history, his age, that he was active prior to surgery and had a normal weight, and that he had recovered from B cell lymphoma last year [Louise]*

She then started to examine the chest and because his saturations dropped, it caused her to respond to the acute deterioration and she started to treat him based on her initial hypothesis of a chest infection.

The evidence suggests that some ‘triggers’ or ‘cues’ stimulate the recall of knowledge, which is then used to build a picture or a collation of information that for some physiotherapists is summarised as a hypothesis, for others it is a synthesis of all the problems. The educational implication is that we can encourage and facilitate students to synthesise the facts and develop initial hypotheses that inform their diagnosis or problem lists. Educators could encourage students to do this by using the ‘analysis tool’ (as described in section 2.3.4) or a mind-map (Buzan and Buzan, 1996, as described section 2.5.1).

5.1.2.2 Communication skills

An interesting observation from the videos is how and when the physiotherapist chose to communicate with the patient. It is acknowledged in the hypothetico-deductive model that physiotherapists must develop a rapport with their patient for collaboration to occur. In this study, all the physiotherapists created some level of rapport with the patient; some did this quickly, for example Sue, Kate and particularly Sarah (who did this within two minutes and forty-two seconds), whereas the other five participants took longer, after they had read his notes and were beginning to assess him (see section 4.1.2). This may be explained by the simulated experience and or the participant's own preference in how they sequence their assessment. The timing of when to speak to the patient and find out his perception of the situation may not be of significance, but what is important to recognise is that the patient's perspective must be gained where possible. This requires the physiotherapist to have good communication skills to see things from another's perspective and have emotional and social capabilities (Smith et al, 2008). Collaborative and interactive reasoning strategies were identified by Edwards et al, (2004) and are important in establishing an on-going rapport with the patient.

Good communication skills are another significant finding in this study that has not previously been discussed within the cardiorespiratory physiotherapy clinical reasoning literature. The educational implication is that educators need to encourage students always to try to speak to the patient directly, if possible. As Jenny said, the way the patient spoke, also gave her significant information relating to his condition particularly, how short of breath he may have been and also how alert he was. Students need the opportunity to practice and rehearse their communication skills in many different environments, and client groups, and not think there are any exceptions to this. Currently, communication skills are not being given sufficient attention within our physiotherapy programme and are only given a few hours as part of formal teaching prior to clinical placement.

This study has shown that incorporating the patient voice with the manikin can give a real context to the scenario and this will give students the opportunity to develop their emotional cognitive skills and active listening skills. Sue, Kate and Sarah were particularly empathic with the patient and demonstrate this during their encounter with the simulation. Overall, the physiotherapists in this study all demonstrated a caring, considerate, kind, and thoughtful, empathic and occasionally humorous interaction with the patient. These behaviours all contribute to the development of a rapport with the patient and illustrate that the simulation was realistic. Again this professional behaviour can be rehearsed and practised by students using simulated scenarios. See Table 5.1 Extracts from the participants' transcripts to illustrate some of the common behaviours observed.

Behaviour	Example from transcript
Care and consideration	*"would you like a bit more mouthcare?" [Jenny] [Sue] [Sarah]* *"if you get a bit of sleep now" [Sue]* *"has the paracetamol helped?" [Anne]* *"shall I just hold your tummy?" [Anne]* *"Ok so we need to get you some more pain relief" [Sue]* *use a towel to support tummy when coughing [Kate]* *'good see your getting the hang of it now, its helping you to do things when you get sore that's when you need to top it up [Sarah reinforces using the PCA for pain relief]*
Encouragement and reassurance	*"that's really good try and support your wound and do that again for me, go on you can do it" [Louise]* *"your in a safe environment, we're all here to help you. You have fantastic nurses looking after you, your quite safe" [Sarah]* *"...well done you've worked really hard" [Louise]* *..."having the pain control is not going to stop you going home, what we need to do is get your chest better...you're not going to get addicted to it or anything like that... your monitored by the Dr's so if your in pain use it...its probably more beneficial ...[Jane]* *..." lot's of patients have a PCA after surgery, it only gives you a tiny amount every time you press it so you build up your pain relief...[Jo]*
Empathy	*"...yeah, I've heard you've had a bit of a rough night... I understand that lots of people have been to see you, we're all trying to get you more comfortable" [Jane]* *"...yeah, I know it's probably the last thing you feel like doing...[Kate]*
Humour	*Sarah has been explaining about using a machine called the Bird to the patient but unfortunately she is unable to use it the patient makes a joke about the birdy flying away and she answers "yes the birdy has flown away"* *Kate and the patient joke about being forgetful ..."but you've probably got more of an excuse than me though"... [Kate]*

Table 5.1: Extracts from the participants' transcripts to illustrate some of the common behaviours observed.

5.1.2.3 Forming a diagnosis

When the participating expert physiotherapists had gained sufficient information and had developed a preliminary hypothesis, they moved onto examine the patient to gather more information. They collected information either by assessing each system: respiratory, cardiac, renal and neurological or by going through the Airway, Breathing, Circulation, Disability, and Exposure ABCDE assessment (McQuillan et al, 1998) to help confirm or refute their initial hypotheses. However, as soon as the physiotherapist started to examine the manikins' chest with auscultation as part of the examination of his breathing, the oxygen saturation levels deteriorated and the patient's breathing became more laboured. This imposed an acute situation, which needed to be dealt with promptly by the therapist to prevent further deterioration of the patient, such as a respiratory arrest. This is an illustration of predictive reasoning, as the physiotherapists responded immediately to the acute situation. It also illustrates ethical reasoning as the physiotherapists acknowledged that they could do something to prevent any further deterioration of the patient, i.e. they acted out of a duty of care for the patient (deontology). As part of this quick thinking, the physiotherapists had to form a diagnosis about the patient's condition and what was best to do in this situation.

Most of the physiotherapists discussed the situation with the nurse and some also with the doctor, illustrating how a collaborative approach is often taken with an acute problem in this setting. This social influence on decision-making has been described previously in multi-disciplinary settings, such as intensive care units. Patel et al (1996) reported that where multiple players were involved in decision-making, the process and outcomes were influenced by the urgency of the situation and the hierarchy and social structure of the organisation. Similarly, Smith et al

(2008 p.97) “found that practitioners referred aspects of their decision-making to others in the context, particularly when a decision was difficult to make, used chatting with others to generate novel perspectives, and anchored their decision-making to decisions others had made in the past”. The educational implication from this is that we have an opportunity to create inter-professional scenarios and thus provide students the opportunity to rehearse and practice their own professional behaviour and also collaborative decision-making.

5.1.2.4 Taking action and intervention

As discussed in chapter 4, the physiotherapists responded to the acute desaturation and demonstrated their procedural and clinical knowledge by suggesting treatments such as increasing the patient’s oxygen by using a re-breathe bag, increasing his pain control, applying suction to help clear his secretions, encouraging deep breathing exercises to improve his oxygen saturations, encouraging coughing to clear secretions, and other possible adjuncts such as the Bird, Continuous Positive Airways Pressure CPAP, and Positive Expiratory Pressure PEP (see operational definitions). The physiotherapists made their own judgement as to what treatment they felt would be most beneficial and all were appropriate choices. The educational implication from this is that if a simulated scenario is used with the students, it would give them an opportunity to practice different treatment approaches and, as the educator facilitating the simulated session, I can mimic either a positive or negative response with the manikin. Students can practise clinical techniques, explaining how a technique works to the patient, and evaluate its effectiveness so that they can gain valuable feedback without causing harm to a real patient. There is also an opportunity for reflection-in-action and after-action about the choice, execution and effectiveness of the treatment.

5.1.2.5 Evaluation-Information gathering and processing

Both during and after the intervention (whatever treatment had been applied), the physiotherapists gathered information about the effect it was having on the patient's status. This finding correlates with both the hypothetico-deductive model and the five-rights models (Jones et al, 2000; Levett-Jones et al, 2010). The physiotherapists gathered new information from the patient to see how they responded to the applied treatment. This evaluation, together with planning the next intervention, was based on these findings. Unique qualities of the individual physiotherapist such as their personal frames of reference, their individual capabilities, their self-efficacy, confidence, experience and level of expertise (Smith et al, 2008), are recognised here and the context of the situation. The physiotherapist used their previous experience and knowledge to reflect on the effectiveness of their intervention in order to plan future care. When teaching students, we can encourage them either to communicate verbally or to practice writing-up clinical notes at the end of the treatment session, to give them valid feedback.

5.1.3 Metacognition and reflection

All the participants in this study took part in a debrief interview (as explored in section, 3.1.5), which provided an opportunity for reflection. As described in the models of clinical reasoning in the literature review, both metacognition, the thinking about one's thinking (Higgs and Jones, 2000) and reflection (Levett-Jones et al, 2010) are recognised as qualities required for effective clinical reasoning to take place. This is because reflection and metacognition are believed to enhance the connection of knowledge and cognition, and deepen learning (Moon, 2004). Reflective practice is the active engagement in this process including reflection in-action, and evaluating reflection on-action and re-conceptualising thinking differently about the situation as a result of the experience that has been reflected on (Schön, 1983, 1987). Reflection can either be done by the individual or it can be a facilitated exercise such as the debrief interview. The latter is normal practice following simulation and was used in this study, unlike other teaching methods, which do not create or allow this opportunity. “As a learning strategy, simulation accommodates review of actions, self-evaluation of own performance and others, receipt of feedback and a place to develop alternatives” (Bland et al, 2011, p. 666). “Simulation experiences can be created to promote the development of a reflective practitioner. Emphasis can be placed upon supporting the learner to plan, act (reflect in-action), evaluate (reflect on-action) and re-conceptualise a situation leading to changes in behaviour and personal values” (Murray et al, 2008, p.5). Again, I propose that this is another advantage of simulated practice over more traditional teaching methods. The other advantage of the simulation is that the software enables the actions taken during the scenario to be video-recorded; which the students can playback to review their own performance, which may further facilitate learning. I next discuss how the findings from this study can contribute to an evidence-based teaching strategy using simulation to facilitate the development of clinical reasoning in undergraduate physiotherapists.

5.2 Simulation as a teaching strategy for clinical reasoning

5.2.1 Authenticity of simulation

Gaba (2004, p.i2) states that: “simulation is a technique, not a technology to replace or amplify real experiences with guided experiences that evoke or replicate substantial aspects of the real world in a fully interactive manner”. This study has confirmed that simulation can create a realistic contextual experience and that this was a suitable medium for an observational study of this type, as it created the opportunity to study the physiotherapists without harm coming to a real patient. It also meant that participants could spend as long as they wanted to assess the patient, as there were no time constraints, as in real clinical practice.

From the debrief interviews, it would appear that the participants enjoyed their experience and commented on how realistic it was, particularly having the patient voice. The evidence from the videos of the participants’ behaviour and interaction with the patient, the nurse and the supporting peripheral equipment, suggests they were immersed in the scenario. Therefore, this study achieved the three fidelities that are required to enhance the realism of the simulation: environment fidelity; “the realism of the environment in which the simulation takes place; equipment fidelity; hardware and or software realism of the simulator and psychological fidelity; the degree to which the trainee perceives the simulation to be a believable representation of the reality it is duplicating” (Fritz et al, 2007, p.2). The five attributes of using simulation as a learning strategy, as recommended by Bland et al (2011), were also achieved in that it created a hypothetical opportunity, authentic representation of a patient, integration of three health professionals, and an opportunity for repetition and reflection. This study has therefore shown that simulation can be used for an observational study of this kind and answered research question 2(a) (see p. 62).

I next discuss how I propose to implement simulation as a teaching strategy to develop clinical reasoning skills in the undergraduate cardiorespiratory modules of the physiotherapy curriculum to answer the final research question: 2(b) (see p. 63). I begin by discussing the perceived benefits of simulation for students and why I think it will be advantageous to make this educational change.

5.2.2 Student benefits of learning through simulation

There is growing interest in the use of simulation within health care, with an increasing number of studies that have shown positive outcomes for simulation being used to “prepare nursing and allied health students with high level cognitive, psychomotor and procedural skills to meet the demands of increasingly complex patient presentations and health care system” (Blackstock and Jull, 2007, p. 3). Studies have shown that simulation has a broad range of benefits for students' learning across a wide range of health professions. Harper et al (2013) reported that operating-department students had improved self-efficacy and perceived ability in performing psychomotor activities following a six-week placement in a simulated learning environment compared with a clinical environment. Brannan et al (2008) showed that using a human patient simulator to teach nursing students about a myocardial infarction helped improve their cognitive skills compared to traditional classroom lecture. The results from a systematic review to identify the effectiveness of human patient simulations manikins (HPSMs), in the education of nurses by Lapkin et al (2010), has shown that the use of manikins improves knowledge acquisition and critical thinking and enhances students’ satisfaction with the learning. Harder (2010) also conducted a systematic review of the literature published between 2003 and 2007 on the effectiveness of high fidelity patient simulators as an education tool, and showed that simulation increased students' clinical skills performance in the majority of studies and that the students reported higher levels of self-confidence and perceived competence as compared with other education and training methods (i.e. standardized patient, traditional psychomotor skills laboratory sessions with task trainers, and computer-based programs and lectures).

Wong et al (2008) analysed a problem-based learning and teaching episode in a simulated clinical situation, using a patient actor, a nursing student and an expert clinical teacher. Conversation analysis was used to examine the scenario and this revealed six-key manifestations of learning: collection of information, data analysis, formulation of hypotheses, validation, discussion and reflection, and learning synthesis. The authors proposed that the simulated clinical environment provided realism in learning and allowed students to experience a full-range of learning issues within a short time frame. “Problem-based learning was a deliberate approach that helped students achieve the following learning outcomes: patient-focused care, student-directed learning, inductive learning and translation of theoretical knowledge into practical information” (Wong et al, 2008, p. 508). Learning was further enhanced with self-evaluation and peer analyses after the simulation. The authors conclude, “the incorporation of the problem-based learning approach can bring out the optimal effects in a simulated learning environment” (Wong et al 2008, p. 508). From this brief overview, mainly from nursing literature, it would therefore appear that learning through simulation seems to improve knowledge, psychomotor skills, levels of confidence and clinical skills. However, there is a lack of evidence of the effectiveness of using high fidelity manikins in the teaching of clinical reasoning skills to undergraduate-nursing students and further research is recommended. The key therefore is to develop a teaching framework that can develop students' clinical reasoning using simulated learning. My next step was therefore to identify if there was any relationship between the stages of the clinical reasoning observed in this study and the learning theories that could develop this process and then if there was any correlation with simulation learning theories. An illustration used by Wong et al (2008) was pivotal for me to exemplify the interrelationship of how the clinical reasoning process observed in my study could be incorporated with the learning theories of simulation, and PBL. This conceptual model is now discussed.

5.2.3 A conceptual model of teaching clinical reasoning using simulation

I have constructed a conceptual model to bring together the stages of clinical reasoning observed in my study, to show how this could be integrated into a simulated teaching session, and to illustrate the relationship with the underpinning educational learning theories. This model integrates the eight sequential stages of clinical reasoning observed in my study (see figure 4.1 p. 101) and hence incorporates the four key concepts of information perception; information processing; treatment and evaluation and reflection as discussed in the conceptual model of clinical reasoning (figure 4.2 p. 134).

This conceptual model for the simulation pedagogy that can facilitate clinical reasoning has been developed from “the framework for adopting problem-based learning approach in a simulated setting” (Wong et al, 2008, p.512). In their framework model, there is a central triangle for the scenario and the relationship between the patient, student and teacher; the patient scenario is the trigger for the PBL process. A ring, which contains six processes that the student is guided through by the teacher, surrounds this. These processes are: collection of information, data analysis, formulation of hypotheses, validation, discussion and reflection, and learning synthesis. An outer ring consists of four learning outcomes: patient-focused care, student directed learning, inductive learning and translation of theoretical knowledge into practical knowledge.

My study has shown similarities to that of Wong et al (2008) in that the six manifestations of learning are similar to the eight stages of clinical reasoning observed. I also suggest that the simulated scenario creates a learning opportunity that is similar to the problem-based learning approach. This is because the student will be at the centre of the learning activity and the educator will facilitate the students working towards understanding the patient presentation to resolve the problem. This method will combine both the adult learning theory and problem-based learning which have both previously been recommended for the development of clinical reasoning (Terry and Higgs, 1993).

In my conceptual model, I have used the central ring for the simulated patient, and the educator who acts as a facilitator with the student, the next ring indicates the eight stages of clinical reasoning (as observed in my study), in which the educator guides the student through during the simulation, and the outer ring displays the underpinning educational theories of simulation that support learning clinical reasoning (see Figure 5.2). From the simulation literature and the findings of this study, it is acknowledged that the reality of the context of the scenario is an important consideration for the teaching session and so every effort must be made to have environmental, equipment and psychological fidelity (Fritz et al 2007). Additional members of staff may need to be recruited: a nurse to look after the patient and a patient voice so as to mimic the clinical environment so as to create an opportunity for the communication aspect of the reasoning process to be facilitated. This aspect of the clinical reasoning process is not reflected in this model, but it will be the role of the educator to ensure this is incorporated into the simulation beforehand and monitor the students communication and that interaction with the patient and the other members of the team is appropriate for the scenario and appropriate for the level of the learner.

In the simulated learning session the educator works alongside the students in a similar way to PBL and guides them through the case scenario. The complexity of the scenario and the learning objectives are specific to the stage of the learner (see simulated learning trajectory figure 5.3, p. 173). In all levels, the scenario begins by focusing on the first stage of the clinical reasoning process; that is, the information perception stage (starting point 1 in figure 5.2) and students are encouraged to observe and identify the signs of the patient’s clinical status and compare these to normal values. This also facilitates the development of their cognitive processing skills, which is normally difficult to develop in a traditional classroom setting. The scenario develops and they continue with their assessment process and this can be stopped at any stage by the educator or the whole process can be run from the beginning to the end, which is then followed by a debrief to reflect on their performance. Alternatively, the educator can interrupt at any stage if and refer students back to a learning point if so required.

This conceptual model of the simulated learning can be linked with the learning trajectory and depending on the stage of the learner different parts of the cycle can be facilitated. For example, for level 4 students, the emphasis will be on learning the systematic ABCDE assessment process and finding the information from the patient, nurse (if this can be included in the scenario) notes and charts. In level 5, the ABCDE assessment process will be rehearsed again, but students will be more familiar with the process and so the emphasis will be on the ability to identify the signs and symptoms and synthesise these to form an initial hypotheses and problem list from which they can discuss a potential treatment plan. With level 6 students, this procedural knowledge will be rehearsed again with a more complex scenario and the emphasis may then be on evaluation of effectiveness of their treatment and the ability to manage the patient independently with less supervision, as if in real practice. In all teaching sessions the students will have the opportunity to reflect on their experience in a debrief and identify what went well and not so well thus developing their reflective and metacognitive skills.

