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Urine Output: how and why is it monitored in acute medical environments?

by

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ABSTRACT

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Background: Urinary tract infection is a leading cause of healthcare associated infection in hospitals with around half of these being attributable to indwelling urinary catheters. Overuse of urinary catheters in healthcare settings is a known problem yet the extent to which it is possible to avoid catheter use is unclear. Urine output monitoring is one of the main indications for short-term catheter use, with acute kidney injury (AKI) and sepsis as key drivers to detect oliguria (low urine output). However, published guidance lacks clarity on when a catheter is needed for urine output monitoring, fueling uncertainty and potential for overuse in clinical practice.

Aim: The aim of this research is to explore how and why urine output is monitored in acute medical environments.

Methods: A sequential, explanatory mixed methods study was designed. Two approaches to data collection were used: a point prevalence survey of 17 medical wards, using the whole source population as the sample and analysed using descriptive statistics, followed by a focused ethnography in an acute medical unit and a medicine for older people ward using a purposive sample and reflexive thematic analysis.

Findings: The prevalence survey identified 107/389 (27.5%) patients had an indwelling urinary catheter. Almost half (n=49/107; 46%) were placed solely for the purpose of urine output monitoring. Most (n=87/107; 81%) catheters had a urine meter attached to enable 1-2 hourly measurements, but only 12% (n=7/60) were utilised for this purpose outside of critical care. The focused ethnography revealed how clinicians were influenced both by clinical and non-clinical rationales when justifying the need for a urinary catheter to monitor urine output. Distrust in the use of non-invasive collection methods was a significant contributing factor to catheter use.

Conclusion: Urinary catheters are thought to champion the accuracy of urine output monitoring, but it is debatable whether the drive for accuracy is jeopardising rather than improving patient safety. The redundancy of most urine meters outside of critical care in one hospital reveals considerable potential for reduction in urinary catheters and thereby in catheter-associated infections. However, uncertainty about the reliability and practical application of non-invasive approaches for urine output monitoring is likely to hinder such reduction and requires further investigation.

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Research Thesis: Declaration of Authorship

Print name: Camilla Elizabeth Holmes

Title of thesis: Urine output: how and why is it monitored in acute medical environments?

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

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7. None of this work has been published before submission.

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Definitions and Abbreviations

Acute Care: Acute care is a level of health care in which a patient is treated for a brief but severe episode of illness.

Acute Kidney Injury: Acute kidney injury is a form of kidney damage characterised by rapid and persistent decline in the glomerular filtration rate (GFR) resulting in the inability of the kidneys to eliminate nitrogenous waste products or to maintain adequate fluid and electrolyte balances.

Acute Medical Unit: This is the first point of entry for patients referred to hospital as emergencies by their GP and those requiring admission from the Emergency Department.

Antidiuretic hormone: Also known as vasopressin, a hormone that increases the volume of water reabsorbed from the collecting tubules of the kidney.

Dehydration: State of containing insufficient water in blood and other tissues.

Diuresis: Excess production of urine.

Healthcare assistant: Non-qualified nursing staff in the UK who assist in patient care and practice-related duties as directed by and under the supervision of a registered healthcare professional.

Track and Trigger: A system which uses periodic observations of basic vital signs (heart rate, blood pressure, etc.) together with pre-determined criteria to ensure timely recognition of deteriorating patients.

Medicine for Older People: A clinical service within hospitals providing care to those over 80 who are acutely unwell.

Registered Nurse: A person trained in the scientific basis of nursing, meeting certain prescribed standards of education and clinical competence.

Sepsis: Sepsis is characterised by a life-threatening organ dysfunction due to a dysregulated host response to infection.

Sepsis Six: The Sepsis Six is the name given to a bundle of medical therapies designed to reduce the mortality of patients with sepsis.

Oliguria: Reduced urine volume < 400 mL/24 hr or urine production less than 0.5ml/kg/hr.

Abbreviations

AKI: Acute kidney injury

AMU: Acute Medical Unit

ADH: Antidiuretic Hormone

BSI: Bloodstream infections

CAUTI: Catheter associated urinary tract infection

HCA: Health care assistant

HCAI: Healthcare associated infection

FBC: Fluid balance chart

MOP: Medicine for Older People

NHS: National Health Service

IUC: Indwelling urinary catheters

UTI: Urinary tract infection

RN: Registered Nurse

WHO: World Health Organisation

Chapter 1 Introduction

Measuring of urine output is common practice in hospitals to provide indication of kidney function, haemodynamic stability and to monitor fluid balance. It is a nursing responsibility to monitor whether a patient has an adequate urinary output and to report any significant reduction to the medical team. Measurements are used to guide therapeutic decision-making, such as fluid management or escalation of care. However, in practice, monitoring urine output accurately can be difficult to achieve and there are concerns that oliguria (low output of urine) is often overlooked leading to acute illness. Catheterising patients is one way clinicians have sought to mitigate the risk of missing possible reduced urine output.

Overuse of catheters continues to contribute to the burden of urinary tract infection, one of the most frequent infections acquired in hospital (European Centre for Disease Prevention and Control (ECDPC) 2013, Health Protection Agency (HPA) 2012). Somewhat ironically, by alleviating a possible risk of missing low urine output through use of a catheter, patients are exposed to an increased risk of a catheter associated infection, as well as other catheter-related complications. Urinary catheters are often left in place for longer than clinically necessary, putting patients at risk and contributing to the burden imposed by healthcare associated infections (Meddings et al. 2010). Overuse of urinary catheters for measuring urine in hospital is a known problem (Hu et al. 2014), yet the extent to which it is possible to avoid catheter use for urine output monitoring is unclear.

Catheter associated urinary tract infection poses a significant risk to patient safety and so too does undetected persistent oliguria. Paradoxically, the catheter offers early detection of deterioration yet exposes patients to potential harm. Clinicians must balance possible benefits of monitoring urine output with a catheter against the unintended adverse consequences. However, the limited empirical research and rigorous evaluation in this area has left clinicians to navigate this without an underpinning evidence base or clear guidance. Current guidance does not adequately particularise when hourly urine output monitoring is preferential over non-invasive measures and does not specify indications. This needs to be addressed to ensure patients receive the safest, evidence-based care. The work reported in this thesis contributes to this goal by identifying the clinical

rationales for urine output monitoring and establishes understanding on why clinicians in acute care believe the placement of a urinary catheter is necessary.

1.1 Structure of Thesis

This thesis presents a mixed methods study of how and why urine output is monitored in acute care environments. This in-depth study was undertaken across acute medical wards and explores what clinical practice related to urine output monitoring looks like in one large teaching hospital. A detailed explanation of participants perceptions of problems associated with monitoring urine output has been provided with a view to improve practice and help reduce overreliance on indwelling urinary catheters (IUC). The following section provides details on the structure of this thesis.

Chapter 2 provides the background to the study offering a full exploration of the literature on why monitoring urine output is important and the risks/benefits associated with IUC. The catheter paradox as a patient safety issue is presented leading to the rationale for the integrative review and mixed methods study presented in this thesis. Although there was no 'a priori' theory that informed this study, theories on clinical decision-making and reasoning were considered as the study evolved and explored in Chapter 2 and the discussion chapter. Research questions and objectives are presented at the end of Chapter 2.

Chapter 3 presents an in-depth integrative literature review reporting on urine output monitoring for adults in acute care to determine the underpinning evidence base, current guideline recommendations and what is known about present practice. This chapter highlights gaps in the current knowledge base, which includes a lack of studies exploring urine output monitoring practices in acute medical environments. This emphasises the need for this research study to move the topic towards an evidence-based approach.

Chapter 4 introduces the methodological framework that guided the design of the study. A sequential explanatory mixed methods approach that integrates quantitative and qualitative data was chosen as the most appropriate design to provide an in-depth understanding of urine output monitoring practices in acute care environments. This study adopted two approaches to data collection: a point prevalence survey of medical

wards followed by a focused ethnography in an acute medical unit and medicine for older people ward. Data collection occurred sequentially with quantitative data collected followed by qualitative data. Descriptive statistics and reflexive thematic analysis were used to analysis the data. Within this chapter, strengths and weaknesses of the methodology and methods chosen are discussed and a rationale for the study approach is provided.

Chapter 5 details the research methods and analysis undertaken and includes an account of the overall research design, considerations for ethical approval, the recruitment process, data collection and analysis procedures. The first phase consisted of a point prevalence survey across seventeen medical wards. The second focused ethnographic phase consisted of three main methods of data collection: observations, interviews and medical document analysis. The data were collected in the form of recorded interviews, informal conversations and field notes. Reflexive comments were recorded alongside to keep track of any personal influences, as well as identifying any underpinning themes as witnessed. A variety of different healthcare professionals participated in the research, including doctors, nurses and healthcare assistants, in order to allow for varying viewpoints and expertise related to the phenomenon.

Chapter 6 provides a personal reflexive account of the background of the researcher and their experience of collecting data in the field. Ethnographic research is shaped by the researcher acknowledging the insider/outsider view and the impact this has on reality and their research. This chapter therefore provides the reader with background information on how the researcher acknowledged their own involvement in the project and how this informed and influenced the research.

Chapters 7, 8 and 9 report the quantitative and qualitative findings of this study. These chapters describe the data from both the point prevalence survey and the focused ethnography to provide an in-depth understanding of urine output monitoring practices in acute medical environments within the study site. Descriptive statistics are presented in Chapter 7 to describe prevalence in order to understand the clinical problem and what current practice looked like at the time of the study. In Chapter 8, reflexive thematic analysis is used to present themes alongside selected quotations to support analysis and offer further insight. Chapter 9 provides a synthesis of the findings from the previous two

chapters towards meeting the research aim. The development of a descriptive and prescriptive conceptual framework for urine output monitoring practices was constructed from the findings to offer insight on the aspects of care since this has previously received little attention in the literature.