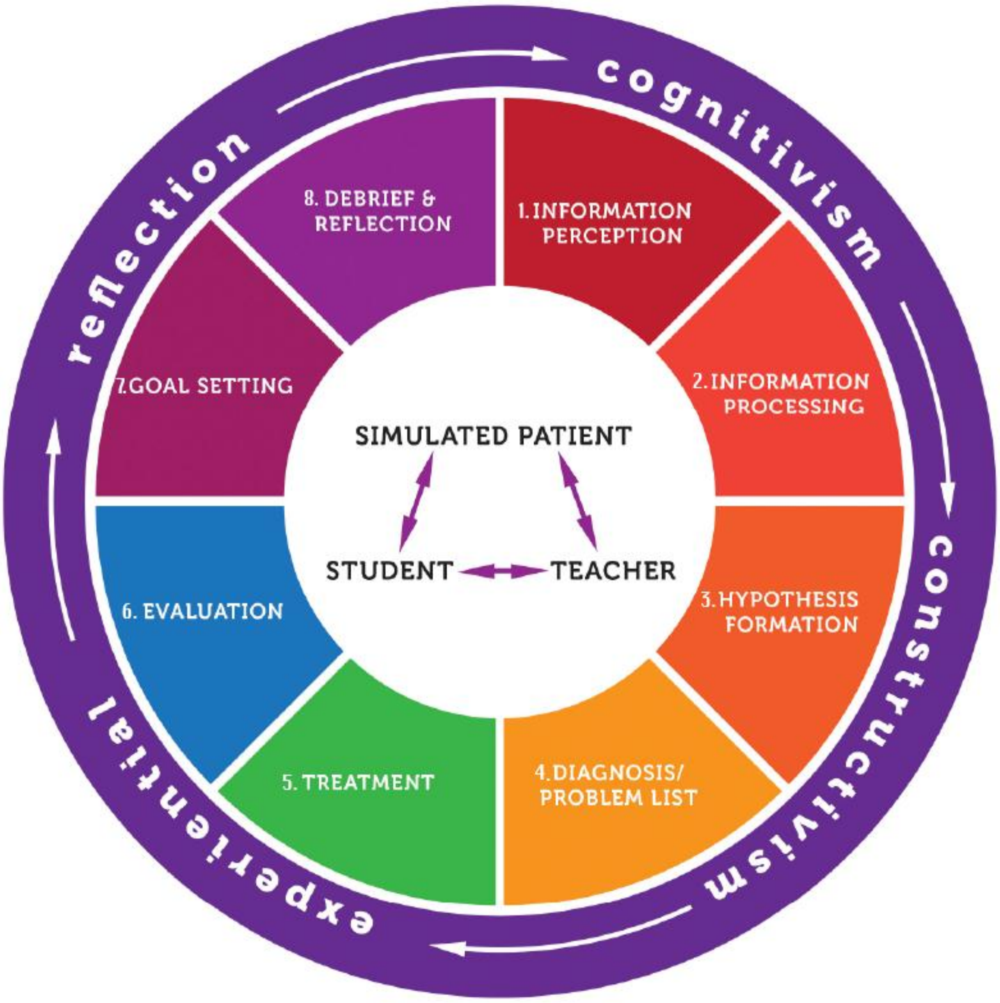


Figure 5.2: A conceptual model of teaching clinical reasoning using simulation (based on Wong et al, 2008).

I am proposing that through deliberate rehearsal and practice (Maran and Glavin, 2003, p. 22), and also because of the underpinning educational learning theories of simulation (see section 2.5.1), simulated scenarios will support the development of the four key concepts required for effective clinical reasoning: knowledge acquisition; knowledge storage and recall; information processing and cognitive skill development; metacognition and reflection. The other benefit of simulation is that it enables students to integrate their psychomotor and communication skills and by undertaking this experiential learning, they may also gain improved self-confidence prior to entering the clinical setting (Harper et al, 2013; Jones and Sheppard, 2007; Shoemaker et al, 2009).

5.2.4 Integration of simulation into the curriculum

The main aim of this study was to identify the clinical reasoning of expert cardiorespiratory physiotherapists so as to inform and develop teaching strategies to facilitate clinical reasoning. Here, I propose how to integrate simulation into the cardiorespiratory modules and combine the findings from this study with principles from:

- the Dreyfus and Dreyfus (1986) model of skill acquisition (see 2.2.6);
- Benner's novice to expert model (1984), (see 2.2.6)
- Vygotsky's (1978) zone of proximal development (see 2.5.2)
- the principles of Bloom's cognitive domain taxonomy (Bloom et al 1956); and
- the simulation-enhanced learning trajectory (Curran, 1986).

These latter two are discussed here for the first time.

According to Dreyfus and Dreyfus (1986), a novice has minimal textbook knowledge and is unable to connect theory to practice. However, by using simulation, we can create an opportunity to contextualise the learning and connect to a clinical scenario and this may accelerate their development. By also using Bloom's cognitive taxonomy and the principles of the zone of proximal development (Vygotsky, 1978), the level of complexity of the simulation can be matched appropriately to the level of the learner, so that the simulated learning experience is appropriate. This methodology can be applied over the three levels of the programme (mapping on to years one to three) until the student reaches the level of clinical competency whereby they can assess and treat a cardiorespiratory patient with a more complex presentation confidently, with minimal supervision. Thus, simulated learning activities are created that are suitable for the level of the student and that consider their underpinning knowledge, the learning outcomes and the competencies required for the module they are studying. Furthermore, simulation becomes a technique within the range of blended learning approaches (a combination of using on-line resources, lectures, seminars, practical sessions and small group work). In considering the three-year BSc programme, which has three levels of learning (level 4, level 5 and level 6), I have proposed a plan of simulated learning activities appropriate for each level that will progress the student from the novice, in level 4 of the BSc programme to achieve a level of advanced beginner, in level 6 prior to graduation. The level of competency can be assessed with appropriate assessments staged over the three levels that are aligned with the learning outcomes of the modules. I am proposing a simulation-enhanced learning trajectory for the development of clinical reasoning from level 4 to level 6 which and this could be extended to post-graduation, see Figure 5.3.

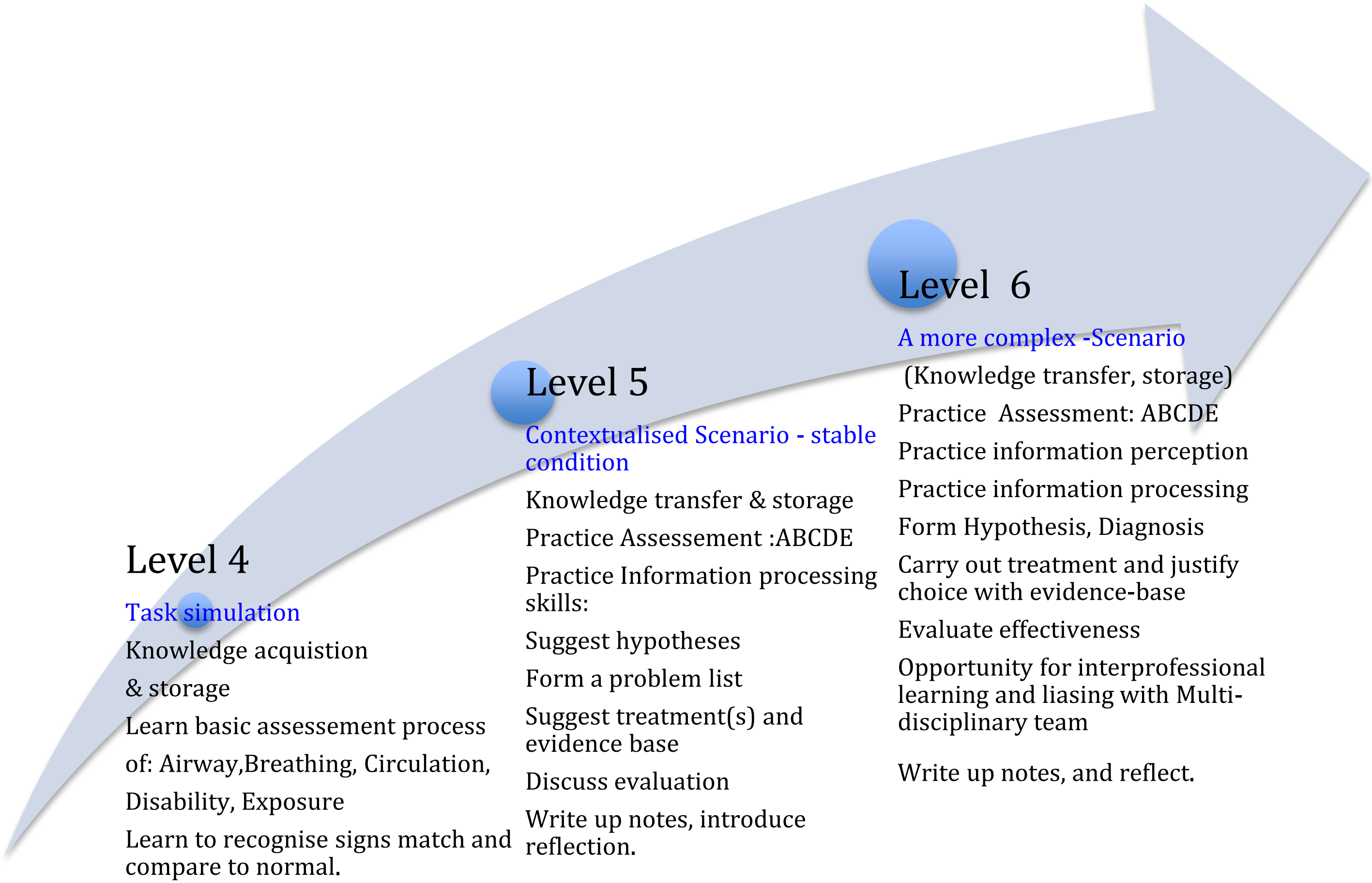


Figure 5.3: Learning trajectory for clinical reasoning over the three levels of the three-year BSc physiotherapy programme using simulation.

I have planned the simulated learning activities across the three years of the BSc programme based on Bloom's cognitive taxonomy. This taxonomy has six levels and I have aligned these to the appropriate level of the programme:

> Level 4 (year 1) students at this stage of the programme are beginning to acquire knowledge, to recall, to identify and to recognise. They are also beginning to comprehend, translate, interpret and extrapolate.
>
> Level 5 (year 2) students are beginning to apply their knowledge and transfer it to clinical scenarios: they can analyse, discriminate, distinguish and organise.
>
> Level 6 (year 3) students are beginning to synthesise, constitute, combine, specify, propose, evaluate and validate, argue, appraise and re-consider. (See Table 5.2)

Therefore to summarise: Level 4, is primarily about knowledge acquisition, recall, identification and recognition. Level 5, is about knowledge transfer, interpretation and extrapolation, a clinical application of knowledge with development of procedural knowledge, and psychomotor skill development. There is further refinement of cognitive skills so as to discriminate, or distinguish and this helps to organise knowledge further. Level 6, is about synthesis of domain-specific and procedural knowledge, and the ability to validate, argue, appraise and reconsider and further refinement of cognitive skills (this is illustrated in Table 5.2). Within each level of the programme, the simulated session has an underpinning "scaffolding instruction" whereby a more knowledgeable instructor "scaffolds or supports the learner's development" (Van der Stuyf, 2002, p. 1). The scaffold facilitates a student's ability to build on prior knowledge and internalise new information. The activities provided in scaffolding instruction are just beyond the level of what the learner can do alone (Van der Stuyf, 2002). Vygotsky (1978) defined scaffolding instruction as the role educators play in supporting learners' development and providing support structures to get to that next stage or level. An important aspect of scaffolding instruction is that the scaffolds are temporary. As the learner's abilities increase, the support provided by the facilitator is progressively withdrawn. Finally, the learner is able to complete the task or master the concepts independently (Van der Stuyf, 2002). I am proposing that the "scaffold" for each simulated learning activity will be the clinical reasoning stages identified in this study: information perception; information processing; hypothesis formation; diagnosis and problem listing; treatment; evaluation; goal setting and planning appropriate for their level of learning. By rehearsing these clinical reasoning stages in conjunction with conducting the systematic ABCDE assessment process, I anticipate that both will become more familiar, which again may have transferability to clinical experience in the future.

I have also proposed from my findings that there are four key aspects of clinical reasoning that the individual must develop: the acquisition of knowledge; knowledge storage and retrieval; information processing and cognitive skill development; metacognition and reflection. In considering the transformation from novice to expert, it would appear that these aspects can be developed and progressed with more exposure to clinical scenarios (both at university and clinically) and that the student can be stretched to deepen their understanding and through application of their learning to the clinical context, thereby moving them from novice to a competent beginner. I have summarised how the different components (level of learning; prior knowledge; Bloom's taxonomy; clinical reasoning and learning theory) have been considered to create the module plan required for the simulated learning activity for each level of the programme and each concept is illustrated in Table 5.2.

Table 5.2: Module plan of simulated learning over the three levels of the UG curriculum

This table illustrates the key concepts for the simulated learning activity and how this relates to: the learner and their pre-conceived knowledge; Bloom's taxonomy; the clinical reasoning process and the underpinning learning theory.

Level	**Knowledge**	**Bloom's Cognitive Taxonomy**	**Simulated learning activity**	**Clinical reasoning**	**Learning theory**
4 – Novice Based on Dreyfus model of skill acquisition	Domain-specific knowledge Anatomy, physiology, pathology	Vocabulary for signs and symptoms Recognise some signs and symptoms Psychomotor development	Present a simple case study prior to the simulation in which students undertake some self-directed study and or directed study about surface markings of the lungs, auscultation, hip replacements and surgical procedures and effect of anaesthetic on respiratory system. Present a simulated scenario: post-op chest infection. Students learn how to assess and listen to the manikin's chest to identify normal breath sounds and abnormal breath sounds Debrief after scenario	Knowledge acquisition Knowledge storage Cognitive skills: • Observation • Recognition Psychomotor auscultation skill Reflection	Constructivism Cognitivism Experiential Reflection

Level	**Knowledge**	**Bloom's Cognitive Taxonomy**	**Simulated learning activity**	**Clinical reasoning**	**Learning theory**
5 – Beginner Working knowledge of key aspects of practice	Level 4 Knowledge Six weeks Clinical experience (not necessarily respiratory) Some Comprehension	Application of knowledge to case study Relate transfer associated knowledge Analysis: recognise; relate; discriminate distinguish Development of procedural knowledge, Psychomotor skill development.	Introduce a case study prior to simulation for student to undertake self-directed and directed study to gain knowledge about chronic obstructive pulmonary disease (COPD) and the common signs and symptoms Come to a simulated teaching session and assess the manikin to identify the patients problems: exacerbation of COPD and retained secretions and increased work of breathing Create a problem list Suggest suitable treatment plan Discuss evidence base for treatment Debrief after scenario	Knowledge transfer Knowledge storage (potential for early pattern-recognition) Cognitive skills: observe, recognise, identify, discriminate, relate, infer Reflection	Constructivism Cognitivism Experiential Reflection

Level	Knowledge	Bloom's Cognitive Taxonomy	Simulated learning activity	Clinical reasoning	Learning theory
6 - Advanced Beginner competent good working and background knowledge of area of practice	Level 5 Knowledge + six weeks clinical experience x3 (not necessarily respiratory) Greater Comprehension Evidence base building	Synthesise combine domain-specific and procedural knowledge, ability to validate, argue appraise and reconsider further refinement of cognitive skills	Contextualised simulation Student reads patient's notes on the ward and extracts relevant information Assesses simulated scenario Forms a problem list Carries out a treatment, justifies and evaluates effectiveness Writes up notes, communicates with others in team Has a debrief after	Knowledge transfer Knowledge storage Cognitive skill development Psychomotor development Reflection	Constructivism Cognitivism Experiential Reflection

5.2.5 Possible limitations

It has been recognized that clinical reasoning and decision-making are influenced by factors in the environment (Higgs et al, 2004; Lette et al, 2003; Thornquist, 2001). "Acute cardiorespiratory physiotherapy care is rich in factors that have the potential to influence decision making. Acute care is a complex, busy organizational context that involves physiotherapists engaging in multiple interactive roles with patients and members of health care teams, while they provide care that is often urgent, multi-focused and associated with possible adverse effects" (Smith et al 2007, p. 261). This study identified three main contextual factors:

- Physical factors: equipment used such as adjuncts in respiratory care, furniture and equipment that constitute the physical environment, furniture available for all staff, structure and layout of the context;
- Organisational factors: the physiotherapists workload, formal and informal decision guidance systems, clinical pathways and protocols;
- Socio-professional factors: actions and decisions of other health professionals, availability and provision of physical assistance by other staff, gatekeeper functions controlling physiotherapy access to patients, provision of information knowledge and guidance communication and information systems and such as designated professional roles responsibilities and unique skills.

Whilst every effort was made to achieve environmental, psychological and equipment fidelity as recommended by Fritz et al (2007) and care was taken to include these contextual factors, by including a patient voice, a staff nurse and the sudden deterioration, the simulation did not fully replicate an acute clinical setting as the participants only had one patient to see and they did not have the stress of competing priorities that is common in the workplace. Smith et al (2007) identified that daily workload was a significant contextual factor and that participants reported a range of ways their decision-making was altered when they had high workloads, in that it changes their priorities of what to do with each patient and that they changed from the best management to management that will be enough for the patient. The ability to focus on the patient for the whole duration of forty-five to sixty minutes without any interruption by another member of the medical team is also less realistic than clinical practice. However, the alternative viewpoint, made by all eight participants was that the scenario was realistic; especially the inclusion of the patient voice and so they felt suitably immersed in the simulation. This can be interpreted that the environmental context was sufficiently realistic and that this scenario replicated the stress of an on-call/ out of hours scenario: as the participants had to travel to the department, without any prior information about the patient and undertake a complete assessment of the patient from the beginning in an unknown unfamiliar environment. Therefore, this study replicates more the clinical context of acute problem solving, which is required in on-call scenarios. In conclusion, context is an important consideration as a “professional’s skilful action is adapted to the context of practice and that learning from one’s practice is a legitimate source of knowledge” (Jensen et al, 2000, p. 31).

Nonetheless, whilst it is necessary to be cognisant of these limitations, it is important to reiterate that the simulated environment was chosen deliberately, so that the emphasis was on the physiotherapist and no-harm would come to any patient whilst undertaking the study.

The research has generated practical suggestions for how simulation can develop clinical reasoning in the undergraduate physiotherapy curriculum. A possible limitation of this work is that there are no other studies like this in physiotherapy and a lot of the supporting evidence has come from insights gained from theoretical and empirical literature on simulation in nursing and related disciplines. However, my work does relate to a simulation protocol based at the University of Maryland, Baltimore School of Nursing (Larew et al, 2006) that has been based on the work of Benner. The protocol utilises a cue-based system with escalating prompts to move students through recognition to assessment, to intervention and to problem resolution. It would also appear that in nursing, Tanner's (2006) model of clinical judgement has been applied to simulation learning activities. This is because so much of what simulation is, involves clinical judgement and decision-making. Tanner's description of aspects of the process includes noticing, interpreting, responding and reflecting (Hetzell Campbell and Daley, 2013). My work also has similarities to that of Fink, (2003) who discusses the significant learning experiences and has compiled six major dimensions to formulate significant learning goals. These goals include a) foundational knowledge;
b) application: enactment of the scenario allows for use of knowledge and skills in a safe environment; c) integration: synthesising the science of nursing with knowledge from all disciplines in conjunction with critical thinking this dimension incorporates decision-making and priority setting; d) human dimension: interacting with themselves and others to form a view of who they are as nursing professions including opportunities for collaboration; e) caring: the role of the nurse; f) learning how to learn (empowering students for professional lifelong learning). Therefore, there does seem to be some correlation with my ideas and the nursing literature.

My suggestions for my module design are also based on my pedagogical content knowledge (PCK). In my proposed model, I have considered the knowledge of what the students are capable of at the different levels and of their clinical learning experiences and also what we expect when the student graduates and how they need to fit into the workforce. I believe that my study, although only small in size, has the potential to change undergraduate cardiorespiratory physiotherapy education. As Hetzell Campbell (2013, p. 9) says: “simulation often begins with one faculty member in one course”. This study has contributed to understanding more about what the clinical reasoning process is and as a consequence has created an evidence-informed opportunity to change how we teach cardiorespiratory physiotherapy within the undergraduate curriculum.