In Chapter 10, the findings of this study are discussed in light of the current literature. The unique contribution this study has made is highlighted and the potential for the research findings to add substance to existing theories are considered. Strengths and limitations of the study are reviewed and implications for practice emphasised. The chapter concludes by offering recommendations going forward to improve urine output monitoring practice and reduce reliance on IUC in acute medical environments.

Chapter 2 Background

2.1 Introduction

In years past, the use of indwelling urinary catheters and urine meters to monitor urinary output in medical patients were more commonly used for critically ill patients in intensive care (Maki and Tambyah 2001, Gould et al. 2009). In contrast, it is now common to find patients in acute medical wards with IUC inserted to monitor urine output (So et al. 2014). When a patient is unwell in hospital, oliguria has been linked to an increased risk of mortality (Vaara et al. 2015). Consequently, accurate monitoring of urine output is now a common indication for use of an IUC. An IUC with attached hourly collection bag (urine meter) is used by clinicians to obtain precise urine output measurements in order to assess renal perfusion, detect episodes of oliguria, and guide fluid resuscitation in haemodynamically unstable patients (Ralib et al. 2013). Whilst accurate hourly output monitoring necessitates use of an IUC, accurate, but not hourly, monitoring does not. Urinary catheterisation is not without risk, therefore it is important to distinguish those patients for whom a catheter is medically beneficial so that complications can be avoided whenever possible.

2.2 Contextual Background

It is known that catheters can be overused in acute care for urine output monitoring (Meddings et al. 2015, Murphy et al. 2015, Hu et al. 2014, Jain et al. 1995). Despite initiatives to decrease IUC placement, over one hundred million urinary catheters are used internationally every year (Nasr 2010). Up to 25% of hospitalised patients have a urinary catheter placed during their stay, of which nearly a third (31%) are recognised as inappropriate (Shackley et al. 2017, Saint et al. 2000). Moreover, even when catheters are indicated initially, they frequently remain in place longer than necessary. Jain et al. (1995) identified 64% of continued catheterisation was unjustified, which resulted from excessively prolonged use for monitoring urine output. A decade later, Hu et al. (2014) identified catheters are still being inserted for urine output monitoring when there is no evident reason to require monitoring.

So et al. (2014) audit results in acute care established urine output monitoring as the most commonly used indication for catheterisation (27%). In addition, Fernandez-Ruiz et al. (2013) found the most common inappropriate indication for catheterisation was urine output monitoring in a cooperative, non-critically ill patient. Over 40% of hospital associated urinary tract infections are attributable to IUC, therefore driving down unnecessary IUC use may be a key determinant to improve patient safety (HPA 2012). Despite this, there is a lack of in-depth exploration of healthcare professionals' perspectives on urine output monitoring practices, which has likely limited our understanding of behaviour in clinical practice.

It is unclear what has caused the 'normalisation' of catheters and urine meters to monitor urine output on acute medical wards. Conceivably, the 1980s invention of the urine meter drainage bag, which included a novel metering receptacle that facilitated the emptying of contents into a bag periodically, has allowed practitioners to monitor urinary output more precisely. Urine meters are now commonly available in most hospital settings. However, it is also possible that the complexity of modern medicine has led to an increase in the acuity of patients requiring closer monitoring on medical wards than in the past (National Confidential Enquiry into Patient Outcome and Death (NCEPOD) 2005).

In the United Kingdom (UK) shortages of intensive care beds has been well publicised (NCEPOD 2005). In comparison to European systems, the UK has one of the lowest number of critical care beds relative to the population (Rocks and Idriss 2020). Therefore, the lack in provision of critical care facilities has potentially led to acutely ill and unstable medical patients being cared for in a variety of environments throughout the hospital. A growing body of evidence has documented late recognition of deteriorating patients on general wards has led to delays in treatment and subsequently poorer outcomes (Goldhill and Sumner 1998, Bright et al. 2004, NCEPOD 2005, National Institute for Health and Care Excellence Clinical Guideline 50 (NICE CG50) 2007). Concerns have been raised that acutely unwell patients on general wards may receive sub-optimal care due to clinical deterioration not being recognised, appreciated or acted upon sufficiently quickly (McQuillan et al. 1998, National Patient Safety Agency (NPSA) 2007a).

McGloin et al. (1999) study revealed the unexpected deaths of thirteen patients in hospital were considered potentially avoidable as gradual deterioration in physiological and biochemical variables were recorded but appropriate and timely action was not

taken. The authors concluded that patients with obvious clinical indicators of acute deterioration can be overlooked or poorly managed in general ward environments. NPSA (2007b) analysis of 576 reported deaths identified 11 per cent (n=66) were as a result of deterioration not recognised or acted upon, highlighting how years after concerns were first raised, little improvement in care had been achieved.

In view of this, the past decade has seen increased focus on responding to deteriorating patients and an emphasis has been placed on early recognition and escalation. Initiatives to improve safety and the care of the acutely unwell patient have been widely implemented across hospitals in the UK following the NCEPOD (2005), NPSA (2007b) reports and NICE CG50 (2007). Track and trigger systems that alert staff to early warning signs of clinical deterioration and guide staff to initiate an appropriate response have been rolled out across the NHS. Early tools varied across the UK; however, they generally followed a similar format containing parameters to measure respiratory rate, oxygen saturations, heart rate, blood pressure, urine output, temperature and consciousness (Figure 1).

Figure 1. Example of an early Physiological Track and Trigger System

Score	3	2	1	0	1	2	3
Pulse		≤ 40	41-50	51-100	101-110	111-130	≥ 131
Respiratory Rate	≤ 7	8-10		11-14	15-20	21-29	≥ 30
Temperature		≤ 35.0	35.1-36	36.1-38	38.1-38.5	≥ 38.6	
CNS Response or GCS*			agitation/confusion	Alert 15	Voice 14	Pain 9-13	Unresp ≤ 8
Urine Output	≤ 10*	< 0.5**		> 0.5**			
Systolic Blood Pressure	≤ 70	71-80	81-100	101-199		≥ 200	

Although the reasons for increased hourly urine output monitoring remain uncertain, it is possible the change in approach to monitoring urine output in acute care environments has been driven by the requirement to calculate urine measurements as part of the track and trigger systems and the need to respond to a clinical deterioration in urine output more promptly.

In 2012, in order to reduce variation in healthcare, the Royal College of Physicians (RCP) developed a standardised tool called the National Early Warning Score (NEWS) which was subsequently updated to NEWS2 in December 2017 (RCP 2017). Notably, although urine output was considered as a parameter, the emphases on measurements was omitted from the national tool. The RCP justification for this choice is shown below.

> **"**The monitoring of urine output is important in many clinical situations. However, formal estimation of urine output is not always available at first assessment, and measurement of urine output is not routinely required for the majority of patients in hospital. The NEWS Development Group did not consider it practical or necessary for formal monitoring of urine output to be part of the scoring system for the NEWS. That said, we recognise that urine output monitoring is essential for some patients as dictated by their clinical condition."
>
> (Royal College of Physicians 2017 p19)

Within England, there has been rapid progress towards universal adoption of NEWS2 (The UK Sepsis Trust (UKST) 2019). However, although urine output as an early warning score was excluded from NEWS2, many other guidelines advising on acute kidney injury (AKI) and sepsis still promote judicious monitoring of urine (NICE 2019, UKST 2014).

2.3 Why is monitoring urine output important?

2.3.1 Anatomy and Physiology

Water makes up approximately 60% of human body weight and is vital for survival. Dehydration can occur when the body loses more fluid than it takes in, a loss of just 4% total body water will result in dehydration and a loss of 15-25% can be life threatening (Ashcroft 2000). The cardinal principle of fluid balance is that intake must equal output. The average intake and output of a normal adult is about 2,500 ml of fluid daily to which the main source of body fluid is from ingestion of fluid/food and the normal channels of exit of body water are in respiration (300ml), perspiration (500ml), urine (1500ml) and stools (200ml) (Saladin 2003).

The urinary system is one of the main routes through which the human body excretes waste and extra fluid. The urinary tract is divided into two sections: the upper and lower tract. The upper urinary tract consists of the kidneys and the ureters. The kidneys filter blood to remove toxins from the body and converts these waste products into urine (Kerr 2008). The ureters are narrow muscular tubes that allow urine to pass from the kidneys

to the lower urinary tract which includes the bladder and urethra. When functioning normally, urine is then stored in the bladder before being expelled from the body through the urethra during micturition (Chapple 2011).

Regulation of urine concentration and volume

The only way to control water output significantly is through variations in urine volume. Oliguria is defined as a urine output that is less than 400 mL/24 h or <0.5ml/kg/hr, anuria is defined as urine output that is less than 100 mL/24 h or 0 mL/12 h and polyuria is a condition characterised by the frequent passage of large volumes of urine (at least 3000 mL over 24 h) (Chen and Zeng 2019). A minimum of 500 ml of urine must be excreted from the kidneys daily, a reduction can lead to the accumulation of toxic waste products within the body, most notably creatinine and urea. Failure to produce the minimum volume of urine means that metabolic wastes cannot be effectively removed from the body, a situation that can impair organ function and lead to volume overload, acute kidney injury and electrolyte toxicity (Scales and Pilsworth 2008).

Antidiuretic hormone (ADH) secreted by the hypothalamus and stored in the posterior pituitary, regulates renal output. If a patient's intake of fluid is inadequate, the healthy kidney can compensate for this by excreting small amounts of concentrated urine, under the stimulus of ADH (Guyton and Hall 2006). If the patient is given intravenous fluids or urged to drink more than is required, the kidney is able to excrete the excess. However, disturbances of fluid balance and the ability to excrete excess fluid for some patients is impaired by disorders such as cardiac failure, cirrhosis of the liver, kidney disease or an acute illness (Roumelioti et al. 2018). Urine output is the only direct observation that can indicate end-organ perfusion of the kidneys.