Conclusion

In this study, simulation provided a contextual environment to observe the clinical reasoning of eight expert cardiorespiratory physiotherapists. This chapter provides a discussion of the findings and their educational implications and I have proposed how simulation can be used in the future to support the specific development of the four key components of clinical reasoning: knowledge acquisition; knowledge storage and retrieval; information processing and cognitive skill development; metacognition and reflection. Simulation also allows the educator to create an environment for repeated practice and guidance where the learner can be the focus of attention, which can improve their self-confidence and performance in clinical skills. Another advantage is that scenarios can become progressively more complex and I have made suggestions about how the simulation learning activities can be progressed across all three levels of the undergraduate physiotherapy curriculum to develop the students’ clinical reasoning to the appropriate level for their learning and competency as expected in the programme. The outcomes from this study and the implications for the inclusion into the undergraduate physiotherapy curriculum are innovative and current. In the next chapter, I discuss how this study contributes to the physiotherapy profession and how this work can be taken forward locally and nationally.

Chapter 6: Conclusions

Introduction

This observational study has used a simulated patient and simulated environment to answer the four research questions I set out to address. It has generated considerable insight from both a clinical and educational perspective into the clinical reasoning of eight expert cardiorespiratory physiotherapists.

Through undertaking the research, I have been able to review not only the practice of experts, but also to develop my pedagogical content knowledge and critically review my current teaching practice. As a result of this work, I have proposed a new conceptual model of clinical reasoning in cardiorespiratory physiotherapy, and I have discussed how this could be incorporated into simulated learning sessions. I have further proposed a simulated learning trajectory and a plan for teaching cardiorespiratory across the three levels of the BSc undergraduate programme to aid the development of clinical reasoning from novice to competent beginner supported with the appropriate underpinning educational learning theories.

This chapter is written in a reflective style. I begin by reviewing the problem statement, and the research questions; I next summarise the outcomes and go on to discuss how they contribute to professional practice both clinically and educationally. I consider the limitations of the study and discuss developments and recommendations for future practice and research. I end by reflecting on what I have learnt from the process of undertaking the doctorate and my future ambitions.

6.1 Why this study was undertaken

This study began from the underpinning research question: "*what model of clinical reasoning is used in cardiorespiratory and how should it be taught?"* The main aim was therefore to identify the clinical reasoning of expert cardiorespiratory physiotherapists so as to inform and develop teaching strategies to facilitate the development of clinical reasoning. There is a dearth of literature about what method of clinical reasoning is used in cardiorespiratory (see section 2.4) and clinical supervisors often complain that students have poor clinical reasoning skills on clinical placement. In response to this negative feedback, I had begun teaching some clinical cardiorespiratory scenarios using simulation and had observed that students found these sessions enjoyable and valuable in their learning. As an educator and former clinician in this field, I saw the relevance of these sessions and believed they provided an opportunity for the students to start developing their clinical reasoning prior to seeing patients in practice. However, I had no evidence for this, and therefore, taking both of these ideas into consideration, I decided to undertake this study to explore the clinical reasoning of expert cardiorespiratory physiotherapists, so as to analyse what they do and then use that information to inform future teaching practice. This led to the development of this study, in which I used the principles gained from my teaching experience, but further enhanced the simulation by using a relevant clinical case study, an actor for the patient's voice, and a nurse and doctor to look after the patient during the scenario. There are no precedents for this kind of study in physiotherapy, medicine or nursing. The study has addressed all four-research questions that were specified at the outset:

Clinical research questions:

(1a) What model(s) of clinical reasoning is/are used within cardiorespiratory physiotherapy?

(1b) What are the similarities and differences in this reasoning to the collaborative hypothetico-deductive model?

Educational research questions:

2a) How can simulation be used to explore the clinical reasoning process in expert cardiorespiratory physiotherapists?

2b) In what way can the findings contribute to an evidence-based teaching strategy to facilitate the development of clinical reasoning in undergraduate physiotherapists?

6.2 Outcomes from the study

There are seven main outcomes from this study, which are summarised below. I have:

1. designed a simulated patient and a simulated environment, using a real case study from clinical practice - the simulation achieved three levels of fidelity: environmental, equipment and psychological (Fritz et al, 2007) (see section 5.2);
2. described the clinical reasoning of eight expert cardiorespiratory physiotherapists with a mean of seven years post-graduation experience (range 3.5-16 years) in this simulated environment (see section 4.1);
3. analysed and compared the clinical reasoning of the eight expert cardiorespiratory physiotherapists in this study with current models in the

literature and shown there are similarities with pattern-recognition (Groen and Patel, 1985), hypothetico-deductive (Jones et al, 2000), five-rights (Levett-Jones et al, 2010), clinical reasoning strategies (Edwards et al, 2004) and inductive reasoning (Croskerry, 2009) (see section 4.3 and 4.4);

4. developed a new conceptual model of clinical reasoning in cardiorespiratory based on the analysis of the actions, behaviour and thought processes observed - this model has four key stages: information perception; information processing; taking action; evaluation and reflection (see section 4.2);
5. proposed that these four stages of clinical reasoning link to four key concepts that are required for effective clinical reasoning to occur - knowledge acquisition, knowledge storage and retrieval, information processing and cognitive skill development, metacognition and reflection (see section 4.2);
6. developed a conceptual model for integrating the clinical reasoning stages observed in this study into a simulated learning session and also linked this with learning theories of simulation (see section 5.2.3); and
7. developed a trajectory of using simulated learning and a module plan for teaching clinical reasoning across the three levels of the BSc undergraduate physiotherapy programme (see section 5.2.4).

These outcomes are next discussed in terms of the contribution they make to the physiotherapy profession clinically and educationally and also how the findings contribute to the evidence base of using simulation for research and teaching.

6.3 The main outcomes from the study that contribute to the physiotherapy profession

This is the first study of its kind to identify the actions, behaviours and cognitive processes that are used in clinical reasoning by cardiorespiratory physiotherapists. Previous studies by Case et al (2000) and Roskell and Cross (2001) have identified the differences between a novice and an expert, but they have not determined the model or process of clinical reasoning undertaken. Similarly, Smith et al (2007) identified the contextual factors that contribute to the clinical process observed in cardiorespiratory physiotherapists, but did not identify the model or process undertaken.

My analysis has shown that clinical reasoning is a complex multi-dimensional phenomenon that concurs with previous research in other domains of physiotherapy, nursing and medicine (Groen and Patel, 1985; Patel and Groen, 1986; Arocha et al; 1993; Jones et al, 2000; Edwards et al, 2004; Smith et al, 2007; Croskerry 2009; Levett-Jones et al, 2010). The key similarities are that all the physiotherapists went through similar stages in their assessment process and these were consistent with those in the hypothetico-deductive (Jones et al, 2000) and five-rights model (Levett-Jones et al, 2010). The overall model being used by these eight experts appeared to be a slow deductive backward reasoning process (Arocha et al, 1993) that was aided by some pattern-recognition (Groen and Patel, 1985). However, at the time of the critical incident in the simulation (due to the urgency of the situation) the reasoning was a faster or forward reasoning process (Patel and Groen, 1986, Arocha et al, 1993), which was more inductive (Croskerry, 2009) and procedural (Edwards et al, 2004) in recognition of the desaturation pattern and the potential consequences for the patient. When I compared my data with the hypothetico-deductive (Jones et al, 2000) and the five-rights (Levett-Jones et al, 2010) clinical reasoning models, I identified that there were similar stages in the process but that the overall model was not linear or cyclical as these models suggest. Instead the stages were iterative, dynamic and interrelated. For this reason, a new clinical reasoning model took much iteration because the whole process is so interrelated and dynamic. After much iteration, the conceptual model for clinical reasoning (figure 4.2 p. 134) was produced. However, it must be acknowledged, that this simple model does not reflect the complexity of the clinical reasoning process as observed in this study, as it is difficult to capture the interrelated nature of the events and the complexity in a diagram. Thus for simplicity, I reduced it to the four key stages required in clinical reasoning: information perception; information processing; taking action; reflection and evaluation which are related to the four concepts required of knowledge acquisition; knowledge storage and retrieval; information processing and cognitive skill development; metacognition and reflection (p. 132). This simple conceptual model includes a circle in the centre; which represents that the process is cyclical, and the segments are interrelated, the text describes the background knowledge or skills that are required for each stage.

One of the reasons for this challenge of producing a new conceptual model was that I had observed that information processing, which has previously been described as a unique stage in the hypothetico-deductive and five-rights models, was embedded throughout the whole process. The information processing needs to be considered within this diagram as if it is an iterative spiral whereby information builds layer upon layer through each stage of the clinical reasoning process, so that each piece of information builds upon another as in the iterative spiral as illustrated by Higgs and Jones 2000 (see p. 28). In addition, my analysis of the information processing further identified that four main cognitive processing skills are being used repeatedly throughout the assessment and the treatment. These are recognition, matching, relating and inferring. These four main cognitive skills are used repeatedly and sequentially throughout the assessment so that each piece of information builds upon another. This finding was particularly interesting as these cognitive processing skills have not been identified in any of the previous literature about clinical reasoning in physiotherapy and this finding has both clinical and educational implications.

My intention of this simple conceptual model was that it could be easily used to identify problems with a struggling student on placement. For example, it could be that a student is struggling with their clinical reasoning due to a failure in any of the four areas; a lack of background knowledge would cause difficulty for then to identify and gather appropriate information or they could be failing in the information processing through a lack of development of analysis skills which would mean they are unable to identify the patient's problems and administer an appropriate treatment which then means they fail to evaluate the ineffectiveness of their treatment and so the cycle perpetuates. Clearly, the underpinning theory of this simple conceptual model would need to be disseminated before it can be employed by clinicians and/ or teaching staff to facilitate and improve a student's clinical reasoning. The original conceptual model of clinical reasoning (see figure 4.2 p. 134) has been re-designed to illustrate that information processing (which uses the cognitive skills of recognition; matching; discriminating; inferring; and predicting) is used repeatedly throughout all four stages of the clinical reasoning process (see figure 6.1 a conceptual model of clinical reasoning in cardiorespiratory physiotherapy).

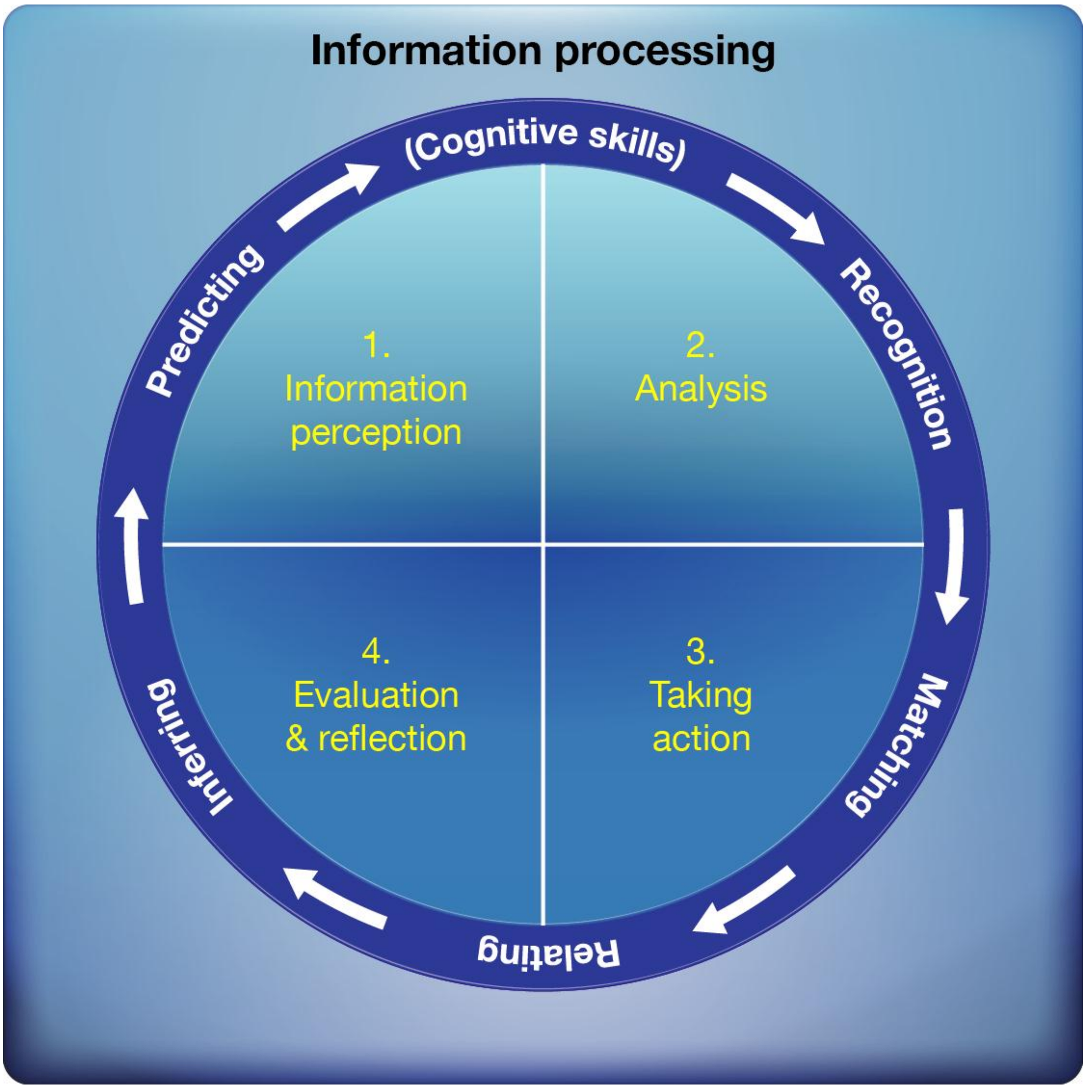


Figure 6.1: A new conceptual model of clinical reasoning in cardiorespiratory physiotherapy.

The identification of these key cognitive processing skills also seemed to explain how pattern-recognition, described by Groen and Patel (1985) and Boshuizen and Schmidt (1992) as being a component of the experts' clinical reasoning, could be developed. Pattern-recognition has been proposed as the reason why expert cardiorespiratory physiotherapists can reason more quickly than novices (Case et al, 2000). These authors hypothesised that experts develop pattern-recognition through knowledge encapsulation (Boshuizen and Schmidt, 1992). This occurs when theoretical knowledge is integrated with experiential knowledge to form a more organised knowledge base. As pattern-recognition was also evident in my study and I had seen a relationship between the cognitive processing skills being used, it led me to explore information processing further. Firstly, to understand how information is stored in the brain as patterns, schemas or illness scripts as originally described by Groen and Patel (1985) and Boshuizen and Schmidt (1992), and secondly, how this stored knowledge is accessed and used when problem-solving.

I gathered that information processing occurs through new information being received in the STM from the auditory and visual memories, which is then coded into schemata or patterns of data before being transferred to the LTM from where it can subsequently be retrieved when triggered (section 5.1.1). As part of this process, theoretical knowledge can be merged with experiential knowledge and thus both are encapsulated together and stored as a pattern.

This insight about information processing has helped confirm why the four key concepts: knowledge acquisition; knowledge storage and retrieval; cognitive processing skills; metacognition and reflection are required for clinical reasoning. Consequently, I have recognised from this insight, what knowledge students require and also that I need to actively engage students with their learning, as it is important to make the information we are giving the students interesting, and if this knowledge can be also be linked and stored as schemata, or patterns, then it is more likely to be transferred to the LTM where it can then be retrieved when triggered.

As a parallel development, students also need to develop their cognitive processing skills. This can start with simple skills of observation and recognition so that this information is encapsulated with their theoretical knowledge. For example, a student will learn the fact that a normal rate of respiration is between twelve to sixteen breaths a minute. If they observe someone breathing, and count their respirations they can compare this data to their stored knowledge of what a normal rate is. My interpretation of this finding is that: if students are taught how to store clinical signs in patterns, they may be able to transfer the information to their LTM where it can later be retrieved when faced with similar patterns/presentations with patients.

By giving information in an interesting and stimulating way through using simulation and by rehearsing these cognitive processing skills at the university, it could make their information processing more effective and similar to that of an expert; and by students actively contributing to the debriefing session after the simulation they will have the opportunity to reflect and develop their skills of metacognition. As a consequence of the simulated learning session, the student may then be better prepared for clinical placement than by traditional learning strategies.

By establishing the four concepts required for clinical reasoning, I was able to look at the underpinning educational theories of simulation to explore the potential of the approach to teach clinical reasoning. From a review of the learning theories and my pedagogical content knowledge, I designed a theoretical model of how clinical reasoning can be incorporated into a simulated teaching session (see section 5.2.3). This conceptual model of teaching clinical reasoning in simulated sessions is using principles similar to problem-based learning (Barrows and Tamblyn, 1980) in that it places the learner at the centre of the learning and the educator acts as a facilitator in the simulation, taking the student through the stages of clinical reasoning. This also aligns with the recommendation by Terry and Higgs (1993) that problem-based learning and the principles of adult-learning theory are helpful for teaching clinical reasoning to undergraduate students and helps to justify my original thoughts that simulation can promote the development of clinical reasoning. Furthermore, because simulation can replicate the clinical environment, the clinical reasoning is contextualised in an authentic scenario (Smith et al, 2007). As illustrated in my study, physiotherapists bring their own unique experience, personality and attributes to the situation as was illustrated in their communication with the patient, nurse and doctor (section 5.1.2.2). This finding also highlighted the need for the physiotherapist to have good communication skills and be socially aware, so as to work as part of the multi-disciplinary team on an HDU, (Patel et al, 1996) and simulation can help develop the communication skills of the student physiotherapist and also their professional identity. Creating authentic clinical simulations like this could also create opportunities for the development of inter-professional learning.

Following on from showing how clinical reasoning can be embedded into a simulated teaching session, I decided to take the idea further and have reviewed the cardiorespiratory modules of the physiotherapy programme. I have developed a learning trajectory that takes the novice (level 4) students through to becoming a competent beginner (at level 6 of the programme). The supporting plan for the modules incorporates progression of the clinical reasoning, with an increasing level of complexity of case studies over the three years of the physiotherapy programme (see section 5.2.4). I have stated that the progression of the learner from novice to competent beginner will occur through scaffolding the learning and deliberate rehearsal and practice in simulations (Maran and Glavin, 2003) and this will be in conjunction with their clinical placements. It is also possible to develop assessments using simulation that can be used to assess the progression of the learners and their levels of competency. (This is discussed further in recommendations for future practice).

The conceptual model of clinical reasoning, the model of incorporating reasoning into a simulated learning session and the learning trajectory using simulation across the three years, are all novel, evidence-based educational developments emerging from this study. I have therefore contributed to the physiotherapy profession, both clinically and educationally.

6.4 Limitations

Being reflective, it is important to acknowledge there are limitations to this study. The first being, that it has only included eight physiotherapists with a mean of seven years' post-qualification experience. Secondly, there are some limitations of the simulation such that, this simulation only required the physiotherapists to consider one clinical situation. Whilst this latter point has been acknowledged as being similar to an on-call scenario, this did not truly reflect the normal daily workload of the physiotherapists working in the acute environment, where they would have many patients to consider and have other priorities that may affect the clinical reasoning (Smith et al 2007). As well as these organisational restraints, there may have been other physical factors of the environment that could have influenced the decision making processes which were also excluded for example: the equipment such as the IPBB and CPAP could have been made available to add to the realism of the clinical environment. Therefore in considering these limitations, in a future study it may be necessary to have more than one scenario for the physiotherapists to assess and include more dynamics that occur in the clinical environment such as bleeps going off and other health care staff interrupting the assessment.

Thus, the transferability of these findings is limited, as they only considered one post-operative clinical scenario in a simulated environment. Therefore the findings can only make a theoretical generalisation (Yin, 2008) of what expert cardiorespiratory physiotherapists currently do and further studies are required to explore if the physiotherapists behave in the same way with a different scenario. My recommendation would be to undertake similar studies that use different case studies to see if the physiotherapists display similar actions, behaviour and thought processes and compare across all the scenarios. Alternatively, clinicians could be observed in practice and their actions compared with the clinical reasoning stages identified from this study to see if they follow a similar process in the real clinical environment. However, conducting this type of research in a clinical setting can be problematic and the consistency may be interrupted by other events that can take place in a real setting.