In clinical practice a fluid balance chart (FBC) is used by healthcare professionals to record and monitor a patient's fluid status (Shepherd 2011). Scales and Pilsworth (2008) recommend a patient's fluid balance and hydration status should be assessed by reviewing fluid balance charts and blood chemistry alongside clinical assessment. Clinical assessment should include taking observations of vital signs, measuring capillary refill time, skin elasticity and body weight and monitoring urine output (Scales and Pilsworth

2008). However, these recommendations appear to be based on expert opinion and preference rather than on a sound evidence base.

2.3.2 Acute Kidney Injury

Acute kidney injury (AKI) involves a rapid and persistent decline in the rate at which the kidneys are able to filter waste products. Causes of AKI can be classified into pre-renal, intrinsic renal or post-renal and can all result in the inability of the kidneys to eliminate waste or maintain adequate fluid and electrolyte balances (Think Kidneys 2020). Appendix 1 provides an additional summary of AKI classification, risk factors and management.

AKI Detection

Acutely unwell patients may often already have, or be at greater risk of developing AKI. Therefore, NICE NG148 (2019) advise when adults are at risk of AKI, systems should be place to recognise and respond to oliguria (urine output less than 0.5 ml/kg/hour) if the track and trigger system does not monitor urine output. AKI can be detected, in line with the RIFLE (Risk, Injury, Failure, Loss, End stage renal disease), AKIN (Acute Kidney Injury Network) or KDIGO (Kidney Disease: Improving Global Outcomes) definitions, by using any of the following criteria:

- a rise in serum creatinine of 26 micromol/litre or greater within 48 hours
- a 50% or greater rise in serum creatinine known or presumed to have occurred within the past 7 days
- a fall in urine output to less than 0.5 ml/kg/hour for more than 6 hours in adults and more than 8 hours in children and young people

(NICE NG148 2019)

AKI Risk Factors

For patients admitted to hospital, NICE NG148 (2019) recommends clinicians investigate for acute kidney injury by measuring serum creatinine and comparing with baseline in adults with acute illness if AKI risk factors are present (Appendix 1).

For identified patients, ongoing assessment of urine output to ensure oliguria is recognised and responded to is advised (NICE 2019). This guidance highlights how significant numbers of patients admitted to hospital have risk factors for developing an AKI and therefore require urine output monitoring. Increased numbers of patients requiring fluid balance monitoring is likely to impact nursing workload which could affect accuracy of recording.

AKI is common in hospitalised patients, occurring in 10-20% of emergency hospital admissions (Think Kidneys 2016). However, older people are more susceptible to AKI, due to high rates of comorbid disease and reduced functional reserve that is needed to withstand insults such as sepsis (Think Kidneys 2018). Frail patients in hospital are particularly as risk of dehydration as they are often reliant on healthcare professionals to access fluids. The Mid Staffordshire NHS Foundation Trust Public Inquiry (2013) and a Care Quality Commission (2011) report identified hospital patients who were not being provided with enough water to drink, increasing their risk of dehydration. Input and output charts were also not accurately recorded, so progress was not monitored. Prioritising AKI detection and management in older people is a key intervention as AKI may be avoidable (Think Kidneys 2018).

AKI Prevention

Healthcare professionals play a vital role in the prevention, detection and treatment of AKI. The NCEPOD (2009) report demonstrated a need for significant improvement in AKI management as only 50% of patients were deemed to have had a “good” standard of care. An estimated 100,000 deaths in secondary care are associated with AKI, up to a third of which could be prevented (NICE 2013). Selby et al. (2012) reports that 39% of AKI were acquired within hospital, of which there was a 21% mortality rate. NHS England (2014) safety alert to clinicians highlighted the current delays in detecting and managing AKI within secondary care settings.

Harty (2014) advocates the prevention of AKI should follow the following principles:

- Risk assessment
- Optimisation of fluid balance
- Optimisation of blood pressure
- Medication review

A change to urine output, particularly a major reduction in the amount of urine passed (oliguria) is often a clinical hallmark of impaired renal function. In the majority of clinical situations acute oliguria is reversible if identified promptly and treated appropriately. However, if this therapeutic window is missed patients can develop AKI, which is associated with poor clinical outcomes (Kellum et al. 2015). Catheterising patients to monitor their urine output is one of the ways clinicians have sought to mitigate this risk which has likely increased the reliance on IUC in acute medicine.

AKI Management

For patients who do develop AKI, clinical management is directed at treating any causes, attempting to halt or reverse the decline in renal function, and if unsuccessful providing support by renal replacement anticipating renal recovery (Fry and Farrington 2006). As the majority of cases of AKI occur in association with volume depletion and sepsis, it is essential to restore effective renal perfusion as soon as possible (Harty 2014).

2.3.3 Sepsis

Sepsis is characterised by a life-threatening organ dysfunction due to a dysregulated host response to infection (Singer et al. 2016). It can also be described as the body's immune system overreacting to infection, leading to widespread inflammation and vasodilatation which can result in hypovolemia and reduced cardiac output (UKST 2019). Sepsis is also associated with increased risk of AKI (UKST 2019). UKST (2019) recommends that a screen for sepsis should be triggered when a patient has worsening vital signs (aggregate NEWS2 score of 5 or more) and in cases where red flag sepsis criteria are identified, clinicians are encouraged to implement the 'Sepsis 6' care bundle which contains the requirement to monitor urine output.

Sepsis has been recognised as a significant cause of mortality and morbidity in the NHS with an estimated 200000 episodes of sepsis and 52,000 deaths annually (NCEPOD 2015, UKST 2019). In 2017, an estimated 48.9 million cases of sepsis were recorded worldwide and 11 million sepsis related deaths were reported, representing 19.7% of all global deaths (Rudd et al. 2020). Ree et al. (2017) revealed sepsis carries a 35% mortality rate, highlighting the importance of rapid diagnosis and treatment.

Sepsis Risk Factors

NICE NG51 (2016) states the below group of people are at higher risk of developing sepsis:

- the very young (under 1 year) and older people (over 75 years) or people who are very frail
- people who have impaired immune systems because of illness or drugs
- people who have had surgery, or other invasive procedures, in the past 6 weeks
- people with any breach of skin integrity (for example, cuts, burns, blisters or skin infections)
- people who misuse drugs intravenously
- people with indwelling lines or catheters
- women who are pregnant, have given birth or had a termination of pregnancy or miscarriage in the past 6 weeks

Sepsis Screening

The Parliamentary and Health Service Ombudsman (2013) report "Time to Act" revealed failure to diagnose, monitor and rapidly treat sepsis is a major cause of avoidable death in NHS hospitals. NCEPOD (2015) 'Just Say Sepsis' explored remediable factors in the process of care patients with sepsis receive. Just over one third of the study population were considered to have received good care during their admission due to clinical aspects of care. Recommendations were made to ensure all hospitals used a formal protocol for the early identification and immediate management of sepsis.

In response to these failings, policy drivers such as national CQUIN goals (NHS England 2015) have promoted the systematic screening of patients to ensure identification and early treatment of sepsis. In 2015, the UKST in collaboration with NHS England developed Red Flag Sepsis, a set of criteria to rapidly measure is a patient was displaying a degree of organ dysfunction, aimed at empowering healthcare professionals to promptly act (UKST 2019).

Red Flag Sepsis criteria include:

- new or altered mental state
- systolic blood pressure ≤ 90mmHg (or drop of >40 from normal)
- heart rate ≥ 130
- respiratory rate ≥ 25 per minute
- needs O_2 to keep SpO_2 ≥ 92% (88% in COPD)
- Non-blanching rash / mottled / ashen / cyanotic
- lactate ≥ 2 mmol
- recent chemotherapy
- not passed urine in 18 hours (<0.5ml/kg/hr if catheterised)

Sepsis Management

In 2002 an international campaign was launched called the Surviving Sepsis Campaign with an aim to reduce mortality from sepsis, with early work concentrating on improving sepsis care in intensive care units (Dellinger et al. 2012, Robson and Daniels 2008).

Robson and Daniels (2008) developed an initial resuscitation care bundle designed to be deliverable at the bedside on general wards called the 'Sepsis Six', subsequently it was adopted by many NHS hospitals. The original Sepsis Six care bundle (Table 1) comprised of early goal-directed therapies to be delivered within one hour (Robson and Daniels 2008).

Table 1. The Sepsis Six

1. Deliver high-flow oxygen
2. Take blood cultures
3. Administer intravenous antibiotics
4. Measure serum lactate and send full blood count
5. Start intravenous fluid resuscitation
6. Commence hourly urine output measurement

Interchangeable use of “accurate urine measurement” and “hourly urine output measurement” has been described in different guidelines reporting the Sepsis Six (Robson and Daniels 2008, UKST 2014, Daniels et al. 2011) adding ambiguity to the recommended method of urine output monitoring. Daniels et al. (2011) found a significant reduction in mortality associated with reliable implementation of the Sepsis Six care bundle. The study reports when urine output was monitored, mortality rates reduced from 42.9% to 31%. However, due to the inability to control confounding factors, the study was unable to draw any ‘cause and effect’ conclusions.

Of note, NICE NG51 (2016) advice on sepsis management differs from the Sepsis Six recommendations as it does not explicitly promote the requirement to monitor urine output. More recently, the UKST (2019) updated the Sepsis Six care bundle to the Sepsis 6 as depicted in Table 2.

Table 2. The Sepsis 6

1. Ensure senior clinician attends
2. Give oxygen if required
3. Obtain IV access, take bloods
4. Give IV antibiotics
5. Give IV fluids
6. Monitor

Although UKST (2019) emphases there is still a requirement to monitor urine output, there is no longer the explicit recommendation for hourly measurements. It is unknown whether this refined guidance will reduce catheter reliance in patients with sepsis or whether the requirement for hourly monitoring has been so successfully implemented by prior campaigns to promote the Sepsis Six, that this practice will now be difficult to change or de-implement.