Secondly, my inexperience in qualitative research may have led to certain errors in the way I conducted the study and managed the data. Certainly, if I were to repeat the study, I would consider using the think-aloud again, but have a microphone attached to each participant so as to improve the quality of the sound recording so that the transcript can be generated directly from the video in Synote and this would reduce time in preparing the transcript by hand. This will greatly improve the data management and subsequent analysis.

Furthermore, I would also conduct the debrief interviews differently (as discussed in chapter 3), and in a similar way to Fonteyn et al (1993) who used the concurrent think aloud coupled with the retrospective think aloud to provide a fairly complete and detailed description of participants' reasoning during a problem solving task (see section 3.1.4). This may then have yielded more information about the actual thought processes the physiotherapists were using at the time and may have confirmed the analytical skills they were using rather than relying upon my own interpretation of the data from their verbal transcript. This data could then be used in conjunction with the video data of the actions, behaviour, and think aloud to triangulate and bring all the data together to cross-reference the same information, and this may have increased the credibility and validity of the study by giving more insight into the topic and therefore reducing any inadequacies in my primary analysis. Any inconsistencies in the data may have been minimised by this approach, thus providing a more comprehensive data analysis.

6.5 Future developments and recommendations

The future developments and recommendations derived from my findings are discussed in terms of the physiotherapy programme, the students, the clinicians, and the stakeholders (the managers of the local Trusts who take our students on clinical placement), the managers of the allied health professions at the faculty, fellow health care educators and the physiotherapy profession.

The first development following this study is to embed more simulated teaching sessions into the cardiorespiratory modules in the undergraduate physiotherapy curriculum. This is endorsed by the Department of Health in their Framework for Technology Enhanced Learning (DH, 2011), which proposes that there is a need for more simulation training to improve patient safety, outcomes and experience. This framework sets out a clear vision for technology-enhanced learning across health and social care, grounded in six key principles, whereby training using technology is patient-centred and service driven; ensures equity of access and quality of provision; delivers value for money; delivers high-quality educational outcomes; is evidence-based; and is educationally coherent. This study builds on these six key principles in that it is innovative and has produced an evidence base for teaching clinical reasoning using simulation, and has proposed a learning trajectory that is educationally coherent. Since commencing the study, I have integrated simulation teaching into level 4 and level 5 modules and the next step will be to include simulation teaching at level 6 in the undergraduate physiotherapy programme.

Following integration of simulation into the curriculum, I would recommend using it also to improve and deliver high quality educational outcomes in our teaching practice. As this study has identified the actions and behaviour of the physiotherapists and a new conceptual model of clinical reasoning, I would recommend that, in conjunction to teaching with simulation, I also develop assessments that are constructively aligned to these competencies. This study has shown how an expert can assess a simulated patient as if they are a real case study and a similar methodology can be applied to assess the student prior to clinical placement. We currently use Observed Structured Practical Examinations (OSPE), whereby the students are given three case studies to research prior to the examination, and then on the day, they have to perform and demonstrate their knowledge, comprehension and skills of assessing and treating a model as if they were a real patient (from one of the three case studies randomly selected by the examiner). This is often very difficult for the student as there is no context; the model (a student from another cohort) does not try to act or pretend to be the patient in anyway and so there is no opportunity for the students to immerse themselves in the situation and considerable performance anxiety is evident. My recommendation is that we use simulation for the cardiorespiratory OSPE as the context is more realistic, thereby activating the emotional and cognitive aspects of reasoning as was evidenced in this study. This would be a more credible way of assessing a student's professional behaviour and competencies than the current OSPE.

Following on from integrating the simulation into the undergraduate curriculum for teaching and assessment, I think that if this proves successful, then a future development from this study could be to discuss with the Association of Chartered Physiotherapists in Respiratory Care (ACPRC) about using the outcomes from this study to help design a post-graduate course to train newly qualified physiotherapists for on-call duties. My idea would be to extend the proposed learning trajectory beyond level 6 to post-registration and so create an opportunity for an educationally coherent model. This is in-line with recommendation B5c in the Framework for Technology Enhanced Learning (DOH, 2011, p. 8): "the use of simulation ... should be achievable and clearly mapped to specific learning outcomes in identified areas of the curriculum or learning framework". Furthermore, these post-graduate simulation training courses could incorporate other allied health professionals such as nursing and medical students so as to foster multi-disciplinary teamwork and this could ultimately improve patient care and safety which aligns with recommendation A 2.4 (p. 20) of the framework: “that improving patient outcomes, safety and experiences requires not only the improvement of systems of care but also the improvement of education, training and the personal development of the health and social care work force”.

To take these ideas forward will involve consultation with the ACPRC and the Chartered Society of Physiotherapy, stakeholders, clinicians and educational managers at the faculty. The aim will be to adopt a seamless approach, from undergraduate level to post-graduate on-call training and produce a national framework that all educators and clinicians can implement. Previously, there has been no accepted national minimum standard for on-call preparation, and training has been provided on an ‘ad hoc’ basis within hospital trusts. However, stakeholders may support this idea as they currently need to maintain a high quality on-call service and this situation has placed therapists in a difficult and stressful position, trying to balance a service commitment with limited training and support. These issues have been highlighted in numerous audits within practice nationally, but unfortunately few have been published. The ACPRC recognised this situation, which led to the development of an educational package “on-course for on-call” (developed by the on-call project team (Thomas et al, in conjunction with the ACPRC, 2005). This educational package aims to facilitate a more consistent approach to on-call training by setting a minimum standard of training for therapists with a respiratory on-call commitment. There is an increasing drive by the Health and Care Professions Council (HCPC) to demonstrate continuing professional development to maintain competency and link this with professional registration. This on-call educational package is currently in the process of being reviewed by the ACPRC committee and it would be timely to integrate the findings and my recommendations from this study. This topic is current, as recently there has been a new discussion on the interactive discussion forum (iCSP) about developing the on-call course into a more simulation based learning course.

The ACPRC may support this recommendation as they recently hosted a simulation workshop and the seven clinicians who participated in the simulation reported favourably about their learning experience. They reported they had learnt by participating in the scenario, by watching others and by the post-scenario debriefing. The debriefing was considered the most useful learning experience:

> Participants identified that simulation training emphasised particular issues that had not been taught successfully elsewhere including: an appreciation of the stress of a real life critical situation, the practical application of skills required in a medical emergency and the importance of non-technical skills to effective performance. (Thomas and Keilty, 2012, ACPRC website)

Similarly, a clinical colleague (E. Corner, 2013, personal communication), has recently successfully run a three-day on-call training programme where twenty-nine physiotherapists completed the training. There was an overall improvement in perceived confidence levels to manage on-call situations of 13% measured by a questionnaire. The staff also reported improved clinical reasoning, teamwork, leadership and delegation, effective communication, improved self-efficacy and specific clinical knowledge. All the physiotherapists reported that they felt that this was a much better learning environment than lecture-based, respiratory physiotherapy refresher days.

My recommendations are based on the findings from this study and could contribute to developing clinical reasoning in cardiorespiratory across the undergraduate programme and beyond into post-graduate registration. There is currently much interest within the profession in developing this type of training; unfortunately, none of these recommendations can be achieved unless there is evidence to show the cost-effectiveness, improved student learning experience and improved patient outcomes. Therefore, further studies are required to evaluate the effectiveness of using simulation as the teaching method for developing clinical reasoning. Firstly, this could be evaluated by simply exploring the perceived benefits from a student's perspective. I have used this approach to evaluate my simulated teaching sessions and received very positive feedback from the students on the BSc and MSc programmes. To quote one level 5 UG physiotherapy student:

> *... I found the simulation to be an enjoyable, effective way of learning; it helped apply my knowledge and develop my respiratory assessment skills; it developed my clinical reasoning; it improved my self-confidence. [Level 5 UG physiotherapy student.]*

Self-confidence and self-efficacy have already been shown to improve following just one session of simulation (Shoemaker et al, 2009) and this would be an important consideration in evaluating effectiveness of simulation as a teaching strategy. In addition, the views from clinical supervisors could be determined by a questionnaire to explore whether they have observed any improvements in the students' performance in clinical practice. Another method to assess if the students' reasoning improves following teaching with simulation might be to use a recognised test such as the Diagnostic Thinking Inventory (DTI) (Bordage et al, 1990, Bordage and Lemieux 1991), which is a validated psychometric questionnaire that measures the structure and flexibility of thinking in clinical

problem-solving. It has been widely used in medical and health professional education for research to help students understand their thinking processes (Groves et al, 2002). In the long-term, improved patient outcomes, safety and experience should also be evaluated
(DH, 2011) although the causal effect of the student being taught by using simulation may be difficult to isolate.

6.6 Dissemination of the findings from the study

I can see the potential of using the findings from this study and future studies to influence the design of a national framework for training cardiorespiratory physiotherapists both at undergraduate and at post-graduate levels. I am personally involved with the CSP to look at a framework for simulated practice within the undergraduate curriculum and I have delivered a presentation to fellow educators about the early findings from this study and how it can enhance teaching cardiorespiratory at an educational forum at the CSP. Now that the study is complete, I would like the opportunity to share the findings and my vision with key stakeholders such as clinicians in clinical practice, managers in practice and leaders of the physiotherapy undergraduate courses.

I have also been selected to work on a joint national project with the Higher Education Academy (HEA) and the Association of Simulated Practice in Healthcare (ASPiH) as a physiotherapy advisor. Within this role, I am beginning to foster links with other physiotherapy clinicians and educators to contribute to one of the outcomes of the project, that is: to describe good practice in terms of developing appropriately skilled faculty (educators). From this first project, further opportunities may come to gain more explicit professional recognition and organisational support for learning with simulation (ASPiH /HEA national simulation project). In the long-term, if simulation can be successfully embedded into the undergraduate physiotherapy curriculum, there could also be an opportunity to replace some clinical hours in the physiotherapy programme with simulated learning, similar to the Nursing and Midwifery Council, which allows a maximum of 300 hours of 2300 hours practice component of general nursing training to take place in a simulated learning environment (NMC Circular 36/2007). However, it is important to recognise that simulation has limitations and as stated by Hetzell Campbell (2010, p. 151) "simulation will never replace actual student contact with real patients, but it has the potential to make student and faculty time in clinical settings more valuable and cost effective."

It is important that educators recognise the limitations of simulation, as it is only a technology that can enhance learning as part of a managed and integrated learning process. Nevertheless, by developing sound national pedagogical guidelines for its use, I believe we can successfully integrate simulation into the physiotherapy curriculum and I anticipate that this research will make a significant contribution. It is, however, also important to acknowledge that not all educators and clinicians will share the same enthusiasm for this work and that to begin with there might be resistance amongst other staff and clinicians to fully embrace simulation as part of the physiotherapy curriculum. Also, managers may be against the use of the new technology because of the amount of time it takes to set up and that extra resources and staff-time are required to create the authentic environment. Fortunately, we have the equipment and facilities in place at the Faculty, but as I found, learning and maintaining skills in how to use the technology is also a time intensive activity that can distract from other duties. A pragmatic solution would be to employ technicians to look after the manikins and set up the simulations for teaching. This will mean the educator can focus on the delivery of the session rather than having to worry about whether the simulation software is going to work. It is timely that the Faculty is about to review its curriculum in 2015 and joint simulated learning sessions between the nurses and the allied health professions may be an area that can be developed, so investing in a technician to help set up these sessions would be extremely beneficial.

6.7 Reflection on my study

This study came about through wanting to know more about the clinical reasoning process in cardiorespiratory, so that my teaching reflected current practice. The idea came from my previous experience of studying for a master's degree in musculoskeletal physiotherapy in which I had explored clinical reasoning, and an awareness that no similar model existed in cardiorespiratory. I had also started to use simulation to teach cardiorespiratory skills, as I considered it a more realistic way to deliver clinical scenarios and learn clinical skills, including reasoning. Hence my thoughts became integrated and I undertook this study, but I had no concept at the time, that this study would generate such rich conceptual and empirical insights or be so clinically and educationally relevant to the profession.

My background knowledge of reasoning from a clinical perspective in both musculoskeletal physiotherapy and cardiorespiratory both contributed to my understanding of the literature and the analysis of my findings. My pedagogical content knowledge has developed, particularly in understanding more about the learning theories that underpin simulation and also my own technological pedagogical content knowledge TPCK (Koehler and Mishra, 2008) for how and why I want to integrate simulation into the curriculum. This new knowledge, combined with my fifteen years of teaching experience and my previous clinical experience of five years in the speciality, have all contributed to the development of the conceptual models and the learning trajectory.

Furthermore, my knowledge of qualitative research has greatly improved. I acknowledge the limitations of this study, but I would recommend using this methodology again; as this study has shown that simulation can be used for observational studies of this kind, as it creates consistency and a repeatable experience for participants. Simulation has not been used previously for any research of this type and hence this study was original and innovative in its design. The video-recording was beneficial in that it allowed me to watch the participant repeatedly for the analysis, which is advantageous compared to a single observation. The think-aloud gave insight to the thought processes of the participant as they occurred during the assessment which was very important for the analysis, and the debrief interviews gave further insight about the whole experience and an opportunity for the participant to reflect. Overall, this methodological approach of simulation plus the simulated HDU environment, the video-recording, the think-aloud and the debrief interview have worked to create some very rich data.

Conclusion

The major contribution of my study to the physiotherapy profession is that it has helped identify the actions, behaviour, knowledge and cognitive thought processes used by professionals working in this speciality and has started to address the gap in the literature about what model of clinical reasoning is used in cardiorespiratory physiotherapy.

Chapter 6 Conclusions

The findings have helped create a new conceptual model of clinical reasoning and have enabled me to recognise as an educator that the four key concepts of knowledge acquisition; knowledge storage and retrieval; information processing and cognitive skill development; metacognition and reflection are needed for effective clinical reasoning. I have identified that knowledge needs to be both domain specific and procedural; that four main cognitive processing skills of recognition, matching, relating and inferring are required for information processing and that these need to be used constantly throughout the assessment and treatment of cardiorespiratory patient. Metacognition is higher-level cognitive skill that can be developed through reflection after the event.

By reviewing learning theories associated with simulation, I have illustrated how using it as a teaching strategy may facilitate the development of these four areas, and I have proposed a conceptual model that links these ideas together with the stages of clinical reasoning identified in my empirical research. I have therefore produced an evidence-base that justifies using simulation to develop clinical reasoning rather than just accepting the new technology into my teaching practice. Hence this study contributes to the expanding area of research of simulation pedagogy and is the first study of its kind that has used simulation as a research medium to explore clinical reasoning. I have proposed that the conceptual model and the structure of the learning sessions across the three levels of the programme could be extended to post-graduate level and contribute to a national framework for teaching cardiorespiratory. If this happens, then this study will make a significant contribution to professional practice.

Undertaking the educational doctorate has enabled me to evaluate my current teaching practice and has allowed me to explore a topic of specific interest of professional relevance. The suggested educational approach could enable the development of the students' clinical reasoning. I recommend further studies to evaluate the effectiveness of using simulation for the students learning and also to continue to explore professional behaviour, using different scenarios with this methodology. These studies will contribute further to developing this essential skill of clinical reasoning to facilitate the student to become more confident and ultimately on graduating, to be an autonomous practitioner so that they can deliver safe and effective care, which can potentially improve patient outcomes in the long-term. Simulation is a technology, but it is how we use it that needs to be embraced. Educators need to continue to strive to enhance the quality of education training and the development of physiotherapy students and to work in partnership with other allied health professionals for the ultimate benefit of patient care.

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Appendices

Appendix 2.1 A summary of learning theories and their application to simulated teaching sessions and the development of clinical reasoning

Teaching strategies suggested to teach CR & underpinning educational theory	Relevance to CR	Evidence for
Adult learning (Knowles, 1970)	Student is Autonomous & independent; self - motivated	Adult learning suggested as a way to teach CR by (Refshauge and Higgs, 2000, Terry and Higgs, 1993) No supporting evidence of effectiveness in literature
Problem based learning (Barrows & Tamblyn, 1980) Learning that results from the process of working toward the understanding or resolution of a problem (based on constructivist learning theory Dewey, 1938)	Analytical problem solving.	PBL recommended as a teaching strategy for CR – No supporting evidence of effectiveness in literature
Integrative curriculum Various innovative teaching and learning methods (based on constructivist learning theory Dewey, 1938)	Constructivist educational theory may help student to problem solve.	IC suggested by Refshauge and Higgs, 2000 Different teaching activities suggested to promote CR No supporting evidence of effectiveness in literature
Reflection (Schön, 1987)	Reflection on an event, analysing and trying to understand the meaning from the event (based on Reflective practice Schön 1987)	Reflection through writing, verbalising Supporting evidence of effectiveness: Schön, 1987)
Concept mapping/ mind mapping (Buzan and Buzan, 1996**)**	Assimilating new concepts in circles or boxes creating hierarchical arrangements between concepts and sub concepts that can be connected with lines or linking words May help with cognitive analytical skills, lateral thinking or interconnections	Supporting evidence of effectiveness in nursing literature (Cahill and Fonteyn, 2000).

Appendix 2.2 Educational theories and how they support simulation as a learning strategy for clinical reasoning

Learning theory		Application	
		Simulation	**CR**
Adult learning	Adult learning philosophy, student at centre of their learning, motivated and autonomous.	Students are at centre of the learning, educator acts as a facilitator during simulation. Student has access to other resources to support learning outside of the session.	Terry and Higgs, 1987 proposed an adult learning approach for developing CR.
Behaviourist	Environmental stimulus conditions and reinforcement promote changes in responses.	Students can practice behaviour of an expert: constructive feedback given during simulation and in debrief. Opportunity for repetition and rehearsal if incorrect.	Students may learn CR behaviour from facilitator or expert clinician.
Cognitivism	Internal perception and thought processing within context of human development promote learning and change.	Educator structures simulation session to encourage organisation of knowledge and uses principle of scaffolding (Vygotsky, 1935).	Knowledge acquisition and storage essential for CR.
Constructivism	Learners construct knowledge themselves: each learner individually & socially constructs meaning as he or she learns. Learners are self directed; creative and innovative, they learn by being hands on and by experimentation, learners are left to make their own inferences discoveries & conclusions to solve problems.	Student brings their own unique experiences to the simulation and builds on them learns in an environment that is perceived to be safe through rehearsal & practice. This builds confidence (Harper et al, 2013, Bradley and Postlethwaite, (2003 a).	Self directed learning part of adult learning approach proposed by Terry and Higgs, 1987. New knowledge is acquired or theoretical knowledge is combined with procedural, practical knowledge, which if processed together can be stored in long-term memory as a pattern and this can be retrieved later in clinical practice.
Experiential	Concrete experience, observation and reflection, the formation of abstract concepts and testing in new situations	Learner is at the centre of learning and is learning through their experience of the simulation that mirrors clinical practice.	Experience becomes encapsulated with previous knowledge -which can be stored as patterns in the long term memory essential for CR which can later be

Learning theory		Application	
		Simulation	**CR**
		Simulation may provide opportunities to for experiences not encountered on clinical placement.	retrieved when required clinically.
Social constructivism	Role of interaction in helping learners to construct their new understanding	Learning in relevant clinical context and with others. Bradley and Postlethwaite, (2003 a).	CR is Contextual (Smith et al, 2007)
Situated learning	Puts an emphasis on the importance of the social context of learning: Encourages learner to arrive at his /her version of the truth influenced by his/her background culture (previous experience) effective learning occurs through social interaction, collaboration & negotiation	Learning is in relevant clinical context and can incorporate others e.g. patient voice, and other health professionals so the learning experience is seen as participating in the real world of medical provision for patients Bradley and Postlethwaite, (2003 a)	CR is collaborative with the patient and other health professionals (Higgs and Jones, 2000)
Reflective practice	Reflection- in-action occurs immediately it is the ability to learn and develop continually by creatively applying current & past experiences and reasoning to unfamiliar events while they are occurring. Reflection- on-action is a process of thinking back on what happened in a past situation what may have contributed to the unexpected event whether actions taken were appropriate and how this situation may affect future practice.	Debrief interview after the simulation encourages student to look at own practice and identify what went well not so well. Gives an opportunity to learn from any mistakes that have been made	Reflection necessary for clinical reasoning ability to question self critically about practice during and after action (Higgs and Jones, 2000)

Appendix 3.1 Pre-vip protocol

University of Southampton | School of Nursing and Midwifery

Programme of Research and Education/ Ethics into Virtual Interactive Practice (VIP)

(PREVIP)

1.1 INTRODUCTION

This is the over-arching protocol describing the Ethics Procedures and Practices governing the VIP® database. This will be adhered to for all of the research projects to be undertaken in this research and development programme. As such it will be referred to in subsequent research proposals and applications to the School Ethics Committee and NHS RECs.