2.4 Urine Output Collection Methods

2.4.1 Non-invasive collection methods

Before placing an indwelling catheter for urine output monitoring it is advisable to consider whether non-invasive alternatives such as bedside commode, urinal, incontinence pads for both genders or external urethral sheaths for males would be more appropriate (Meddings et al. 2015). Although advisable, it is unclear whether such assessments take place in clinical practice as little research has been undertaken in relation to this element of decision-making.

External urethral sheaths have been identified as having the potential to be used for daily measurement of urine volume in male patients; however, it is unknown how well this method is utilised in practice. Saint et al. (2006) randomised trial found that the use of external urethral sheaths instead of an IUC in male inpatients was associated with a lower risk of bacteriuria and symptomatic UTI. This highlights how urethral sheaths could offer a possible, less risky alternative to IUC for monitoring urine output. A further study by Saint et al. (1999) explored patients' and nurses' preferences between external urethral sheaths and IUC in men with urinary incontinence. Results identified both patients and nursing staff prefer urethral sheaths to indwelling catheters for patient comfort, but they recognised that dislodgment and leaking are major drawbacks. It is possible, that leakage and therefore reduced accuracy could deter clinicians from implementing this method for urine output monitoring. However, further research is required to explore whether this alternative method of monitoring urine is both acceptable to clinicians and beneficial to patient outcomes.

Little is known about the possible reasons why non-invasive alternatives are used less often in adult care than in paediatrics for urine output monitoring. In paediatrics, alternative non-invasive methods such as weighing nappies and bedpans are often utilised instead with the rationale that urinary catheterisation is invasive, increases the risk of infection and causes significant distress to a child. Non-invasive monitoring of urine output is a well-established approach, where such alternatives are used in preference to indwelling catheters (Dutta et al. 2009). Despite reduced IUC use, anecdotal evidence suggests fluid balance monitoring within paediatric care settings is still considered to be

safe. Therefore, this raises a question as to why practice varies between these two patient groups and the reasons for this disparity.

Potential explanations could be perceived accuracy of fluid balance charting when using a catheter, convenience for staff and acceptability to patients. It is unclear what would be required in practice for there to be less reliance on catheters. It is conceivable that nurses default to urine output monitoring as a 'good answer' to justify catheter use and ongoing use. Although this has not been evidenced in the literature it is possible that the convenience afforded by catheters could be legitimated by an ostensibly more justifiable reason such as AKI risk.

2.4.2 Indwelling Urinary Catheters

For more than 3500 years urinary catheters have been used to drain the bladder of urine. The word *catheter* originated from the ancient Greek *kathienai,* meaning to *"send down"* or *"thrust into".* Historically urinary catheters were used exclusively for the treatment of urinary retention and early accounts describe the use of materials such as glass, pewter, and reeds. These primitive catheters were usually rigid and used for intermittent (in-out) catheterisation (Feneley et al. 2015).

The development of the malleable indwelling Foley catheter in the 11th century by American urologist Dr Frederick Foley, was a therapeutic milestone which made short and long-term catheterisation possible. In turn this opened up a new era of management for various medical procedures as well as general problems such as urinary retention and incontinence (Carithers and Palumbo 2018). Whilst traditionally used for the above indications, modern day indwelling catheters are now used for a variety of reasons. The principal reasons for IUC use are as follows:

- to permit urinary drainage in patients with neurological conditions which cause bladder dysfunction;
- to manage urinary in continence in patients lacking cognitive function;
- to minimise skin breakdown and pressure ulcers in paralysed, comatose or terminally ill patients,
- to irrigate the bladder;
- to administer chemotherapy;

- to aid in urological surgery,
- to undertake urodynamic studies;
- to obtain hourly/accurate measurements of urinary output in critically ill or post-operative patients. (Feneley et al. 2015)

However, given the current lack of empirical evidence on the appropriateness of IUC use, such lists are generally derived from guidelines based on expert consensus and practical considerations (Loveday et al. 2014, Conway and Larson 2012, RCN 2012, Gould et al. 2009).

Catheter prevalence in patients receiving National Health Service (NHS) funded care varies. A prospective study by Shackley et al. (2017) found patients who were catheterised in hospital, were more likely to be male, over the age of 70 and in critical care environments. However, Reilly et al. (2007) Health Protection Scotland prevalence survey found 20% of inpatients had a urinary catheter in place and were most commonly found in acute medicine and medicine for older people. Similarly, in England, a prevalence survey recorded the use of catheters in medicine for older people as 20%, although the report did not distinguish between appropriate and inappropriate use (HPA 2012).

It is evident from IUC prevalence rates (HPA 2012) that catheters must provide certain benefits to both clinicians and patients. Physiological benefits of an IUC include draining the bladder, which can help solve problems of urinary retention and unmanageable incontinence. In addition, patients have also reported psychological benefits of a urinary catheter, expressing how using an IUC has taken away anxieties about incontinence and has improved their quality of life (Health Talk 2017). However, literature reporting on benefits of IUC appears to be directed at long-term use with minimal research exploring the benefits of short-term urinary catheters used in hospital settings.

Murphy et al. (2015) qualitative study to understand clinicians' decisions to place a urinary catheter in hospitals reported a medic's view that "sometimes, it's just easier to stick a tube in" to monitor urine output. This study highlights, how clinicians often perceive catheters as convenient. Similarly, Hu et al. (2014) also revealed convenience of care was the most common reason for inappropriate catheter use in hospitalised older

patients. Despite the undisputed importance of prompt catheter removal, the convenience that catheters appear to provide clinicians may possibly offer an explanation as to why IUC are often left in place for longer than necessary. Research is required to explore why catheters are viewed by healthcare professionals as beneficial compared to other toileting methods.

Whilst it is acknowledged that IUC provide some benefits, use is also associated with negative infectious and noninfectious outcomes, including urethral trauma, mobility impairment, increased hospital stay, pain, discomfort and catheter associated urinary tract infections (CAUTI) (Hollingsworth et al. 2013). These risks should not be overlooked by healthcare professionals when assessing the need for catheterisation.

2.5 Risks and Benefits Associated with IUC

2.5.1 Urethral Trauma

The most immediate risk when inserting an IUC is urethral injury. Complications such as pain, bleeding and haematuria can occur instantaneously from excessive pressure applied during insertion or incorrect inflation of the balloon whilst in the urethra (Lee and Malatt 2011). Further iatrogenic urethral injury can occur as a result of ongoing catheter use, particularly when not adequately secured. Secure catheter fixation is an important part of catheter management but it is often neglected (Freeman 2009).

Long-term consequences of urethral trauma include urinary incontinence and urethral strictures, which can significantly impact on patients' quality of life (Hollingsworth et al. 2013). Davis et al. (2020) prospective study monitored the incidence of traumatic urinary catheterisation and the spectrum of long term complications associated with traumatic catheterisation. The incidence of traumatic catheterisation was 13.4 per 1000 catheters inserted in male patients. In total 78% of patients with iatrogenic urethral injuries developed urethral stricture disease during their follow up. Treatments included urethral dilation, urethrotomy, long term indwelling urethral or suprapubic catheter placements. One patient died due to severe urosepsis resulting from catheter balloon inflation in the urethra, highlighting the risks that catheterisation pose.

2.5.2 Mobility Impairment

During hospitalisation, older people often experience reduced mobility and activity levels, resulting in the loss of function and deconditioning (Kleinpell et al. 2008). Having an IUC may adversely affect the patient's mobility and thereby contribute to this problem. Indeed, urinary catheters have been described as a "one-point restraint" inferring reduced movement (Saint et al. 2002). However, the actual effect of IUC on mobility is an under-researched area. Kumar and Fisher (2012) retrospective case control study provides some evidence for short-term IUC and their impact on mobility. Findings reported that step activity of case groups compared to the control was significantly lower. The study concluded that older patients are less mobile when they have a urinary catheter and also have significantly longer lengths of stay in hospital.

In addition, Brown et al. (2007) qualitative study on perceived barriers to mobility during hospitalisation of older patients identified urinary catheters were recognised by health care providers as adversely affecting mobility amongst hospitalised older adults. When asked during semi-structured interviews most clinicians believed medical devices such as urinary catheters were barriers to mobility. However, in contrast only 30% of patients described their mobility as hampered by medical devices although one patient did spontaneously report "*I have had that catheter hooked up to me until today. That was a relief to get that out...I couldn't hardly do nothing with that.*"

2.5.3 Patient Experience

Relatively little research has been carried out on patients' experiences of IUC in acute care. A qualitative study by Safdar et al. (2016) assessed patient perspectives of IUC and reported 45% (9/20) of patients found IUC to be convenient as they did not have to walk to the bathroom. However, 100% reported alternative methods of toileting had not been discussed. 50% of patients reported an IUC as uncomfortable or painful and 25% described a sense of impairment on mobility. Remarkably, only 30% patients reported they were aware an IUC increased the risk of infection and 75% of patients perceived that they had not received adequate education on IUC risks.

These findings echo those of Greer et al. (2011) who reported 35% of the patients felt that IUC caused a significant amount of discomfort, however 52% (aged under 60) and 84% (aged 60 and over) preferred the placement of an IUC to using a bedside commode, bedpan, or incontinence pad. Once again, only 47% of patients knew that there was a risk of infections linked to IUC use.

It is clear from these findings that patients require information on the infectious and noninfectious risks of IUC. Improved knowledge of adverse complications may empower patients to participate actively in decisions about their continence care and may help motivate earlier catheter removal. Patient preferences towards IUC despite experiencing discomfort could be impacting on clinicians' decisions to insert and remove urinary catheters. Further research in this area would be beneficial in order to better understand patients' reluctance to use alternative methods of toileting whilst in hospital.

2.5.4 Catheter Associated Urinary Tract Infection

There has been extensive research on the development of healthcare associated infections as a direct result of medical treatment or contact in a health care setting. One of the most serious risks associated with urinary catheter use is catheter associated urinary tract infection (CAUTI). The European Centre for Disease Prevention and Control point prevalence survey of 2011-12 (ECDPC 2013) discovered 18.2% of acute care patients in England had a IUC in situ and the 59% of urinary tract infections in acute care were associated with IUC use. Similarly, HPA (2012) prevalence survey reported 43% of patients with a UTI had a IUC present within seven days prior to the onset of infection emphasising catheters as a risk factor for development of infection.

When the human body is functioning normally, the lower urinary tract flushes out the urethra as the bladder empties, preventing the movement of bacteria up from the periurethral skin into the urethra and then into the bladder. If bacteria manage to enter the bladder of a healthy individual, they will usually be expelled during micturition (Chapple 2011). However, the insertion of a foreign body such as an IUC can disrupt the body's natural defences and introduce microorganisms into urine creating a reservoir for infection (Mandakhalikar et al. 2016).

CAUTI are linked with a range of micro-organisms, in particular the gram-negative species. Escherichia coli (E.coli) is the most frequent bacterial species isolated from bacteraemic CAUTI patients in acute care facilities (Nicolle 2014). There is strong evidence to support these pathogens may gain access to the urinary tract either via the extraluminal route (on IUC insertion, contamination of the IUC from the healthcare worker's hands, ascending contamination from the perineum, colonic or perineal flora) or the intraluminal route (reflux of bacteria from a contaminated urine drainage bag) (Adams et al. 2012).

The risk of acquiring bacteriuria (bacteria in the urine) increases by 3-7% daily, emphasising how prolonged catheterisation is a major risk factor for CAUTI (Nicolle 2014). Approximately 3.6% of patients with CAUTI develop life threatening secondary bloodstream infections such as bacteraemia or sepsis, where mortality rates range between 10-33% (Shuman and Chenoweth 2010). Melzer and Welch (2013) discovered catheter-associated bacteraemic UTI were significantly associated with 7-day mortality compared with CVC-associated bacteraemic infections. Highlighting how efforts to reduce CAUTI should be prioritised.

In addition, healthcare-associated urinary tract infection has been found to extend the average length of hospital stay by 4 days, increasing NHS financial cost (Mitchell et al. 2016). It has been estimated that the cost of CAUTI to the UK National Health Service (NHS) could be as much as £99 million per year (Davenport and Keeley, 2005) at an estimated cost per CAUTI episode of £1968 (Ward et al. 2010). Feneley et al. (2015) suggests overall harm resulting from use of IUC, costs the NHS between £1.0-2.5 billion annually and accounts for 2100 deaths per a year, which highlights the need for intervention to reduce unnecessary use.

The actual economic impacts of CAUTI are difficult to accurately assess and therefore the health-economic evidence to inform investment in prevention is lacking. Smith et al. (2019) developed a decision-analytic model to estimate the annual prevalence of CAUTI and catheter associated bloodstream infections (CABSI), and their associated economic costs. The model estimated 43-61 thousand CAUTI and 6.9-8.6 thousand CABSI per year, resulting in 1.3- 1.7 thousand deaths and £37-78 million in direct hospital costs. For each percent reduction in urinary catheter prevalence, it was estimated that hospital trusts could avoid an average £7-15 thousand in excess direct costs owing from hospital-onset infection.

Recently in the UK, there has been a significant increase in the incidence of Gram-negative blood stream infections (GNBSI). In response, the Government launched an ambition to halve healthcare-associated E.coli GNBSI by 2020/2021 (Public Health England / NHS Improvement 2017). In addition, HM Government (2019) published a national action plan to tackle antimicrobial resistance which included a focus on reducing healthcare associated infections in particular reducing all gram-negative blood stream infections by 2023/24. Recent estimates suggest that 34-56% of hospital catheter-associated UTI may be preventable, in particular through prevention of unnecessary urinary catheterisation (Schreiber et al. 2018). Prevention of CAUTI is therefore classed as a high impact action in healthcare and better use of urinary catheters is a target for intervention in England to reduce healthcare associated *E.coli* bloodstream infections (Abernethy et al. 2017).

2.6 Catheter Associated Urinary Tract Infection Prevention Strategies

Since an editorial titled 'The case against the catheter' (Beeson 1958) was published, innumerable best-practice campaigns and guidelines have sought to reduce unnecessary urinary catheter use in order to prevent CAUTI (Gould et al. 2009, Loveday et al. 2014, RCN 2021). CAUTI prevention strategies have included clinical guidelines, bladder bundle initiatives and catheter passports. However, numerous attempts to reduce IUC and CAUTI have had limited success highlighting the complexity of the issue. More recently attempts to understand decision-making related to IUC use has received focus (Murphy et al. 2015, Atkins et al. 2020).

2.6.1 Clinical Guidelines

Multiple guidelines have provided recommendations to reduce CAUTI across the world. However, it is beyond the scope of this review to present all published IUC related guidelines. Therefore, as this study focuses on IUC use in acute care within the UK, clinical guidance in this area has been prioritised. The review identified four national level guidelines that have been widely adopted to reduce CAUTI. A brief overview of recommendations is given in Table 3.

Table 3. Guideline recommendations within the UK to reduce CAUTI

Year	Policy Name	Policy Category	Recommendations to reduce CAUTI
2014	epic3: National evidence-based guidelines for preventing healthcare-associated infections in NHS hospitals in England **UK**	Guideline	The Epic3 guideline recommends six distinct interventions for preventing CAUTI: • assessing the need for catheterisation • selection of catheter type and system • IUC insertion • IUC maintenance • education of patients, relatives and healthcare workers • system interventions for reducing the risk of infection.
2014	NICE QSG1: Infection prevention and control **UK**	Guideline	NICE quality standard G1 states there should be evidence of a written protocol to ensure that people who need a urinary catheter have their risk of infection minimised by the completion of specified procedures necessary for the safe insertion and maintenance of the catheter and its removal as soon as it is no longer needed. A list of specific procedures is provided which include: • accessing need for catherization • hand hygiene • IUC maintenance

2018	Health Protection Scotland Preventing catheter associated urinary tract infections – Acute Settings **UK**	Guideline	To help reduce CAUTI HPS has produced a bundle for preventing infection when inserting and maintaining an IUC. Key recommendations for inserting IUC: • alternatives to IUC have been considered • hand hygiene is performed • aseptic technique is used • smallest gauge IUC is selected Key recommendations for maintain an IUC: • daily review and remove if possible • ensure connection between IUC and drainage bag is not broken • empty drainage bag as clinically indicated
2021	Royal College of Nursing Catheter Care: RCN Guidance for nurses **UK**	Guideline	The RCN guideline recommend clinicians perform a risk assessment in order to decide in an IUC is the best management plan for the patient or whether non-invasive alternatives would be appropriate. The guidance highlights how some patients are particularly vulnerable to CAUTI. The guidance states it is important to minimise the use and duration of IUC in all patients, but especially those at higher risk for CAUTI-related morbidity and mortality such as: • women • the elderly • individuals with impaired immunity

Clinical guidelines to date are in agreement that the need for catheterisation should be assessed by clinicians before insertion however there are missed opportunities to detail specific non-invasive alternatives that could influence and/or change practice. A Public Health England report by Atkins et al. (2020) highlights how CAUTI policy interventions often serve the function of shaping knowledge but do little to motivate or restructure the environment. Instructions on how to perform certain behaviours, such as catheter insertion are frequently provided and health consequences are highlighted. However, guidance on prompts and cues to aid decision-making are limited. Atkins et al. (2020) suggest that by targeting motivation, social and environmental influences in guidelines, interventions may be more effective.

2.6.2 Materials and Design

In an attempt to reduce the risks associated with catheters, various different antimicrobial materials such as silver alloy-coated catheters and nitrofural-impregnated catheters have been trialled. Pickard et al. (2012) reported a randomised control trial, which aimed to establish whether short-term routine use of antimicrobial catheters reduced risk of CAUTI compared with standard polytetrafluoroethylene (PTFE) catheterisation. Results suggested anti-microbial-impregnated catheters were not effective for the reduction of CAUTI in elective surgical patients.

However, Prieto (2013) commentary piece on Pickard et al. (2012) highlights how it is difficult to ascertain whether the study findings are applicable to patients hospitalised for medical or critical care reasons. Such patients are generally more seriously unwell than patients under-going elective surgery, and often have increased hospital stays and a longer catheter dwell time. It is therefore uncertain whether medical patients would benefit from use of antimicrobial catheters.

The above evidence suggests efforts to reduce infection risks associated with catheters by changing the materials or designs have been unsuccessful. Therefore, it is clear clinicians and policy makers need to focus strategies on avoiding unnecessary IUC use as the most important intervention in prevention of CAUTI.

2.6.3 No Catheter No CAUTI initiatives

It has long been recognised that CAUTI rates can be reduced by minimising the number of catheter insertions. Meddings et al. (2013) promotes two types of interventions that target unnecessary urinary catheter use: (1) protocols and interventions to decrease *unnecessary placement* of urinary catheters and (2) interventions that *prompt removal* of unnecessary urinary catheters. Bladder bundles and catheter passports have been associated with reductions in CAUTI however there is limited prospective evaluation on protocols and interventions to decrease initial catheter placement.

Bladder Bundle

In the United States many improvement projects have been aimed at decreasing unnecessary IUC use to reduce CAUTI (Saint et al. 2009). An initiative known as the Bladder Bundle, focused on the timely removal of IUC and insertion only when medically indicated. The intervention led to a significant reduction in use and an improvement in the appropriateness of use IUC in hospital environments (Fakih et al. 2012). Likewise, Crouzet et al. (2007) found daily reminders from nurses to physician to remove unnecessary urinary catheters significantly decreased the duration of catheterisation in two out of five departments and the frequency of CAUTI also decreased. Similarly, Fakih et al. (2008) identified that nurse-led rounds focusing on reducing unnecessary IUC was successful.