The programme duration is therefore on-going with no fixed end-point. However for the purposes of Research Governance this protocol will stand for all studies in the VIP® programme due to commence from the date of approval by the Ethics Committee. Version 4 has been reviewed by the University legal services department – by way of a Risk Assessment. Any amendments to this protocol will need to be reviewed and approved by the University legal services department, research governance officer and the School Ethics Committee who give approval for this protocol prior to adoption by the research programme.

The PREVIP protocol relates to the data collection, storage and use in respect of the Virtual Interactive Practice® (VIP®) Project at the University of Southampton. This project is distinct from the other data uses within the School of Nursing and Midwifery, University of Southampton and therefore requires its own protocol. The project involves the use of both anonymised and identifiable patient data for the purposes of teaching and therefore provides a robust framework for the collection, storage and use of these data in an ethical way. Protection of the subjects is the paramount concern and therefore these guidelines will be followed in every situation related to this project.

The abbreviation HCSP will be used in this protocol to refer to Health or Social Care Practitioners.

1.2 Aim of the Protocol

The PREVIP protocol is designed to provide an over-arching framework under which a number of separate studies will be undertaken, each requiring separate Ethical approval.

The aim of the VIP® research programme is to rigorously investigate the educational properties of the VIP® strategy, to further elucidate the learning processes associated with a complex practical discipline, and where possible to apply this knowledge to nursing practice and education.

There are a number of reasons why this work is important.

The need to address the demographic factors that will affect the Health Service in the next 10 years. The emergence of technology which enables us to record real patient data for education, and the development of ethical guidelines for this purpose, which have as yet not been established. This work will therefore set the standards for the use of real patient data for education. The development of technologies, which allow us to observe, playback and analyse student performance. This requires the research and development of educational methods to capitalise on the experience for students, which will ultimately lead to improvements in patient care. There is now the possibility to gain a variety of different insights about the same episode of activity, and this triangulation will facilitate a more sophisticated and robust approach to researching practical disciplines.

2.0 BACKGROUND.

It is becoming widely recognised that within the next 5-10 years there is going to be a staffing crisis in the nursing profession. The latest available statistic is that 60.24 % of the 660,480 nurses on the NMC Register are over 40 years old (NMC, 2005). It is estimated that a significant percentage of the workforce will retire within the next 5-10 years. The majority of these will be the most experienced nurses. When combined with numbers of younger disillusioned nurses leaving the profession (for example: 7,610 nurse applied for verification to work abroad in the last year, NMC, 2005), this will produce a considerable loss of experienced/expert nurses in the workplace. The need to upskill nurses to fill these gaps will become an imperative over the next 5 years. Strategies to achieve this need to be formulated and it is necessary to undertake research to determine the success of these strategies.

The initial concept for VIP® was generated from two developments which significantly influenced the climate of nurse education. The first was the emergence of fly-on-the-wall documentaries on television. The subject matter of health related programmes has continued to be often intimate and revealing. In education, it has often been considered inappropriate to subject patients to intrusive scrutiny for a mass audience. However the success of these broadcast programmes demonstrates the possibilities, and the willingness of patients to participate; wishing, sometimes insisting, that their stories be told. Therefore, it almost seems negligent for education to miss out on the advantages of using such compelling multimedia resources. In fact, if patients are willing to have intimate details of their medical care broadcast on national television, then using data for the education of health care professionals, under controlled and regulated conditions, should be ethically acceptable to society. The second development was the introduction of computerised information systems in to the NHS. This allows the export of real patient information, in a totally unlinked anonymised form, for educational purposes. There is an immediate and obvious benefit to using real data rather than that which has been fabricated by academics or clinicians for the purposes of education. Fabricated data always tends to be too perfect, and misleads the students into thinking that data interpretation is black and white, where in the real world it is notoriously grey.

The concept for VIP®, was therefore developed, using video and real patient data to develop virtual patient scenarios, with which students can interact both through a web-based resource (but not on-line), and simulation. This blended approach means that different skills can be acquired in different domains. The web-based resource provides interaction with the scenarios in a practical way, such as care-planning, report-writing, referrals to other professions, completion of incident forms, documentation etc. The simulations allow for the acquisition of practical skills and decision-making, team working, communication and problem-solving etc.

2.1 Scientific Justification

An initial literature review has confirmed that VIP® appears to be an innovative way of approaching the challenge of professional skills acquisition, with the majority of papers on the subject referring to either pure simulation (e.g. practicing laparoscopic surgical technique on a specialised piece of equipment Gilbart et al, 2000; Peugnet et al 1998; Grantcharov et al 2001; Ahlberf et al 2002; Gallagher et al, 2002) or an advanced form of Virtual Reality called Immersion, which involves computer generated environments, common in advanced computer games, often using a headset and sensory manipulation involving gloves etc (Schultheis and Rizzo, 2001)

Although VIP® does have a high technology component, in that it utilises real patient data, digital video streaming, DVD recording and instant playback, interactive tasks etc. it is grounded in reality. Although 'Virtual', the student experiences are exactly as they would experience in the workplace in real time. However, VIP® allows the students to perform in a safe environment, and under the constant gaze and/or remote supervision of facilitators. The processes of skills acquisition and experiential learning remain complex little understood concepts. The general understanding in this field is based on seminal texts from psychology and education, and continues to be an area of exploration. The initial work on various typologies of education (Bloom, 1956; Buchler, 1961; Broudy, 1964), contributed to the development of theories pertaining to experiential learning (Jung, 1977; Kolb, 1984; Myers-Briggs, 1980; Hammond, 1980; Heron,1990 to name but a few). More sophisticated thinking around experiential learning and competence began to emerge towards the end of this period. Dreyfus and Dreyfus (1979) described their novice to expert continuum. This was further elaborated upon by Benner (1984) using nurses as her focus, and has subsequently been one of the more important developmental influences for nurse education. More general models of learning e.g. reflection (Schutz 1967; Schön, 1983); knowledge structures (Ryle, 1949; Polyani, 1967, Schmidt, Norman and

Boshuizen, 1990), internal processes (Piaget, 1970; Mulligan, 1993) and competence development (Chomsky, 1968; Minsky, 1977; Messick 1984; Elkins 1990;) also add to the big picture of how we learn, and how we can teach, by experience.

3.0 PARTICIPANT CATEGORIES

The primary purpose of the PREVIP Protocol is to protect the participants involved in the research programme. These participants will fall in to two categories.

Category 1 ; The participants filmed or recorded for the development of multimedia resources. These may be NHS patients, University staff or members of the public.

Category 2; All of the students, actors and staff involved in the research by virtue of their interaction with the multimedia resources, and simulation exercises.

3.1 Principal inclusion criteria.

Category 1: Patients, relatives and Staff

Patients, relatives and staff who are involved in care episodes which are relevant to the designed scenarios. This may also include children under 16, but in this case both the child and the parents must be in agreement, the parents will consent and the child will assent (either verbally or in writing if they are able). In the case of very young children obviously parental consent will suffice, but if the child is considered to be unhappy about the recording process at any time, the process will be stopped and any material acquired will be destroyed

Category 2: Students, teaching staff and actors

Students enrolled on specific modules or other educational activities within the University of Southampton.

Actors and staff involved with the delivery of the modules

3.2 Principal exclusion criteria

Category 1: Patients, relatives and Staff

Any individual deemed unsuitable by the clinical team caring for them.

Any individual who does not consent

Any individual who is in anyway unsure about giving their consent.

Incompetent adults.

Children whose parents do not consent.

Members of NHS or University staff or their families, and current students in the Schools of the Health Care Professions (Nursing and Midwifery, Medicine, SoHPRS) will not be approached to be filmed if they are patients.

Category 2: Students, taching staff and actors

Any individual who does not consent.

4.0 DATA COLLECTION

The success of this project depends on the willing involvement of subjects. The trust of our subjects is vital to the continuation of the project, and therefore a policy of absolute honesty and transparency about the use of their data will be outlined in this document. Clear information about the whole process will be provided to participants, and every effort will be made to include them in decisions about the acquisition, purpose and storage of related data, should they wish to be involved.

Category 1: Patients, relatives and staff

Data is predominantly collected within the NHS and may be acquired from a variety of clinical/public areas. However the data will always be collected by University staff and there will be no local researchers. This protocol is therefore not subject to site specific assessment under the Central Office for Research Ethics Committees (COREC) guidelines. Prior to collection of any data, permission will be sought from the appropriate individual in the organisation (E.g. Trust Board member, Caldicott guardian, may be a different post holder in different institutions) for University staff to approach patients, relatives and Trust staff, and to collect data on their premises e.g. to ensure that the Trust are aware of this protocol There must be agreement in writing that data collection can take place

(If, for example, the recording involved a GP/GP practice, obviously the GP/practice manager would have to give consent as the HCSP. All staff involved and the patient would give written consent, and the copy of the patient consent would be placed in the GP notes.)

A form will be provided for signature to this effect (see Appendix 1).

There are two sub-categories of data which can be collected from Trusts and each has different legislation covering their collection, storage and use:

a) anonymised data e.g. blood results , x-rays etc which have been de-identified at source, and

b) identifiable data e.g. video

Category 2: Students, teaching staff and actors

The students' interactions with multimedia resources will take place as part of their educational programmes. The site where this occurs will normally be outside the NHS. However each project will have its own requirements and if any part of the research takes place on NHS premises, that particular study will be subject to separate NHS Research Ethics approval (The individual studies are outside this application, but will fall under its remit).

Student, actor and staff data collected during interaction with the resources developed from category 1 data will be treated in the same way as the identifiable data from category 1, with the exception that, as this is research data, the participants will not be able to withdraw their data.

4.1 Recruitment of participants

Category 1: Patients, relatives and Staff

Participants will normally be recruited by NHS colleagues. Through our collaborative partnership with the Trusts we work closely with clinicians. This means that we can involve the intermediate management in the consenting process, as well as the higher level trust permission. These individuals will be totally involved in the process of allowing us to film in their area, by not only giving us permission, but also identifying suitable individuals to approach. We will have designed scenarios outlining particular images and data we wish to capture, we will then discuss this with clinical colleagues who will be able to advise us if there are suitable individuals from whom we can collect data. An initial approach will be made by a member of the clinical team caring for the patient, and if the individual is interested the research team will approach the individual. At this point the process will be outlined and consent will be sought.

Participants may be recruited from a number of vulnerable groups:

Children under 16 ; Adults with Learning disabilities ; Adults who are terminally ill; Adults with mental illness ; Adults with dementia ; Healthy Volunteers – actors / relatives etc

The main aim of the database is to record real patient data, and rare/ unusual events to allow virtual scenarios to be developed so that students can be exposed to them, even if they do not meet such an event in practice. It is therefore inevitable that some of the cases will come from these groups. The procedures for data collection take this in to account, and the default position will always be not to record data if there is any doubt.

The health care professionals involved in the care of the potential participants will be helping us to identify suitable patients. In the case of those patients for whom English is not their first language, this will probably mean that they will not be considered suitable subjects. It may be that this is part of the characteristics we are looking for in the scenario, in which case, a situation where excellent interpretation facilities are in place would be sought. This is likely to be through local expertise – and obviously consideration would be made to ensure that the interpreter was unbiased and expert. In potential subjects where communication is the main problem, e.g. learning disability clients, then the carers would be involved and we would utilise experts from the University of Southampton to ensure the appropriateness of our involvement and data collection processes. If during data collection any indication of distress to, or concern by the subject was evident, the data collection would be halted.

Category 2: Students, teaching staff and actors

The students will be those who are undertaking modules targeted for the educational research. These will be identified through the relevant curriculum manager in liaison with the named researcher for the project in the School of Nursing and Midwifery, University of Southampton. It will normally be a member of the curriculum team who will first approach the students. The consenting process will then be followed.

It could be considered that students may have a particularly dependant relationship with the investigator which has informed the above safeguards.

All students are registered for study at a UK university, and therefore will be able to speak and understand English. All staff and actors will be able to speak and understand English

4.2 Number of participants

Category 1: Patients, relatives and staff

This is unknown – but is likely to be several hundred.

Category 2: Students, teaching staff and actors

This will form part of the individual research proposals which will fall under this overarching protocol.

4.3 Participant involvement in other research

Category 1: Patients, relatives and staff

It will not be known whether participants are involved in other research. However, this is not clinical research, and it should have no bearing on any other clinical research involvement past or future.

Category 2: Students, teaching staff and actors

It is possible that some students may be involved in concurrent or recent educational research. There are other programmes of educational research which are on-going e.g. Interprofessional Learning. The School Ethics Committee will review these factors when considering applications, and would limit the over research of any one student group. It is part of the purpose and philosophy of the VIP® research programme to investigate groups on different programmes and at different educational levels, and therefore it would not be desirable to over research any one group.

4.4. Conduct of data collection

Data will be collected from clinical and educational areas in a non-coercive manner. No pressure whatsoever will be brought to bear on any individual to consent to data collection, storage or use. Any individual identifiable in any way (e.g. patient, staff, student, relative) will need to sign a consent form (see Appendix) to give permission for their data to be collected, prior to data collection. The consent form clearly outlines the scope of the individual's consent, i.e. up to and including broadcast, which will be explained may be on the internet. An information leaflet (relating to the individual project) will be provided, and should they consent the individual will also be given a copy of the consent form to keep.

The research team that is involved with filming will all be registered Health Care Practitioners or be under their direct supervision. They will also have enhanced CRB checks and explicit permission from the HSCP concerned to allow such activity on their premises (in some cases this may require the setting up of a temporary contract).

No intervention which would normally be considered routine care will be withheld from either category of participant.

Category 1: Patients, relatives and staff ; Patients and staff will not have any undue interruption to their routine care/practice. All data recording will be in the context of normal care. Relevant health care professionals will be involved in the care activities recorded. The research teams/ data collectors will either be, or under the direct supervision of, registered Health Care Professionals. If there are any concerns about the welfare of the subjects, recording will cease. This would be the case if the concern was as a consequence of the recording, or because of the nature of the care being given. As registered practitioners, the data collectors have a responsibility to protect the public and would deal with any witnessed incidence of poor/malpractice in the recognised fashion, e.g. stopping the activity and reporting it to the manager of the area concerned.

If there is concern after data collection, participants will be encouraged to view the recordings to reassure themselves, if they wish to. They have the right to veto any or all of the recordings made of them, at which point recordings will be permanently erased in front of the participant, and will never be entered on to the database. Participants also have the right to withdraw their consent at any time and the process for this involves only a phone call to the data guardians, this is clearly outlined on the consent form.

Category 2: Students, teaching staff and actors;

Students will receive education as prescribed in their curriculum.

In an educational context, arrangements are in place for debriefing the students after all simulated activities, and appropriately qualified members of staff will be available as facilitators of the sessions.

4.5 Data Collection Log

Throughout the data collection process, the research team will keep an activity log. This log will record all of the activity undertaken, the participants, the code, time, date and researchers present. If the participant wants data to be erased, this will be entered in the log. If data is erased in front of the participant, they would be asked to sign the log to say that they have witnessed the data erasure

Category 1a : Patients anonymised data

Anonymised data, e.g. blood results, monitored data, x-rays, CT scans, ultrasound scans etc. which are truly unidentifiable, i.e. no name, hospital number, no date, no Trust name etc. may be obtained with the permission of the Caldicott Guardian for the Trust. Written consent from the Caldicott Guardian for each Trust where data collection occurs will be obtained.

4.6 Duration of participation

Category 1: Patients, relatives and staff

For patients, staff, relatives etc, their involvement will be limited to the amount of time they are being filmed, and the time taken for the consenting process before filming and the review of the captured data after the filming. Their data however will be stored and used for an unspecified amount of time. This will be until the patient withdraws their consent, or until the care/procedures etc become out of date. These procedures will be updated in the light of any subsequent good practice guidance or relevant legislation.

Category 2: Students, teaching staff and actors

The students will be involved for the duration of their exposure to the educational activity. However, their data may be used for educational research, and therefore stored as raw data for as long as research governance requires (for Higher Degrees, this is currently 15 years in the University of Southampton).

4.7 Potential Risks

Category 1: Patients, relatives and staff

There are no anticipated risks or hazards to patients, in fact having a care episode filmed may actually ensure best practice. The purpose of the database is to provide examples of real practice, it is not the intention to collect examples of poor practice, however it is not within the realms of possibility that such evidence could be captured inadvertently. (e.g. evidence that an NG tube was not in situ on a particular date when it should have been). There is the potential that this could provide evidence of poor practice, or on the other hand it could provide evidence that good practice was being followed. These issues are made clear in the consenting process. The only possibility would be that the filming may be inconvenient – if this were the case the potential participants are free to refuse and if there is any perceived hesitation to consent, the team would not consider filming.

Clinical staff may also feel uncomfortable about their practice being filmed, or may be concerned that we may observe poor practice. The practitioners will be encouraged to talk these issues through with colleagues or the VIP® team, and will not be coerced in any way, if they are not happy, they will not be filmed

Category 2:Students, teaching staff and actors

There are no potential hazards anticipated for the student, actor, or staff groups.

Students may find the experience of being filmed and reviewing their performance distressing, but this is usually about their realisations concerning their performance. This is part of the educational process, and experienced facilitators will always be present to address these issues. Initial evaluations demonstrate that students are able to reflect and gain positive learning experiences from this approach.

Staff and actors may also find the experience of being filmed intrusive. The actors are effectively paid volunteers, and as such do not have to participate unless they are happy to be filmed. The staff, however, could be expected to participate as part of their employment, by virtue of the fact that this is a teaching activity. Our experiences in the pilots demonstrate that staff actually enjoy the process, and find it helpful for their development. However if any member of staff did not want to participate, they would not be compelled to do so.

There are no anticipated risks to the research team.

4.8 Potential Benefits

Category 1: Patients, relatives and staff

It is possible that having a procedure filmed ensures best practice, otherwise no potential benefits

Category 2: Students, teaching staff and actors

The students may benefit from new ways of learning, but all other aspects of their curriculum remain unchanged. The students' participation and evaluation of these activities will inform the development of this type of educational delivery for future students. The staff may also find the experience beneficial, by being given the opportunity to review their teaching style/mannerisms etc

5.0 CONSENT

Consent for data will be on a number of levels.

Category 1: Patients, relatives and staff

Firstly, the Trust will provide consent for the University of Southampton to collect, store and use data from the patients, staff, students and relatives on their premises by the processes described in this protocol. Secondly, any individual identified in the data will give their consent to data collection prior to the data being collected. They then have the right to see the data collected and to veto the storage and use of part or all of the data. If they refuse at this stage the data will be permanently erased and never put on the database. If they agree to their data being used, they will be given an information sheet and a copy of the coded consent form to keep. They are able to withdraw their consent at any time by the "Withdrawal of consent" process.