In 2009, the Chief Nursing Officer for England advocated a bundle approach to minimising the risk of CAUTI (NHS Institute for Innovation and Improvement 2009). Ansell et al. (2017) quality improvement project used multiple approaches to reduce harm from urinary catheters which included implementing a catheter-care bundle alongside awareness campaigns. The programme successfully reduced local CAUTI by 30% emphasising the benefit of targeted approaches.

Catheter Passport

Codd (2014) 'Urinary Catheter Passport' aimed to improve the quality and experience of care for individuals who were catheterised and to encourage timely reviews and prompt removal. HPS (2012b) designed a national catheter passport which encouraged more autonomy in decision-making and aimed to reduce the length of time a catheter was insitu and therefore reduce the risk of infection. The RCN (2021) catheter care guideline advocates catheter passport use, however, uptake of the catheter passport remains low. Thornley et al. (2019) identified that catheter passport scheme was only in place for 13.1% of nursing homes and 5.5% of residential homes in the UK. Jaeger and Robinson (2017) found catheter passports were beneficial at informing nurses and empowering patients, although it is unclear if they have been beneficial in reducing duration of catheter use and CAUTI.

Despite local successes from catheter reduction initiatives and education on the technical protocols for preventing infection, efforts to reduce catheter use have had limited large-scale change and global CAUTI rates remain high (Huang 2016). CAUTI is a product of interrelated behaviours and complex decision-making performed by multiple individuals including nurses, doctors and patients (Atkins et al. 2020). The factors driving individual behaviours are likely to vary adding to the difficultly in uncovering explanations as to why IUC reduction strategies are not always successful. Understanding decision-making in relation to IUC use is essential in order to change behaviour.

2.6.4 Understanding Catheter-Associated Decision-Making

Atkins et al. (2020) focused on understanding and changing behaviours to prevent CAUTI. The secondary analysis of published literature identified six barriers and facilitators that influenced healthcare professionals' behaviour related to CAUTI; 1) Environmental Context and Resources (2) Knowledge (3) Beliefs about Consequences (4) Social Influences (5) Memory, Attention and Decision-making (6) Social Professional role and Identify.

One domain identified by this review, (3) Beliefs about Consequences, offers insight into catheter related behaviours. The report expressed current published literature suggested healthcare professionals have different beliefs about the consequences of catheter

insertion. Within this domain, the most frequently identified theme was convenience and ease of monitoring, for example inserting catheters for convenience purposes such as for measuring patients' urine output or avoiding transfers to a bedpan or commode (Atkins et al. 2020). There was also differing views in the literature on the severity of CAUTI with some studies reporting healthcare professionals perceived CAUTI as benign and others acknowledging risk.

Atkins et al. (2020) advised that interventions to target IUC behaviours related to convenience and ease of monitoring could be strengthened by implementing behaviour change techniques (BCT). The report suggests using BCT to influence how healthcare professionals value the importance of not catheterising patients for convenience.

Additional research by Wanat et al. (2020) explored how national interventions to reduce CAUTI could be improved by addressing healthcare professionals' behaviour in relation to barriers. The following recommendations were made:

- creation of a rule that requires staff transferring catheterised patient to another setting to review the need for a catheter with the receiving team
- before catheter insertion, staff are required to inform patients and relatives about the pros and cons of catheters including associated risks
- ensure availability of agreed guidelines which include examples of how to adapt care to local contexts
- standardised nationwide electronic documentation, accessible across healthcare sectors, requiring the person initiating catheterisation to insert detailed information such as reason for insertion and action plan for removal
- interventions to persuade staff of the benefits of not using catheter, reassure staff that not using catheters does not lead to suboptimal care and reframe severity of CAUTI as a patient safety issue
- introduce 'CAUTI Champions'
- ensure provision of bladder scanners

Meddings et al. (2013) highlights how improving practice regarding IUC placement and removal also requires interventions to change the expectations and habits of nurses, physicians and patients about the need for urinary catheters. Murphy et al. (2015)

acknowledged how opinions on when an IUC is required vary considerably. Variation in practice and beliefs on the level of risk associated with catheters is likely to impact the success of campaigns to reduce catheterisation rates.

In addition, although criteria for insertion and continuation are known, there are few tools to aid with removal decision-making which could impact on nurses' confidence to initiate IUC removal. Wenger et al. (2010) reported some nurses do not feel comfortable removing a catheter without explicit orders from a physician. Whereas, Meddings et al. (2013) state some nurses are reluctant to remove IUC due to disagreement with the catheter policy and/or a desire to avoid inconveniences such as the increased frequency of contact required to care for a patient's toileting needs without a catheter.

Trovillion et al. (2011) developed a nurse led catheter removal protocol using the acronym HOUDINI. The HOUDINI protocol used to list the indications for continued use of an IUC:

- Haematuria
- Obstruction
- Urology surgery
- Decubitus ulcer
- Input and output measurement
- Nursing end of life care
- Immobility

Where none of these indications exist, the catheter should be removed.

A study by Adams et al. (2012) demonstrated a decrease in both IUC usage and *E. coli* IUC-associated positive urine samples after implementation of the HOUDINI protocol. In addition, those using HOUDINI found it a positive aid to optimal decision-making which improved practice. However, in relation to urine output monitoring, the HOUDINI approach could be criticised for failing to identify any recommendations advocating non-invasive methods for urine output monitoring. The approach appears to assume an IUC is the only feasible method for measuring output and should remain in place until the indication ceases.

The above account has provided a review of initiatives available to support the reduction

of catheter use. However, the consensus from the literature is that there is compelling evidence to support the need for further research that aims to understand clinicians' decision-making in order to change behaviour in practice and reduce unnecessary catheterisation. It is important to establish whether understanding clinical rationales for catheter use has any additional value in preventing CAUTI.

2.7 Clinical Decision-Making and Risk Perception

In order to understand a particular healthcare process such as urine output monitoring and IUC use, it is important to consider the context of clinical decision-making and risk perception. It was beyond the scope of this chapter to systematically review all available literature on these topics; therefore, the following section will focus on literature related to decision-making theories and risk perception literature, which has been identified as most relevant to the research study. The decision-making theories discussed offer insight into different aspects of clinical behaviour and although there was no 'a priori' theory that informed this study, theories of decision-making were considered as the study evolved.

2.7.1 The Rational/ Classical Decision-Making Theory

The Rational/ Classical Decision-Making Theory assumes that decisions are completely rational and favours objective data and a formal process of analysis over subjectivity and intuition (Huczynski and Buchanan 2001).

Rational decision-making includes a multi-step process (Robbins and Judge 2007):

1. A problem is identified and framed.
2. Goals and objectives are established.
3. All the possible alternatives are generated.
4. The consequences of each alternative are evaluated in terms of goals.
5. The best alternative is selected—that is, the one that maximizes goal achievement.
6. Finally, the decision is implemented and evaluated.

Lee et al. (1999) emphasises how the rational/classical decision theory views the decision maker as acting in a world of complete certainty. The model assumes that the decision maker has full or perfect information about alternatives; it also assumes they have the time, cognitive ability, and resources to evaluate each choice against the others. Critics of the model argue it makes unrealistic assumptions, particularly about the amount of information available and an individual's ability to processes this information when making decisions (Li 2008). It is argued that decision makers often lack the ability and resources to arrive at an optimal solution, therefore satisfactory solutions are often sought over optimal ones. Beach and Lipshitz (1993) argue logical models of reasoning are of little use in the complex, dynamic, uncertain world in which we live. Therefore, it is unlikely that the rational/ classical decision-making theory can reflect the reality of clinical healthcare settings where complexity, uncertainty and ambiguity prevail. The applicability of the Rational/Classical decision-making theory in regards to understanding practice related to catheters and urine output monitoring is limited as such decisions are usually made in complex clinical environments under uncertain situations (Currey and Botti 2003).

2.7.2 Naturalistic Decision-Making

Naturalistic decision-making (NDM) theory emerged in the 1980s and has been identified as helpful in understanding decision-making. NDM theory can be used to explore how people perform cognitively complex behaviours in real world settings, such as emergency environments, where time is limited and stakes are high (Klein et al. 2010). NDM theory acknowledges three factors that influence decision-making: factors associated with the decision maker such as knowledge and experience, factors associated with the task such as complexity and factors associated with the environment (Currey and Botti 2003).

In clinical practice, healthcare professionals are faced with complex situations, which are affected by hierarchy, ownership and levels of responsibility which are not easily replicated in laboratory or simulation studies (Hancock and Easen 2004). The NDM framework focuses on cognitive functions such as sensemaking, situational awareness, and planning. Situation awareness includes having an understanding of the significance of contextual factors and the potential consequences of these factors on a situation (Nibblelink and Reed 2019). The NDM framework explores how contextual factors such

as organisational systems, workload, time restraints and working within a high pressure environment influences decision-making (Klein et al. 2010). Although it is not frequently adopted within healthcare research, the NDM framework is designed to take place in real world settings and therefore offers an approach to the study of clinical decision-making that can add to current knowledge (Bond and Cooper 2006).

NDM research can develop descriptive accounts which incorporate interplay between task, person and environmental factors (Klein et al. 2010). Klein et al. (1986, 2010) seminal study on how fireground commanders handle emergency events reported commanders saw themselves as acting and reacting on the basis of prior experiences and modifying plans to meet the needs of the situation rather than making choices or considering alternatives. The recognition-primed decision (RPD) model was therefore derived from the NDM framework and identifies how people use their experience in the form of patterns that include relevant cues, expectancies, plausible goals and typical outcomes (Klein 1993). The model suggests when people need to make a decision, they can quickly match the situation to the patterns they have experienced in the past and therefore make a rapid decision (Klein 2003). The RPD model relies on satisficing (Simon 1955) rather than optimising, meaning that people choose the first option that works not necessarily the best option.

The RPD model has applicability to the work of this study as in fast paced clinical environments, rapid decision-making is often required. Previous experience and use of protocols such as the sepsis six are referred to, to guide decision-making rather than individual patient risk-benefit analysis. In addition, in an optimal world, non-invasive collection methods would be used accurately and clinicians would be able to trust the measurements provided to guide therapeutic decision-making. However in reality, the barriers to successfully utilising alternative methods often result in satisfactory solutions being sought by clinicians (instead of optimal) which inevitably leads to the catherisation of patients to monitor urine output.

Nibblelink and Reed (2019) used theory derivation to formulate a new nursing model (Practice-Primed Decision Model) relevant to a practice context of acute care nursing. This model could therefore offer greater insight into catheter related decision-making and

will be discussed in greater detail in the discussion chapter. Details on how this model aligns with the findings of this study will also be addressed.

2.7.3 Risk Perception

Sociological, anthropological and psychological literature has contributed significantly to gaining an understanding of how risk is constructed, perceived and responded to. Risk can be defined as "a measure of the probability and severity of adverse effects" (National Safety Council (NSC) 2003). A calculation of how likely an incident is to occur and given its occurrence, how dire the consequences would be (NSC 2014). A critical part of gaining informed consent from patients for various medical procedures is the understanding of risk, the probability of complications, and the predicted occurrence of adverse events. However, in relation to catheterisation, patients are rarely informed about the potential complications that can arise (Safdar et al. 2016).

Risk quantification and management are not necessarily part of all healthcare professionals core skillsets (Stahel et al. 2017). The ability to accurately assess the risk of a situation is dependent upon an individual's risk perception and risk tolerance. Risk perception is the ability of an individual to recognise a certain amount of risk whereas risk tolerance refers to the capacity to accept it (NSC 2014). Risk perception literature suggests when the outcome or consequence of a risk is perceived to be serious, the more concern a person will have about the risk (Bond and Nolan 2011).

Catheterising patients is one way clinicians have sought to mitigate the risk of missing possible reduced urine output. However, it appears risks associated with catheterisation can be over looked or tolerated as an acceptable risk (Harrod et al. 2013). UTI's appear to be trivialised as a minor infection compared to a bloodstream infection, despite the potential for CAUTI's to lead to this (Atkins et al. 2020). The lack of clarity in the literature of when benefits of using an IUC for urine output monitoring outweigh the risks makes decisions making in practice more difficult.

According to NSC (2014), factors that affect risk perception and tolerance can be organised as macro-, meso- or micro-level. Macro level factors refer to structural or institutional influences. Meso level relates to peer-to-peer factors whereas the micro level focus is on the individual psychological influences. Although evidence suggests that

risk perception affects risk behaviour, little is known in relation to clinical decision-making around catheter use in healthcare settings. Macro-level factors such as the safety culture of an organisation can impact risk perception and tolerance. Workers employed in organisations with a positive safety culture where there is high emphasis on safe working procedures were less likely to display risk taking behaviour (Fleming and Buchan 2002). Despite these examples being related predominately to risk to self (employee health and safety) rather than risk to others, Dixon-woods et al. (2009) reports risks in the environment they studied, were not simply risks to patient safety but when things went wrong or rules were broken, professional identify was at risk too.

Meso-level risk perception factors are influenced by peer relationships (NSC 2014). New employees joining an organisation may quickly begin to take unsafe shortcuts whilst performing tasks if they see other experienced and longstanding employees doing so. Whereas, micro level factors affecting risk tolerance can be attributed to an individuals' level of knowledge. An individual who is less informed in a situation may be less likely to take risks compared to somebody with more knowledge leading to higher levels of risk tolerance. Optimism bias is another factor influencing risk perception on a micro-level as individuals have a tendency to believe that a negative event is less likely to occur to them. Although this predominately relates to risk to self rather than how healthcare professionals view risk in relation to patients, Torrens et al. (2019) suggests that doctors can be affected by optimism bias and these perceptions can potentially have an effect on the patient decision-making process.

2.7.4 The Psychometric Paradigm

The Psychometric Paradigm (Slovic et al. 1982, Slovic et al. 1991) was an influential model used in explaining how lay people (nonexperts) perceive various hazards. The Psychometric Paradigm uses scaling methods to produce quantitative judgments about the perceived riskiness of various hazards. This paradigm envisages risk as a psychological construct, drawing on various characteristics important in influencing risk perception (Krewski and Tyshenko 2011). The fundamental element of this approach is to isolate experts and public risk perceptions on the understanding that these two groups do not perceive or respond to risks in the same way.

Etkin (2016) explains there is a large gap between how experts tend to judge risk and how the lay public does. Experts tend to be far better at solving particular problems, but are more likely to frame a problem within a narrow perspective. Whereas, the public tends to have a much broader perspective on how to assess risk and include factors such as the benefit the hazards may provide to society, dread, controllability, catastrophic potential, uncertainty, and equity.

Notably, not all healthcare staff necessary equate to being "experts" on all the clinical risks patients may face, however, Dixon-Wood et al. (2009) reports staff were routinely engaged in determining what gets to count as a risk and how risk should properly be managed. The Psychometric Paradigm model is therefore helpful in acknowledging that people can understand and rate risks differently, however it is believed by some to be limited in its explanatory ability (Krewski and Tyshenko 2011). In relation to this study, the paradigm was considered to be of limited use as it assumes risks can be assessed using a quantitative approach which does not take into consideration the impact of social and cultural influences.

2.7.5 The Cultural Theory

The Cultural Theory of risk states that individuals may be assigned to different cultural groups based on shared values and similar belief systems (Douglas and Wildavksy 1982). The point of the theory was to identify judgements are not formed independently of social context (Tansey and O'Riordan 1999). A Grid-Group typology was developed as a tool to understand different logics of risk as they are expressed in particular social groups or organisations, these groups were characterised as hierarchists, egalitarians, fatalists and individualists (Douglas 1970).

The significance of Cultural Theory for risk perception, and particularly for health-related risks, is that viewpoints about expertise, scientific integrity and the credibility of health-related messages will all be influenced by the interactional context in which judgements are made (Tansey and O'Riordan 1999). Tansey and O'Riordan (1999) report at the micro level of health interventions, issues relating to Cultural Theory are important for understanding the risks individuals choose to expose themselves to or choose not to avoid. Rather than reducing these choices to psychometric predispositions, cultural theory provides a framework to help understand how those seemingly 'irrational' choices

are shaped by the social context. For patients, this may depend on the extent to which consent for a particular intervention or treatment was informed. In relation to urine output monitoring, the culture of the unit and individual clinician preference or perspective may also shape how risk in regards to catheterisation is perceived.

Harrod et al. (2013) highlights how multiple perceptions of risk, some non-evidence based, were used by healthcare providers to determine if use of the indwelling urethral catheter was necessary. Dionne et al. (2018) emphases how the perception of risk can be subjective. High risks can be underestimated, low risks overestimated and the rationality with which individuals make decisions can be influenced by perceptual biases. Risk is often locally or possibly individually defined by healthcare professionals impacting on their decision-making and responses to perceived patient risk.

In addition, Dixon-Woods et al. (2009) found healthcare professionals social context influenced their ability to adhere to good practice. Healthcare professionals reported influences outside of their control such a demanding workload affected the care they were able to provide. In addition, Dixon et al. (2009) reports staff would frequently describe the absence of certainty that a process would be reliable, particularly if collaborative work across team and time was required. Murphy et al. (2015) highlights how clinicians' view catheters as "easier" for monitoring urine output and were usually required in order to be precise. It is therefore possible, that clinicians recognise risks associated with catheters but the convenience they afford to increase the accuracy of urine output monitoring in a complicated healthcare system outweighs these risks.

Despite the Psychometric Paradigm and Cultural Theory being widely used, these theories originated within anthropology, therefore their application to health-related risk perception is limited. Although risk perception theory in general is a topic well studied, considerably less is known about risk perceptions of healthcare professionals, particularly around the context of urine output monitoring and IUC use. Further research is urgently required to shed light on this important topic.

2.8 Competing Priorities: The Catheter Paradox

AKI and sepsis are not innocuous; they have association with increased mortality across the globe, but so too does CAUTI. Both reducing healthcare associated infections and improving AKI and sepsis care are important to patient outcomes. However, competing national policies can cause priority overload making local compliance difficult to achieve. It is indisputable that both rapid AKI/sepsis management and infection prevention should be healthcare priorities in order to maintain patient safety. However, differing health initiatives need to work in cooperation with each other to prevent the focus of one campaign exacerbating the problems of another.

Both reducing healthcare associated infections and improving AKI and sepsis care remain high on the government's safety and quality agenda. However, patient safety initiatives are often seen by health care providers as competing with one another rather than being complementary (Harrod et al. 2013). The decision whether to insert an IUC to improve urine output monitoring accuracy in acute medical environments or to use non-invasive collection alternatives to avoid infection risks presents a challenging patient safety dilemma for clinicians. The catheter paradox, in which catheters on the one hand can offer early detection of deterioration, however at the same time can expose patients to harm is not a problem that can easily be mitigated.