Category 1a; Patient anonymised data

Consent for de-identified data collected at source will be obtained from the Caldicott Guardian for the Trust concerned.

Category 2: Students, teaching staff and actors

Any individual identified in the data will give their consent to data collection prior to the data being collected.

5.1 Length of time to decide

Category 1: Patients, relatives and staff

Normally clinical colleagues are able to see whether patients etc are interested in filming some time before, and then a time will be made for the research team to come and film. Occasionally, it may be desirable to film opportunistically – if this is the case, consent will be obtained beforehand and the safeguards about withdrawing consent are in place. The professionals involved in the care of the patient will be asked to act as the patients advocates after the research/film team have left, in that if they have concerns that the individual has changed their mind, they should encourage contact with us and we will erase the data, as per the withdrawal of consent procedure

Category 2: Students, teaching staff and actors

The educational interventions are also planned and therefore consent can be obtained at least 24 hours in advance.

5.2 Multiple participants

Should there be more than one individual involved and identifiable in any piece of data, all parties must consent and complete an individual consent form. Should any individual refuse permission, the data pertaining to that individual will be destroyed. Careful coding of this data will ensure that this can be traced.

In order to comply with the Data Protection Act 1998, a copy of the signed and coded consent form will be placed in patients medical notes – this will only apply to the patient group. It is obligatory for any health/social care provider (HSCP) responsible for patient care to be able to trace any images or data of patients collected whilst in their care. Should the HSCP wish to retrieve this data from the research team, this should be with the patient's consent. The exception to this would be after the patient's death, in which case we would release the images to the Trust upon production of official notification of death and request for images/data by the appropriate Trust official.(This person may vary from Trust to Trust, examples could be the patients Consultant, Head of Medical Records, or Patient Liaison Representative).

5.3 Consent forms

Categories 1: Patients, relatives and staff and 2: Students, teaching staff and actors

Staff, students and relatives will give written consent on separate forms which will be linked via the coding, they will be given copies of the consent form and the information leaflet in exactly the same way but no copy will be required for Trust purposes.

Category 1: Patients, relatives and staff

In addition to the above, patient participants will be required to complete an additional form which will be placed in the medical notes.

For children under 16 parents will sign a consent form, and the child will be asked to sign indicating their assent, if they are able.

Categories 1: Patients, relatives and staff and 2: Students, teaching staff and actors

A separate statement of consent will be sought for the storage and use of data. This statement will limit the use of this data to the University of Southampton, for educational purposes. The remit of this project is for the education of Health Care Professionals, and therefore will be limited to that. Consent will be up to and including broadcast, which may be on the internet. Broadcast on the Internet will only occur when the Guardians of the data are content that the data are secure. At the time of writing this is not the case and use of data will be limited to modes of delivery which the Guardians are content are secure, e.g. intranet, CD ROM, in-house lectures/ presentations.

Category 1: Patients, relatives and staff

It is conceivable that this project may also be used for the education of patients. If this is the intended use of the data, a separate consent stating this will be obtained.

5.4 Withdrawal of Consent

Category 1: Patients, relatives and staff

On the consent form is a direct line telephone number which clearly states that Category 1 participants can call to remove their data from the database. To facilitate this process, each consent form will be coded to allow the Guardians of the data to identify all of the data collected from an individual so that this can be achieved efficiently. All the consent forms will therefore be kept in a locked filing cabinet in the School of Nursing and Midwifery, University of Southampton.

The veracity of the identity of the caller in this instance could be considered to be an issue, however if they have access to the consent form and the code it would seem reasonable that they have legitimate reason to make the request. To augment the security of the identification process, a ‘ring back’ and authentication question process will be used. Removal of the data would therefore be the most logical course of action, and likely to cause the least distress to any parties involved. The caller's name and contact details would be taken and logged, as would the date and time of the request in case of any repercussions. If the person making the request is not the individual subject, the data will be removed, but they will not have access to the data.

In the case of the death of a subject, and a request to remove the data from the database by the next of kin, this will be done but the data will not be permanently destroyed. It will be necessary to contact the Trust concerned to ensure that the data is not required by them, as all images and data pertaining to a patient should be available to the authorities for investigation in the event of a patient's death. If the Trust requires the data, a copy will be made available in a secure manner, and the VIP® copies will all be destroyed permanently. If the Trust does not require any of the data, all copies will be destroyed permanently. .

6.0 DATA STORAGE

Categories 1: Patients, relatives and staff and 2: Students, teaching staff and actors

All data will be stored on dedicated servers/secure spaces in the University of Southampton. The data will be archived, as will the coded consent forms to enable efficient retrieval of the data.

The servers/spaces are secure and password protected. The data is backed up on to tape nightly at 9pm; the tapes are stored on site in a locked safe in the finance office. The tapes are rotated every week, with the previous weeks backups stored in a safe offsite

The coded consent forms will be stored in a locked filing cabinet on University premises.

Category 1 a: Patient Anonymised data.

This data will be archived in the database as anonymised data with a coding so that it will be possible to trace which Trust it came from and the date which it was obtained so that it is possible to prove that the data was obtained legitimately. The coding will be such that it will not be possible to identify the source of the data from the data itself, and could only be unblinded from a list held separately and securely.

Category 2: Students, teaching staff and actors

The data being used for research may be accessed by researchers who are not necessarily health care practitioners governed by a Professional Code of Conduct (e.g. Statisticians, Educationalists, Computer Scientists). In this case, they will be required to sign a declaration of confidentiality and agreement to abide by the PREVIP protocol, this is in addition to their responsibilities under the Data Protection Act 1998.

6.1 Length of data storage

Category 1: Patients, relatives and staff

The data will be stored for as long as it remains clinically relevant and accurate, and therefore useful as a teaching resource. If this is no longer the case, the Guardians will follow the procedures for the removal of data.

Category 2: Students, teaching staff and actors

Student research data will kept in accordance with the University Research Governance policy, accurate at the time of the approval of the individual study. This will be part of the individual research proposal. As a guide this is currently 15 years.

6.2 Data Withdrawal

Categories 1: Patients, relatives and staff and 2: Students, teaching staff and actors

The data will be kept securely until a request is made to withdraw it. Should the data become outdated, and the University of Southampton wish to destroy it, they will endeavour to contact the individual, and the Trust (if appropriate) to inform them that the data will be destroyed on a given date, approximately 4-6 weeks from the date of notification. This will provide the person or Trust concerned with the opportunity to raise any issues they may have prior to data destruction In correspondence such as this, we would be very aware of careful wording, as it is possible that the subject may continue to be ill, or may even have died, and we would not want to cause undue distress. Unless we are advised that there is some important matter that necessitates further storage of the data for a given time, then the data will be permanently destroyed.

Should the VIP Data Guardians become aware that one of the professionals who had been a subject of a video clip had had an allegation of professional misconduct laid against them, then they will have a responsibility to follow this up. The data will be withdrawn from use during the course of any investigation. If the allegation is upheld through the proper professional processes, then any data showing that individual will be permanently removed. If the allegation is not upheld, we will ensure that consent has been revalidated with the individual(s) concerned before reinstating any material.

6.3 Requests for Data

Categories 1: Patients, relatives and staff and 2: Students, teaching staff and actors

Should the individual request a copy of their data at any time, this will be provided. It will be necessary to have a written request for this signed by the individual. This will allow us to verify the request by matching the signature with the original consent form. It will not be possible to provide copies of data to anyone other than the person consenting for the data collection, unless the appropriate legal process is undertaken. This would include release of data relating to staff to the Trust as their employer, which would not be allowed without the individual's consent.

The exception to this would be after the subject's death. Upon confirmation of the subject's death from the official sources, a copy of the data may be provided to the recognised next of kin should they request it.

If the data on a subject was requested in this way and other individuals were identifiable within the media, these other individuals would need to consent prior to release of the data. All reasonable measures to contact individuals to gain consent will be made, but it is feasible that contact may not always be possible. In which case the Guardians of the data reserve the right to decide whether release of data is reasonable and justifiable.

6.4 Data Activity log

All aspects of these processes would be logged in the activity log, e.g. letters sent, contacts received, and decisions taken and by whom. This will provide a comprehensive audit trail, allowing all of the database activity to be transparent.

7.0 DATA USAGE

This protocol covers a variety of data uses:

Electronic transfer by magnetic or optical media, email or computer networks

Sharing of data with other organisations

Use of personal addresses, postcodes, faxes, emails or telephone numbers

Publications of direct quotations from respondents

Publication of data that might allow identification of individuals

Use of audio/visual recording devices

Storage of personal data on university computers/ laptop computers

All of this data usage will be governed by the protocol, and the procedures entrenched within. The Guardians of the data are responsible to ensure the best possible protection of the data on behalf of the participants. This may require them to make cost-benefit analyses on their behalf, as the rapid rate of technological enhancement dictates that new advances may be prohibitively expensive when they first appear on the market. As soon as appropriate advances are shown to be safe, reliable and economically viable the Guardians reserve the right to amend this protocol through the appropriate channels.

Categories 1: Patients, relatives and staff and 2: Students, teaching staff and actors

The data collected and held in the database will be only used for the education of Health Care Professionals. The identifiable data will be used in the context in which it was collected. Pseudonyms will always be used; the real subjects name will be kept confidential. Although pieces of unrelated data may be linked to portray a clinical condition, the context will not be manipulated. ‘Personal data’ that identifies an individual and forms part of the key code file will not be released or sold to a third party. The University may use any other data not in the key code file, including voice and visual data, for the teaching/training of Health /Social Care Professionals. This may be to institutions or agencies in countries outside the European Economic Area where data protection laws are not as rigorous as in the UK. There is a specific clause in the consent form highlighting this issue. This will, however, be secure and regulated by a legal agreement between the University and the Purchaser, and will include controls over use and prohibition of selling/giving the data to a third party. There will also need to be a continuing relationship with purchasers which will allow for the update of the resources. This will enable the replacement of resources should any withdrawal of individual data be requested. Income from the sale of any such resources would be utilised by the School for the support of the education of Health Care Professionals and research into Health Care and Health Care Education. It would be the intention to make the programme self-funding, but if the fortunate position that a surplus arose the money would only ever be used for the business of the School outlined above.

The Guardians of the data will be responsible for taking every reasonable precaution to ensure the security and legitimate use of the data.

7.1 Data usage log

Category 1: Patients, relatives and staff and 2: Students, teaching staff and actors

The data use will be logged, so that all data usage, either for educational or research purposes is known. It will therefore be possible to trace what data has been used, when and by whom so that over use of data will not occur. It will also be possible to analyse this log to demonstrate the resource exposure for any one student group, or individual research project.

8.0 GUARDIANSHIP

The Guardians must abide by their responsibilities to the database for as long as it continues to exist. The Guardians comprise a Guardian Group.

The Guardians of the data for the VIP® project will be the Project Lead/ Ethics Advisor (Eloise Monger) , the Educational Technologist for the School of Nursing and Midwifery, University of Southampton involved in the Project (Dr Mike Weaver) , VIP® Research Programme Lead (Dr Mary Gobbi) and Trust representative (currently Anne Spencer, Portsmouth Hospitals Trust.) Should any member of the team leave their post, a replacement should be nominated and appointed, with the agreement of the remaining members. In addition, a lay and other independent person will be appointed to augment the Guardian Group. The database should be managed by the Guardians, and the minimum number of the Guardian Group should be six. The Chairperson of the School of Nursing and Midwifery Ethics Committee will be an ex officio member of the Guardian Group. Additional members may need to be added, particularly as more Trusts become involved. The maximum number of Guardians should be 12. At a later stage it may be prudent to appoint a legal advisor or other Guardians with specialist expertise as a minimum requirement.

The responsibility of the Guardians is to uphold this protocol and to make decisions about the storage and use of the data on behalf of the participants. Their aim is to provide the best possible protection for the data in the database. This may also require the making of collective decisions about the future management of the database and on occasion about the removal of or requests for data. They will only have responsibility for the database, not for the programme as a whole, that will be run by a separate Steering Committee, known as the PREVIP Steering Committee, within the School and is outside the remit of this protocol. The PREVIP Steering Committee will also be bound by this protocol and will respect the integrity of the database and the decisions of the Guardians.

In addition to this, the individual research study co-ordinator will have responsibility and control of the research data pertaining to that particular study. This data will comprise additional questionnaires, transcripts etc. Individual arrangements for each study will be subject to separate individual Ethics approval. Audio/video data will be entered into the database and will therefore also come under the remit of the Guardians.

8.1 Access to data

Category 1: Patients, relatives and staff

Through the Guardians, all the academic members of the University involved in the teaching of students of the health professions will be able to use the data for teaching purposes, this will be carefully managed from an educational perspective as it will be important that the data is used in context. It will also ensure that no one example is over used for the same cohort of students. This will be made possible by the data usage log, which will also track what has been used and by whom.

Category 2: Students, teaching staff and actors

Members of the research team will have access to the student data, this will be overseen by the Guardians. All such activity will be logged in the data usage log.

9.0 PARTICIPANT INFORMATION

Category 1: Patients, relatives and staff

In individual research studies, it may be possible/desirable for subjects to receive copies of the finished resource so that they feel that they are making a valued contribution. If this is the case – this will be facilitated.

It may also be that an episode becomes out of date, in which case, every reasonable effort will be made to contact the individual prior to erasing the data – this would normally be by letter (as outlined in section 6:2). In correspondence such as this, we would be very aware of careful wording, as it is possible that the subject may continue to be ill, or may even have died, and we would not want to cause undue distress.

Category 2: Students, teaching staff and actors

For students we will publish articles in the School newsletters about the research studies, and again individual studies may choose to provide individual feedback to student subjects and this would be outlined in the research protocols.

1 Participant incentives

Individual research participants will not receive payments for taking part in this research. Having said that, if actors are employed in the simulation exercises, then obviously they will be paid the standard rates for this activity – this would be normal educational expenditure and not specifically for the research. Members of Staff will not receive any payment over and above their normal salary.

Individual participants will not receive reimbursements of expenses or any other incentives or benefits for taking part in this research

10.0 INDEMNITY ARRANGEMENTS

In the case of producing audio-visual materials as educational/teaching aids normal Professional indemnity and Public liability insurance will apply.

Where it is intended that a resource may be developed and used for commercial purposes, additional advice regarding insurance must be sought at the planning stage from the Insurance Services Department of the University of Southampton. It is not recommended that existing resources are used for subsequent commercial use due to issues of consent, data protection and liability.

10.1 Negligent Harm

Category 1: Patients, relatives and staff

The research/data collection team will not be involved in any clinical intervention, and therefore this will not be relevant. However, as a precaution it will be recommended that professionals in the research team have current professional liability insurance. The University of Southampton are sponsors of this Project and hold insurance to cover their activities, including harm caused by their negligence. Should anyone have any complaint about the conduct of the project or the way they have been treated, they should contact the Research Office, School of Nursing and Midwifery who will follow the University Complaints procedure- telephone 02380597942.

Category 2 ; Students, teaching staff and actors

The research/data collection team will not be involved in any clinical intervention, and therefore this will not be relevant. However, as a precaution it will be recommended that professionals in the research team have current professional liability insurance. The University of Southampton are sponsors of this Project and hold insurance to cover their activities, including harm caused by their negligence. Should you have any complaint about the conduct of the project or the way you have been treated please contact the Research Office, School of Nursing and Midwifery who will follow the University Complaints procedure- telephone 02380597942.

11.0 CONDUCT OF RESEARCH

11.1 Quality of the research

All of the research studies undertaken under this protocol will be subject to internal review within the School of Nursing and Midwifery, University of Southampton. They will also be subject to appropriate funding applications, Research Ethics and Governance arrangements.

11.2 Research data analysis

Category 1; Patients, relatives and staff

This category is not going to be actively researched

Category 2; Students, teaching staff and actors

The student data will be analysed within the University of Southampton by the members of the individual research team.

11.3 Statistician input

Category 1: Patients, relatives and staff

This is not appropriate

Category 2: Students, teaching staff and ators

This will form part of the individual research proposals which will fall under this overarching protocol.

11.4 Methods of analysis

This will form part of the individual research proposals which will fall under this overarching protocol.

11.5 Monitoring and auditing the conduct of the research

This is managed in three ways. First, the Guardian Group have the responsibility to ensure that this protocol is upheld and to make decisions about the storage and use of the data on behalf of the participants. Their aim is to provide the best possible protection for the data in the database. This may also require the making of collective decisions about the future management of the database and on occasion about the removal of or requests for data. They will only have responsibility for the database, not for the PREVIP programme as a whole, that will be run by the separate Steering Committee, known as the PREVIP Steering Committee. The PREVIP Steering Committee is the second mechanism through which this protocol will be overseen and it will be bound by this protocol, respect the integrity of the database and the decisions of the Guardians.

In addition to this, the individual research study co-ordinator or education programme manager will have responsibility and control of the research /evaluation data pertaining to that particular study or activity and will operate to this protocol or to any subsequent amendments that its specific study may require.

11.6 Criteria for electively stopping the trial or other research prematurely

The only circumstance that can be foreseen leading to a research study being stopped would be an abuse of this protocol, and this would need to be unanimously agreed by the Guardians and the Director of Research for the School of Nursing and Midwifery, University of Southampton.

11.7 Dissemination of results of research, reports of educational theory development

It is envisaged that dissemination will be by the following methods:

Peer reviewed scientific journals

Internal report

Conference presentation

Other publication

This process will be overseen by the Guardians, who will have the responsibility to ensure the integrity if the database.

11.8 Dissemination of developments to the participants of the research

Category 1: Patients, relatives and staff

As the patient/staff/public involvement in this is to develop educational resources, this is generally not relevant. However in individual research studies, it may be possible/desirable for subjects to receive copies of the finished resource so that they feel that they are making a valued contribution. If this is the case – this will be facilitated.

Participants will also be able to access the website which will provide information about the VIP® project, developments, and the research studies, and this will be highlighted in the patient information sheet.

Category 2: Students, teaching staff and actors

All students and staff have access to the School newsletter and individual research studies will publish updates and their results in this forum. They can also access the website as above.

12.0 UNFORESEEN CIRCUMSTANCES

The collection, storage and use of real patient data for development of interactive educational resources, and the subsequent research into their use, is a complex undertaking. To enable this to be achieved ethically has required considerable thought and consultation. This protocol is the culmination of this work. It is hoped that this protocol adequately covers all of the foreseeable ethical issues, but clearly there may be situations which we have not envisaged, and in those cases we will have to work through those issues with the team, through our existing networks, in liaison with current experts in the field and utilising the regulatory authorities that have informed the protocol.

Contact persons for further information

Mary Gobbi: mog1@soton.ac.uk Eloise Monger: E.J.Monger@soton.ac.uk

Appendix 3.2 The simulated scenario: Mr Alan Day

Present Condition (PC):

Mr. A, Day is a 54 year old man, was admitted to the Surgical High Dependency Unit (SHDU) yesterday, following an emergency small bowel resection x 2 via laparotomy.

The day before this he was admitted from an oncology ward to a surgical ward as an emergency, with abdominal pain and fever. On investigation the patient was found to have an infarcted bowel and therefore underwent surgery.

History of present condition (HPC):

2 months ago he was admitted to the oncology ward with symptoms of abdominal pain and diarrhoea. This was diagnosed as a sub acute bowel obstruction secondary to irradiation induced strictures. This resolved with antibiotics and a fluid and diet restriction, enabling Mr. A to go home a week later

5 months ago Diagnosed with transformed monocytoid type B cell Lymphoma, isolated to his left groin.

Management of the lymphoma involved excision of the enlarged lymph nodes, three cycles of chemotherapy and radiotherapy.

This treatment was successful and well tolerated by the patient, with no abnormalities found on regular reviews.

Past medical History (PMH):

Prior to lymphoma diagnosis was fit and well with no significant PMH

Social History (SH): Lives with his wife and works as a restaurant owner and manager.

Moderate intake of alcohol and smokes 5-10 cigars a day continued to work despite health problems.

Drug History (DH):

Diamorphine patient controlled analgesia (PCA),

IV cefuroxine,

IV metrinidazole,

IV Ranitidine,

O/PR Diclofenac,

O/PR Paracetamol,

S/C Clexane,

IV Cyclizine,

IV Hartmans

Day 1 post op

Nursing staff handover:

Mr Day had fluid resuscitation of Saline & Gelofusin giving him a positive balance of +9080 mls. Overnight he was confused his sats kept dropping and his respiratory rate increased. His oxygen requirements increased from 35% to 40% and then to 60% in the early hours of am but this was reduced back to 40% as his sats seemed to be OK.

O: Patient upright in bed

A: Patent airway

B: SV FiO_2 0.4 via Face Mask with cold humidification,

SpO_2 90%, RR 17

ABG's taken at 2.40 AM when on 60% O2

pH 7.42

PaO2 10.22

PaCO2 5.22

BE 1.0

HCO3 25

SaO2 96

Ausc: Decreased BS bi-basally. Upper airways transmitted sounds

Weak non-productive cough

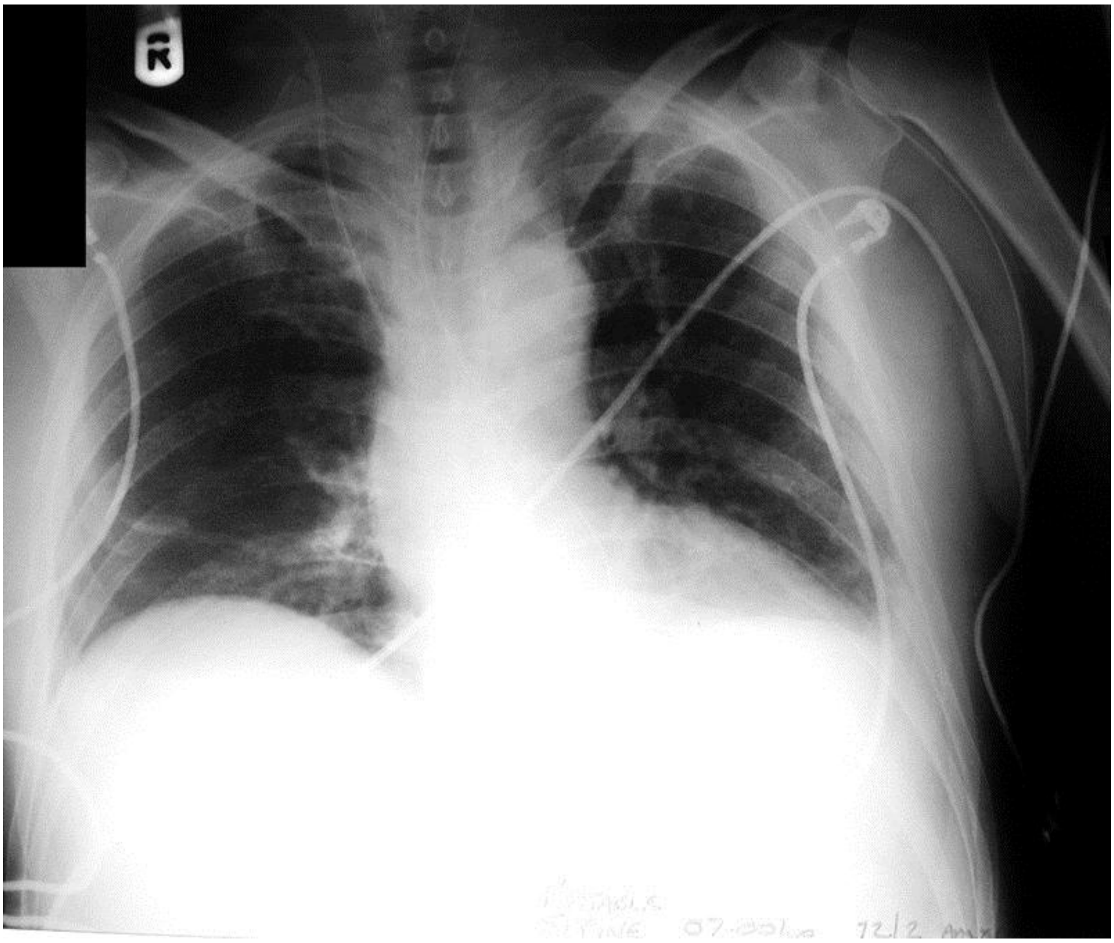
C: HR 91 (SR), BP 113/66, CVP 12, Temp 36.5^{o}C

FB +3902, UO 70mls/hr

D: **A**VPU

E: L Radial Arterial line, NG tube, TPN, PCA, abdominal drain, urinary catheter

CXR day 1



Day 2 post op

On assessment:

S: Nursing staff report patient has had fluid resuscitation. Overnight he was confused, however less confused this morning. Oxygen increased to FiO_2 0.4.

O: Patient upright in bed

A: Patent airway

B: SV on FiO_2 0.4 via FM with cold humidification, SpO_2 90%, RR 17

No arterial line at present. New line to be inserted

Ausc: Decreased BS bi-basally. Upper airways transmitted sounds

Weak non-productive cough

C: HR 91 (SR), BP 113/66, CVP 12, Temp 36.5 ^{o}C

FB +3902, UO 70mls/hr

D: **<u>A</u>**VPU

E: Central line, NG tube, abdominal drain, urinary catheter

Day 3 post op

On assessment:

S: Nursing staff report patient tired as didn't sleep well. Requiring increasing amounts of oxygen and not clearing secretions. Since yesterday analgesia changed to Fentanyl and on regular saline nebs.

O: Patient upright in bed

A: Patent airway

B: SV on FiO2 0.6, SpO2 91%, RR 19

pH7.43, PaO2 6.88, PaCO2 5.29, HCO3- 25.7, BE 1.4

CXR: See next slide

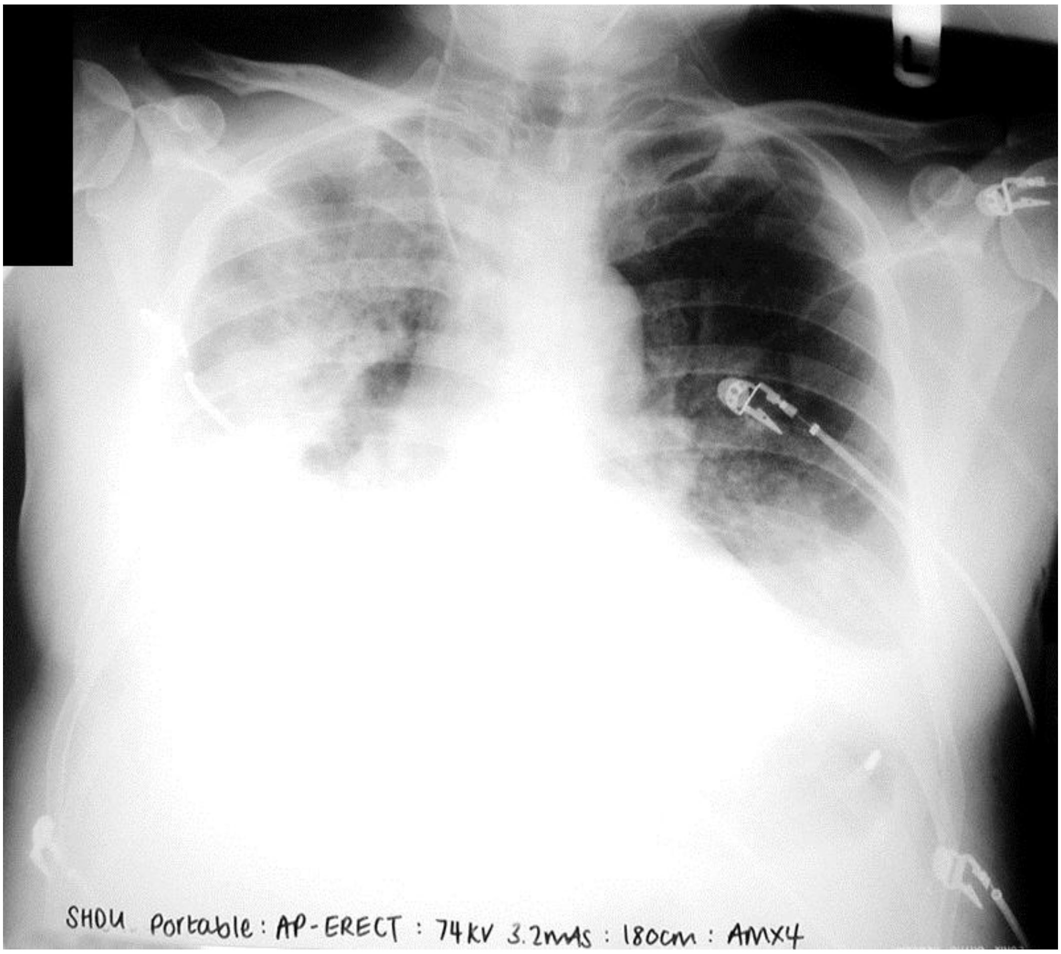
Ausc: Bronchial breathing right middle and upper zones, decreased BS Right base. Decreased BS left base. Upper airways transmitted sounds weak non-productive cough

C: HR 92 (SR), BP 158/86, CVP 4, Temp 37.4 ^{o}C

FB +1209, UO 50mls/hr

D: **A**VPU

CXR Day 2



3.2 The simulated scenario and script : Mr A Day

Based on the transcript from the Pilot study it was decided by the researcher to present the scenario on day 3 when he was at his worst clinically meaning there was more information to be processed and analysed which should enable the clinical reasoning process to be investigated.

Code= PT- Physio, James pt = patient, Kate = N/S nurse)

Scene It is 8.30am on HDU, Mr Day is sitting in bed,day 3 post op following laparotomy for x3 small bowel resection
PT enters room and introduces herself to N/S & pt

Kate N/S introduces self and patient. Gives a handover to PT:

Kate Nurse Handover

Patient is tired this am, the night staff said he didn't sleep very well because of a new admission in next bay, which disturbed him. He was also complaining of pain in the night so the Doctors changed his Morphine to Fentanyl but it doesn't seem to have made much of a difference.

Night staff noticed his sats dropping to 90% at about 6am and so we increased his oxygen to 60% and he has been around 95%-96% since then.

Kate asks PT to assess patient and give advice on how to manage him today.

PT may say: I'm just going to wash my hands & read your notes & then assess you

James = "OK"

(Whilst PT doing this, Nurse is doing things with Mr Day general conversation, maybe wife phoned and she will be in later etc. James can adlib, he might also groan, cough, breath loudly.

PT talks to pt & asks permission to examine the pt she may refer to what she did yesterday or what a colleague did yesterday having read the notes

Pt might say something like: " I don't feel well enough to do anything – can you leave me alone to sleep today, I didn't get much rest at all last night it was so noisy in here and the Doctors kept doing things to me all night"

PT explains that nurse has asked her to take a look at his chest because his breathing was a bit difficult earlier this am

Pt: is a little breathless & unco-operative & says "I'm tired I don't want to sit out today" please speak in short sentences you are breathless and about to have a hypoxic episode

PT may try to explain justify why sitting out/ doing deep breaths/ coughing/mobilising/ is good for him

Pt: says "OK " / "yes" reluctantly agrees to do what PS wants to do but "let me be then"

Pt can do more groaning, noisy breathing here

PT may ask questions about breathing, coughing, clearing phlegm, colour of phlegm, quantity?

Pt "It's OK when I've got no pain, the mask on, "

PT: have you tried to sit out in the chair yet

Pt “No, I don’t want to”.

PT: why is that?

Pt “I told you I’m tired and I don’t want to”

If the physio then asks about pain

Pt can say yes, when I move or cough it hurts, so I don’t want to move or cough”

If there is any mention of pain then N/S can say don’t forget you have that little thing/buzzer you can push that gives you a bit more of the pain killer

PT’s often start their assessment by either feeling chest expansion or auscultation:

Pt: Mr Day could start to be a bit confused as sats are getting a bit low on 60% O2.

If PT auscultates they may ask the pt to br in & out of their mouth just normal breaths,

NB pt don’t breath for real as noises will override the manikin

PT may say:

Mr Day you’ve got a lot of secretions on your chest, what I’d like to do with you is to help clear some of those and your breathing will then be a little easier.

Initial state of scenario stops and the hypoxaemic trend starts SpO2 drops to 89% on 60% O2. Nurse at bedside with physio and says this is what he was like early this am.

N/S Please don’t give any prompts, or suggestions of treatment, wait to see what the physio does).

Pt just does more noisy breathing- audible upper airway secretions, maybe a weak cough, maybe a wheeze.)

PT response might be to continue when sats stabilise again or proceed even if they stay low

PT “Mr Day you’re breathing a little bit fast I’d like you to try & slow it down, feel my hand on your abdomen and just try to take some slow deep breaths in & out through your mouth”

Pt might say ok (still very breathless)

PT might say: I’d like to position you a little more upright/ sitting in chair / side lying

N/S says I’m sorry I really don’t think he can do that today because of his Blood pressure has just dropped (real reason manikin too heavy)

PT may start to treat by introducing the ACBT (Active cycle of breathing exs) and will start by placing her hands on the lateral chest & ask the patient to relax and breathe from their abdomen, then start lateral expansion breathing x3-4

Pt audibly hear him take the deep br in x3-4 (follow instructions from physio)

PT now rest back to abdominal breathing

PT deeper br again -hear the pt take x3 deep breaths

PT rest back to abdominal breathing

PT going to see if you can clear any of the phlegm that’s on your chest now and explains how to Huff as this hurts less than a cough

PT give instructions to patient medium breathe in then blow the air out of mouth keeping mouth open to move secretions if you then feel anything at back of throat short sharp huff to clear

Patient responds to what is being asked to do by physio

The patient starts to complain of more pain following this exercise & wants to be left alone

N/S asks the patient if they pressed the button for some more pain relief?

Pt “Yes” breathlessly answers “it’s worse now I’ve done all that breathing”

N/S I have spoken to Doctor the only other thing that could be given is a voltarol supp but we don’t want to because of his RR (22) have to let the other pain killers work (Fentanyl PCA & paracetamol)

PT may suggest the following options or something else whatever they suggest can the nurse please ask the physio to explain why they want to do it (justify) don’t have to agree or disagree:

Possible suggestions are:

> Positioning in side lying see if that is more comfortable might even improve sats/ V/Q mismatch, move the secretions, leave for about 20 mins like this and I’ll come back

Can you give a saline nebuliser I’ll come back in 20 mins

Stop treatment until pain control sorted

Start Bird

Start BiPAP

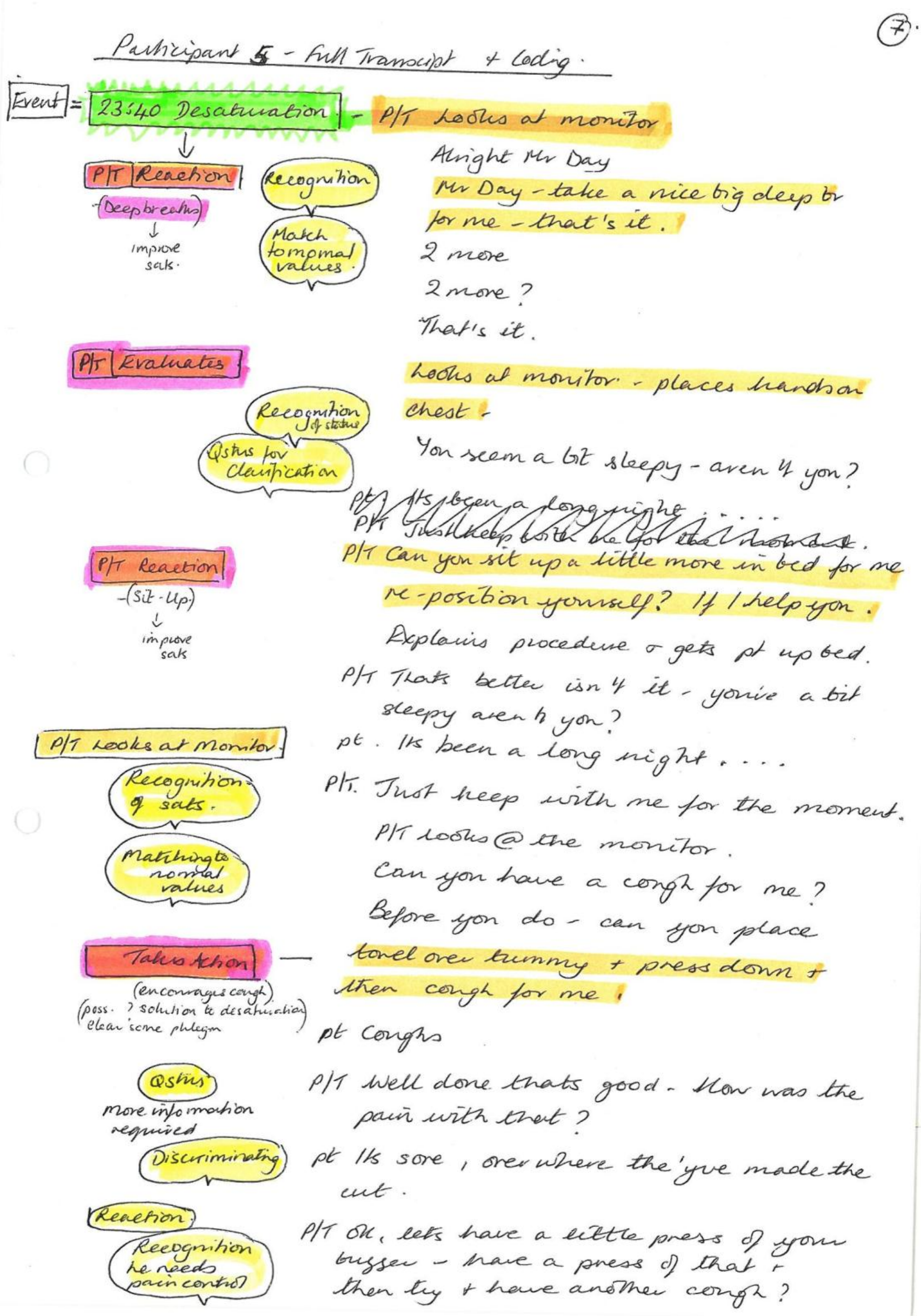
The researcher and nurse analysed the case study together to ensure all aspects had been covered prior to setting up the scenario. This table collates their joint assessment of the case study.

Table 1: Summary of the Nurse & Researcher assessment of case study

Assessment (knowledge base)	Triggers/inferences	Domain concepts (organised mental representations of knowledge relevant to the task that exist in the decision maker's long term memory)	Intermediate conclusions	Intermediate actions
Airway Patent, self ventilating		Normal respiratory function	Airway clear	None required
Breathing Respirations 21. Oxygen 60%. Saturations 93% peripherally from pulse oximeter. Auscultation: decreased breath sounds. pH 7.38 7.36 7.40 PaO2 4.76 5.31 4.83 PaCo2 5.97 5.82 6.06 BE 0.9 -1.2 2.4 HCO3 26.1 24.3 27.6 Sats 73.9 75.4 70	Respiration rate higher than normal Increasing oxygen requirements Low saturations Hypoxaemic, type 1 respiratory failure ?Metabolic alkalosis	Normal respiratory parameters and pathophysiology	Normal respiratory function impaired	Improve impaired respiratory function to restore normal physiology

Cardiovascular Blood pressure decreased (systolic blood pressure 115-145mmHg). Gelofusin bolus given to maintain CVP above 10. Heart rate 95-85bpm. Sinus rhythm. Peripherally warm NG on free drainage – 660mls over 24 hours Diuresis satisfactory (30-100mls/hour) Minimal from Wallace drain Nil by mouth	Decrease in blood pressure and warm peripherally	Normal cardiovascular parameters and pathophysiology	?CVS compensating for underlying metabolic problem	

Appendix 3.3 A sample of the analysis of the written transcript



Appendix 3.4 The debrief interview questions

Opening questions: demographic data

How long have you been qualified?

Which areas of cardiorespiratory have you worked in?

What are you currently working in?

How long have you worked in this speciality?

How did you find the experience?

What do you think went well?

Not so well?

If you were doing it again is there anything you would do differently?

Did anything surprise you?

Assessment process

Did you identify any triggers from the notes?

What were the key points from the handover of the nurse?

What were the key points from the subjective assessment?

What were the key points from the objective assessment?

That’s really interesting tell me about xyz

Any advice you can give me about this?

What knowledge do you think has underpinned your assessment today?

How much of what you did today was based on previous experience?

Have you treated any similar patients?

Appendix 3.5 Sample of the debrief interview transcript analysed with framework analysis

Experience Of simulation	What went well	Not so well	Assessment process	Triggers	Hypothesis	Knowledge	Previous experience of similar patient
Really helpful to have the patient voice responding to my questions made it much more real easier to role play (previous exp of simulation cardiac arrest)	Managed to clear some phlegm which is always good Gave an effective treatment although his sats stayed the same dipped then regained to what they were	Didn't go through everything Maybe if I'd seen the colour of the phlegm that would have given a bit more feedback Green would have indicated infection, pink & frothy fluid overload Because the nurse said it was green it made me go down one route	Not a systematic approach Recognize didn't look at todays CXR	Oxygen increased overnight wondered why? Took in patient status whilst talking to the nurse Felt no pressure no urgency to see the patient whilst I was talking to the nurse Obs fairly stable He hadn't slept all night he was tired and the PCA he wasn't really using it properly no benefit in the change of the drug From the charts he had been fairly stable, BP up & down hypertensive in past, RR rate high, temp Smoking cigars	Piecing together whether he had a post op chest infection Or it was post op retention of secretions ? fluid overload I built up a picture of the patient as I went on and got feedback from the patient Compare back to normal Compare what you expect a patient should be like 2 days after a laparotomy & why he was not doing	Procedural knowledge & Taught knowledge From other seniors & Peers Experience Discussion with colleagues about patients Reflection about patients, formally learn from case study presentations Learn from other professionals	Had a picture in my head & I think I pieced it together as I spoke to the patient

Experience Of simulation	What went well	Not so well	Assessment process	Triggers	Hypothesis	Knowledge	Previous experience of similar patient
				Didn't look at White cell count	this		

Appendix 3.6 Informed consent

Study title: An investigation into clinical reasoning within the context of critical care for cardio respiratory physiotherapists using Simman (Laerdal TM).

Researcher name: Debbie Thackray

Study reference;

Ethics reference: Consent form for photographic and video data collection PREVIP protocol Ethics Approval ref SONAM/006/2006

Physiotherapy Participant consent form

All activity with regards to this consent is governed by the PREVIP protocol Version 4,16th October 2006. If you would like a copy of the full protocol, please ask the research team. In addition, the PREVIP protocol and further information about the VIP project is available at www.vip.soton.ac.uk

Please tick and initial if you are in agreement with each of the following statements:

I have read and understood the information sheet and have had the opportunity to ask questions about the study.

I understand that my clinical decision making is being explored and that my clinical practice is not being scrutinised and reported back to my NHS trust but the information I disclose may be used to for educational purposes.

I understand that the research will take place in a purpose built laboratory and use a simulated patient at the School of Health Sciences, University Southampton.

I understand that the video cameras are located around this laboratory and they are not intrusive and will not interfere with the assessment of the simulated patient.

In consideration of the opportunity to participate in this project I agree to be recorded on video. I agree to the use of my likeness, portrait or pictures, voice and medical condition/history (hereafter called ‘Data’) for the following purposes:

The education of healthcare professionals; and to form part of educational resources that may be broadcast distributed sold to other institutions for educational use.

I give my consent for the University to store, process, reproduce, publish and broadcast the photographs, images and sounds in the medium, format, manner and context and in conjunction with such sounds, images and captions as the University deems fit.

I agree that my participation in this project confers upon me no rights to use, ownership copyright or performing right. I understand that the University will publish information if, as and when it deems appropriate, and may withdraw information as it becomes obsolete. I understand that I will receive no compensation for participating in this project.

I understand that Data may be transferred out of the European Economic Area where data protection laws differ from those in the UK. The terms of this Consent Form will, however, be governed by English law.

I understand that I can request the withdrawal of the Data at any time by telephoning 023 80 595471 and quoting the code number at the top of this form. I also understand that while the University will destroy Data in its possession, it may not be able, nor will it be obliged, to enforce destruction of Data contained in modules that have already been sold to third parties.

Name of participant (Print name)…………………………………………………………………………

Signature of participant…………………………………………………………………………………

Date…………………………………………………………………………………………………

Name of researcher

(Print Name)………………………………………………………………………..

Signature of Researcher…………………………………………………………………………………….

Date…………………………………………………………………………………………………

………

Appendix 3.7 Risk assessment

University of Southampton	School of [insert your school name here]	RISK ASSESSMENT FORM

To be completed in accordance with the attached guidelines

Activity:

Assessment of a simulated critical care patient

Locations:

VIP in clinical skills laboratory Nightingale building University Southampton

Significant Hazards:

None

Who might be exposed/affected?

No one

Existing control measures:

The control is that a simulated patient is being used so that no harm is incurred to a real patient

Risk evaluation: **Low / Medium / High**

Can the risk be further reduced? **Yes / No**

Further controls required:

Date by which further controls will be implemented:

Are the controls satisfactory: **Yes / No**

Date for reassessment:

Completed by:

____________	________________	___________
name	signature	date

Supervisor/manager:

If applicable

______________	______________	______________
name	signature	date

Reviewed by:

______________	______________	______________
name	signature	date

Appendix 3.8 Participant information sheet

UNIVERSITY OF Southampton
School of Education

Participant Information Sheet

Study Title:

“An investigation into clinical reasoning within the context of critical care for cardiorespiratory physiotherapists using Sim-Man. (Laerdal ^{TM}).”

Researcher: Debbie Thackray

Ethics number: Ethics no: SONAM/006/2006

Please read this information carefully before deciding to take part in this research. If you are happy to participate you will be asked to sign a consent form.

What is the research about?

I am a lecturer in cardio respiratory physiotherapy and have been teaching physiotherapy students at the School of Health Sciences for 13 years. I am very interested to know more about what clinical reasoning process a cardio respiratory physiotherapist uses to identify and solve problems with critical care patients. My aim is to “unpick” what experts do in clinical practice so that my teaching of cardio respiratory is current and appropriate for today’s clinical practice. I am undertaking this research as part of my Doctorate in Education through the School of

Education, University Southampton and I am being supervised by Professor Alison Fuller.

As you may well be aware there has been limited research into the clinical decision making in cardio respiratory physiotherapy. To date there have only been three studies which have identified the differences between experts and novices; the characteristics of cardio respiratory expertise and the nature and context of the decision making process in the acute sector. However, none of these studies have identified which process cardio respiratory physiotherapists use and if it is the most widely acclaimed “hypothetico deductive model” used in the other domains of physiotherapy and medicine.

Because it is ethically difficult to conduct this type of research in the natural setting, I would like to invite you to participate in this study using a simulated patient in the Virtual Interactive Practice (VIP) suite at the School of Health Sciences, University of Southampton. This will mean that the study can focus on what you, the expert, are doing and not the care of the patient which in this case will be the human simulator SimMan 3G. Ethical approval has been obtained to include NHS staff and patients and their data under the Programme of Research and Education / Ethics into Virtual Interactive Practice (PREVIP Protocol version 4 2006, Ethics no: SONAM/006/2006).

In addition this study has received ethical approval from the School of Education December 2009. The research will be sponsored by the University of Southampton. A full copy of the PREVIP protocol can be given on request but specific sections will be referred to throughout this document.

Why have I been chosen?

You have been approached to take part in this study because you are an experienced cardio respiratory physiotherapist working in the NHS and have at least 3 years post graduate experience. You belong to the special interest group the ACPRC and you live within a 50 mile radius from the University of Southampton.

What will happen to me if I take part?

Conduct of data collection PREVIP protocol (section 4.4, p. 6)

Data will be collected in a non coercive manner. No pressure whatsoever will be brought to bear on any individual to consent to data collection, storage, or use. Any individual identifiable in any way will need to sign a consent form to give permission for their data to be collected, prior to data collection. The consent form clearly outlines the scope of the individuals consent i.e. up to and including broadcast, which will be explained maybe on the internet.

If you agree to take part, you will be required to attend the School of Health Sciences Virtual Interactive Practice (VIP) laboratory for approximately 2 hours. This will be required to be in your own time and not your working hours because of Research Governance. During this visit you will be asked to assess a simulated critical care patient that is on a simulated critical care unit. An acting Doctor and nurse will be present if you need to ask clinical questions about the patient. The patients' notes and charts will be available for you to read and access pertinent information. During this assessment you will be asked to speak out loud about what you are doing and this will be recorded. After you have completed the assessment you will have the opportunity to see your video recording of your assessment and you will be asked some questions by the researcher. After you have observed your video and answered some questions you will be able to leave.

The data collected and held in the database will only be used for the education of health care professionals. It is the intention of the researcher that when all the data has been collected and analysed to re-use some of the video material to produce an educational resource for student physiotherapists studying on the BSc Hons physiotherapy programme. As stated in the PREVIP protocol (section7.0, p.13) if at any time there is any 'Income generated from the sale of any such resources, it would be utilised by the School for the support of the education of Health Care Professionals and research into Health Care and Health Care Education.'

Are there any benefits in my taking part?

The benefit to you as an individual will be to have the opportunity to reflect and observe your own decision making process for your own professional development record (CPD). The benefit to the profession will be that you will be helping to develop a new area of knowledge and potentially develop a future education strategy for teaching undergraduate physiotherapists.

Are there any risks involved?

There are no risks involved because the patient is simulated and you will not be causing any harm to the patient. As stated in the PREVIP protocol section 4.7 p. 7: 'Category 1: Patients, relatives and staff:

There are no anticipated risks or hazards to patients, in fact having a care episode filmed may actually ensure best practice. The purpose of the database is to provide examples of real practice, it is not the intention to collect examples of poor practice, however it is not within the realms of possibility that such evidence could be captured inadvertently. (e.g. evidence that an NG tube was not in situ on a particular date when it should have been). There is the potential that this could provide evidence of poor practice, or on the other hand it could provide evidence that good practice was being followed. These issues are made clear in the consenting process.'

Video and audio data of the assessment will be collected in a non-coercive manner. No pressure whatsoever will be brought to bear on any individual to consent to data collection, storage or use. Any individual identifiable in any way (physiotherapists, and acting staff) will be required to sign a consent form to give permission for their data to be collected, prior to data collection. The consent form clearly outlines the scope of the individual's consent, i.e. up to and including broadcast, which will be explained may be on the internet. The individual will also be given a copy of the consent form to keep. In addition as

stated in the PREVIP protocol section 7.0 P. 12 'The identifiable data will be used in the context in which it was collected. Pseudonyms will always be used; the real subjects name will be kept confidential.'

The researcher involved with the data collection is a registered physiotherapist who is CRB checked and holds HPC registration. All data will be stored as in the (PREVIP protocol, section 6.0, p. 10) on dedicated servers/secure spaces in the University of Southampton. The data will be archived, as will the coded consent forms to enable efficient retrieval of the data. The servers/spaces are secure and password protected. The data is backed up on to tape nightly at 9pm; the tapes are stored on site in a locked safe in the finance office. The tapes are rotated every week, with the previous weeks backups stored in a safe offsite. The coded consent forms will be stored in a locked filing cabinet on University premises.

Withdrawal of consent Previp protocol section 5.4 p.10

On the consent form is a direct line telephone number which clearly states that participants can call to withdraw at any time and have their data removed from the database. To facilitate this process, each consent form will be coded to allow the researcher to identify all of the data collected from an individual so that this can be achieved efficiently. All the consent forms will therefore be kept in a locked filing cabinet in the School of Health Sciences, University of Southampton.

Data withdrawal Previp protocol section 6.2, p. 11

The research video data will be kept in accordance with the University research governance policy which as a guide is currently 15 years. If at anytime following data collection that a participant wishes to have their data withdrawn they must sign a withdrawal form.

Data request Previp protocol section 6.3 p. 11

Should the individual request a copy of their data at any time, this will be provided. It will be necessary to have a written request for this signed by the individual. This will allow us to verify the request by matching the original signature with the original consent form

There will be research guardians that will be independent contacts for this project should you have any concerns. These guardians are colleagues from the School of Health Sciences: Dr Mary Gobbi; Eloise Monger; Judith Lathlean and Sue Latter.

If anyone has any concerns following reading this information sheet or would like to see the full PREVIP protocol that overarches this project, please contact in the first instance Debbie Thackray dt5@soton.ac.uk, 023 80 595471, or Dr Mary

Gobbi m.o.gobbi@soton.ac.uk, 023 80 598270 or Professor Alison Fuller

a.fuller@soton.ac.uk , 023 80 598864. .

Appendix 3.9 Worked extract of simulated session in Synote

Code: P = physiotherapist, Pt = patient, NS= nurse

Yellow = identification of early themes in synote these were used as “headings” from which tags were created

[Timings from video footage]

[0:00 - 4:24] PT (36070)

P talks to NS about patient **Communication**

[0:02] NS: bowel resection via laparotomy didn't have a great night last night quiet tired 'cos of a new admisson

P: Ok

NS: kept him awake quite a lot he was suffering bit of pain on PCA changed from diamorphine to fentanyl still hasn’t really improved matters unfortunately

P: so he' s still quite uncomfortable as he is now?

NS: quite uncomfortable, compliance with PCA isn't great, he's on 60% humidified, O2 turned up in early hrs of am he dropped sats a bit was on 35% sats 95- 96 obs here today’s & yesterdays drug chart here old notes here, current episode here, X ray here, yesterdays' here

P: have you noticed any difference between how the change in the PCA is? would you say ....no different?

NS: no,no different

P is is he any more sleepy? awake? or.....?

NS: pretty much the same

[4:24] P Ok just wondered

Just looking at his chart now course of events to see if anything has changed last few hours & the preceding time overnight looking at observations here BP OK fairly normal, up & down a bit could be pain related i guess? normal pain score 0 not what the nurse has just said I think that maybe he hasn't got pain at rest but when I ask to do something not very well controlled has been doing some deep breathing theme recognition/identification

[5:20 - 5:44] patient (36090) **patient activity** Breathing

[7:03] P reading notes until 12.50 mins **data collection**

[12:47] P activity hand washing & puts on apron pr**ocedure**

[13:37] P activity (36104) Pt introduces self to patient **communication**

[14:19] P activity (36107) sats drop listens to chest **auscultation**

[14:24] P: assess the patient can I call you Alan

Pt hello there

P: Mr Day can I go ahead?

Pt: yes go ahead

P: alright thank you

P: just keep breathing normally for me Alan if you will examining

Pt oh yes

P; that's it , OK Alan can you take some deep breaths for me - nice big deep breaths in

Alan are you awake?

Pt yes

P how did you say your breathing is at moment? questioning

Pt: it feels tight,

P you feel wheezy?

Pt: a bit of gunge back there,

Pt some phlegm there I cant shift

P: how’s the pain in your tummy when you cough?

[15:51] Pt activity (36110) P asks patient qstns about their chest questioning

[16:28] Pt: sore not very pleasant getting worse

P: need to look at your pain relief so your breathing gets a bit better

P might be a good idea if we can sit you up a bit as well

Pt can I just sit here do things not very with it at moment

P: know you've not slept much, but yr breathing could get worse & deteriorate need more oxygen won't recover as quickly recommend need to do to get better Explanation

pain relief sorted out word with your nurse to get that sorted

Pt: alright

[16:57] P activity (36113)

P suggests sitting patient up to nurse explanation & action

[18:03]

P to NS: He is struggling with his pain relief I know he's only written up for some paracetamol; Turn his O2 up? His sats seemed OK until I went & spoke to him Has he got some Blood gases as well?

[18:40] P activity (36116) Discuss sats communication with nurse

[19:36] PT activity (36119) Discusses O2 requirements with nurse and

Treatment options

[20:04] patient activity (36122) WOB breathing increasing patients breathing rapid cue

[20:32] P: press your button for me to get some pain relief that should only take a minute to get some relief Nurse is going to give you some paracetamol as well if you are

you going to

[20:34] P activity (36125) PCA pain relief **treatment**

[20:34] ,Pt: okay ,

[21:28] nurse (36128) gives suppository **treatment**

[21:54] P activity (36131)

Wants to sit patient up talks through technique **treatment**

[23:00]

P: feel where my hands are, I want to feel your taking a big breath in & then breathe out through your mouth

[23:08] P activity (36134) Deep breathing exs commenced **treatment**

[23:34] deep breath in when you feel ready focus in on that bottom area and try to move those ribs up & outwards it sounds quite rattly to me at the back of your throat okay let's go, that's a good, a man, use your hands on your tummy to support where it sore big strong cough treatment

[24:38] patient activity (36137) tries to cough and expectorates

[24:51] P: More then? do you want to spit it out? i'll get a tissue lovely I'll come to the other side of the bed to give you some mouth care caring

[25:59] P activity (36140) mouth care given

[26:43] P activity (36143) rapport building **communication**

[27:31] [27:48] P activity (36146) try deep breaths again to cough a bit more phelgm up **explanation**

[27:53] P: is it easier to cough?

Pt: yes less painful ,

[29:48] P activity (36149) bend knees up to take strain off tummy **caring /empathic**

[30:29] P activity (36152) empathic **communication**

[31:03] P activity (36155) reassesses by listening to chest evaluaton

[31:43] Pt (36158) quiet **less distressed**

[32:32] P (36161) explanation do a bit more because sats not picking up **treatment**

[33:05] Patient (36164) feels slightly better **acknowledging treatment helping compliance**

[33:47] P activity (36167) aware that compliance not full because of pain

empathy

[34:25] P activity (36170) deep breathing exs more emphasis on deep breathing sigh out **treatment**

[35:02] P activity (36173) empathy pain relief to be working **communication**

[37:25] P activity (36176) monitors sats whole time evaluation

[37:44] P (36182) talks about pain relief press button regularly do br exs ask nurse to remind you to keep pressing PCA button & do Br exs **encouragement explanation**

[37:54] patient (36179) talks to PT about pain relief **communication about pain relief**

[39:20] P (36186) accepts time to let pt have a rest will come back in couple of hrs discusses what she wants to do this pm get out of bed sit out if pain relief OK, rest now, awake any time try br exs **explanation of what to continue doing what to expect later end of treatment session**

[41:41] P activity (36191) exs for legs & ankles for circulation to prevent blood clots

treatment

[42:37] Patient (36194) Pt does what P suggests seems very relaxed with P

compliance

[43:14] P activity (36197) speaks to nurse check temp a bit raised therefore didn't pull covers over patient **reasoning about temp**

[44:01] P activity (36200) speaks to nurse about clearing some phlegm send off sats did dip came back up after clearing he said he felt cold bit of temp pulled up a bit leave for you to gauge Dr done ward round yet? **pain relief communication about chest sats**

[45:47] nurse (36205) verifying action plan press PCA before deep breathing

Communication with Patient