The UK Government has assigned various Commissioning, Quality and Innovation (CQUIN) incentives to support improvements in the quality of services in relation to catheter use, sepsis and AKI (NHS 2013, NHS England 2015). In 2013-2014, the CQUIN addressed IUC related harm in hospitals. However, incentivising a set target for reduction in urinary catheter use was considered to be counterproductive, as for a number of patients there would be a genuine clinical need for catheterisation (NHS 2013). Instead, the CQUIN incentivised the collection of data using the NHS Safety Thermometer on four common healthcare associated harms, one of which was urinary tract infections in patients with catheters (NHS 2013). The NHS Safety Thermometer (NHS 2013) aimed to provide organisations with a point of care survey tool to monitor the proportion of patients with a catheter, and the proportion of patients with a catheter who were also being treated for a UTI. The overall aim being to improve the quality of care provided to patients and reduce incidence of avoidable harms such as CAUTI.

Shortly after, the national CQUIN goals for 2015-16 included incentivising providers to focus on AKI diagnosis/treatment in hospital and promoting the screening of sepsis for prompt recognition and initiation of treatment (NHS England 2015). Initially, the sepsis CQUIN focused on patients arriving at hospitals via Emergency Departments but in 2016-2017 this was extended to all inpatient areas.

The benefit of the CQUIN strategy is to shine a spotlight on patient safety issues at the organisational level, ensuring NHS providers evaluate the quality of their care. However, one downside of the mechanism is that successful campaigns risk diverting attention away from different clinical problems and possibly exacerbate others as an unforeseen consequence. Balancing messaging and risk between the importance of accurate urine output monitoring to promptly detect deterioration and the need to reduce healthcare associated infections related to IUC use is challenging. Addressing this issue will be one of the key areas of focus of this research project.

Further criticisms of patient safety initiatives are that they have led to overly prescriptive guidelines that unintendedly challenge medical autonomy and individual decision-making (Berwick and Leape 2005). The development of guidelines and protocols are designed to enhance quality of care; to be used in conjunction with clinical judgement and risk-benefit assessments of the individual patient being treated. However, there is concern that a guideline culture is exacerbating the practice of defensive medicine. O'Dowd (2015) highlights how doctors are becoming more cautious and practicing "defensive" medicine to prevent litigation after treating patients. The General Medical Council (GMC) states doctors were overly conscious of the possibility of patients taking legal action against them or complaining to the GMC as fitness to practice cases continue to increase.

Accountability for reviewing a patient's fluid and hydration needs on an ongoing basis and documenting this lies with both nursing and medical staff. It is not uncommon to find nursing fitness to practice cases referring to omissions in care when nurses have failed to adequately complete fluid balance charts. In one case, the panel concluded the failure to document an accurate record of fluid balance for a deteriorating patient placed the patient under unwarranted risk of harm and contributed to the patient dying significantly sooner (Conduct and Competence Committee Substantive Hearing 2016.) Fear of regulatory reprisal has the potential to influence a healthcare professional's decision to insert a catheter as a cautionary approach to improve urine output monitoring accuracy.

However, patients can also be harmed from catheter related injuries. Awad et al. (2016) review into IUC and medical malpractice claims in the USA found monitoring urine output was the leading cause for IUC insertion in their malpractice population. Notably, in an effort to prevent CAUTI in the USA, the Centers for Medicare & Medicaid Services has implemented a policy to no longer reimburse hospitals for healthcare acquired CAUTI, as they deem these reasonably preventable (Meddings et al. 2013). They have since been targeted for complete elimination as a "never event", with a national goal to reduce CAUTI by 25% and reduce IUC use by 50% (Department of Health and Human Services 2009).

It is evident that national policies view both focusing on reducing healthcare associated infections and prompt detection of patient deterioration as important. The National Patient Safety Improvement Programme aims to build on the existing focus on preventing avoidable deterioration as well as reducing healthcare associated infection, in particular by aiming to reduce healthcare associated gram-negative blood stream infections by 50% by 2023/24 (NHS England and NHS Improvement 2019). However, addressing the paradox between IUC use and detecting oliguria is not straightforward and there is a need for greater understanding on how these policies translate in practice.

2.9 Rationale for Study

Despite AKI and sepsis causing global concern, there is relatively limited literature on urine output monitoring indications and processes. Conflicting health priorities and the lack of catheterisation guidelines for patients who have or are at risk of oliguria makes it difficult for clinicians to differentiate between when a catheter is required and when alternative, non-invasive, approaches (e.g., urine collection and weighing of urinals, bedpans or incontinence pads, external urinary sheaths) would suffice. There is uncertainty as to when hourly versus accurate output monitoring is needed and which methods of urine output monitoring are most beneficial to patient outcomes. Current guidance does not adequately particularise when hourly urine output monitoring is preferential over non-invasive measures and does not specify indications. It is therefore unsurprising that dissonance exists.

Even with careful implementation of the catheter care guidelines, it is evident that infection remains a significant risk with ongoing IUC use. CAUTI prevention incorporates various decision-making components, such as indications for catheter placement and removal and advocacy for alternative non-invasive toilet options. Murphy et al. (2015) highlight the important role clinicians' individual decisions have on the placement of IUC. Therefore, it is possible behavioural and decision-making aspects remain a prominent barrier to the successful implementation of interventions. Harrod et al. (2013) emphasises the importance of understanding clinicians' decision-making in terms of IUC before attempting to introduce initiatives to change practice. It is known that clinicians frequently insert IUC for urine output monitoring in acute care. However, the decision-making process for this is not fully understood.

Nearly twenty years have passed since Pepperel (2002) highlighted a lack of consensus concerning the point at which patients with oliguria require catheterisation. However, owing to a lack of research, little progress has been made. To improve urine output monitoring whilst also reducing unnecessary IUC use, we need to further understand why clinicians believe an IUC for urine output monitoring is needed and how these decisions are influenced. The issues faced by healthcare professionals when trying to implement urine output monitoring using non-invasive collections methods need to be recognised so the problem can be defined before solutions sought.

Strategies to reduce IUC insertion for urine output monitoring need to be prioritised and implementation of non-invasive alternatives advocated. Understanding clinicians reasoning and decision-making processes regarding urine output monitoring is an important first step to improving care and patient safety. The question 'how and why is urine output monitored in acute medical environments' needs to be explored in order to comprehend these issues before any further initiatives or interventions are repeated.

2.10 Research Questions and Objectives

Despite substantial literature reporting inappropriate use of catheters for urine output monitoring in acute care (Apisarnthanarak et al. 2007, Fernandez-Ruiz et al. 2013) there has been no research that has sought to understand the complexities surrounding this phenomenon. This mixed methods study seeks to offer an original contribution to

knowledge providing insight into urine output monitoring practices in acute medical environments. The long-term goal, although not a current aim for the proposed study, seeks to establish evidence-based criteria that can be used by healthcare professionals to guide decisions on how and when to monitor urine output, in order to promote a more judicious approach to monitoring and prevent inappropriate bladder catheterisations. However, in order to develop effective and usable criteria, an in-depth understanding of current practice is first required. To achieve that goal, the following research questions and objectives are addressed by the study reported in this thesis:

2.10.1 Research questions:

1. What is the prevalence and extent of variation of urine output monitoring using catheters and non-invasive methods in acute medical environments?
    a. How frequently and precisely is urine output measured and recorded?
    b. What are the documented rationales for urine output monitoring in clinical practice and how consistently are they applied?
2. How is information about urine output used by clinicians to provide treatment?
3. What factors influence clinicians' use of urinary catheters versus alternative, non-invasive methods of urine output monitoring in two different medical environments?

2.10.2 Objectives:

a) To establish the prevalence of urine output monitoring using catheters and non-invasive methods in acute medical environments in one NHS hospital foundation trust;
b) To describe how clinicians, undertake urine output monitoring and the factors that influence this in practice;
c) To identify clinical rationales for urine output monitoring;
d) To identify inconsistencies/variations in catheters and fluid balance chart use;
e) To explore how urine output measurements influence therapeutic decision-making;
f) To investigate clinicians' perspectives of the utility of urine output monitoring using catheters and non-invasive methods;

g) To conduct case studies of interest to reveal patient care pathways and illustrate different decisions made over time; where possible patients views will also be recorded.
h) To identify opportunities to improve the quality of care and reduce costs relating to urine output monitoring, including avoiding unnecessary bladder catheterisation.

2.11 Chapter Summary

The preceding discussion highlights the complexities surrounding urine output monitoring and the use of catheters in acute care environments. IUC can cause significant harm to patients due to infection (CAUTI) as well as causing discomfort and other complications. Whether or when to insert an IUC for urine output monitoring remains a clinical problem and practice within hospitals can widely vary. For some diagnoses, placement of a IUC is almost compulsory to accurately measure urine output. Although well meaning, precautions aimed to protect patients and reduce risk of renal injury can unintentionally expose patients to other harms.

Patient safety campaigns such as the 'Sepsis 6' have emphasised the importance of accurate urine output monitoring. However, inaccurate fluid balance charting has driven clinicians to distrust non-invasive collection methods, increasing overreliance on IUC. It is imperative patients receive optimal care by judicious identification of oliguria followed by timely intervention and decision-making. However, there is currently no substantive evidence available on urine output monitoring best practice, nor any nationally agreed standards to support decision-making. In order to improve patient safety and quality of care, it seemed important and necessary to understand how clinicians undertake urine output monitoring and the factors that influence this in practice.

Chapter 3 Urine output monitoring: an integrative review

3.1 Introduction

Within this third chapter the research evidence and broader literature related to urine output monitoring is explored in depth. The process and results of a systematic search are detailed to illustrate how relevant research evidence was accessed. The literature was explored in four stages. First, the underpinning evidence base for why urine output is monitored were identified and discussed. Secondly, literature identifying how urine can be monitored was explored. Third, guidelines, expert consensus and discussion papers were examined for recommendations and fourth, studies describing current practice were identified. An integrative review is a comprehensive methodological approach as it allows for the inclusion of both experimental and non-experimental studies to fully understand a phenomenon (Whittemore and Knafl 2005). This integrative review aimed to synthesise all best available evidence related to urine output monitoring and to understand what literature was influencing healthcare decision-making and to identify future research priorities. The original review identified gaps in the evidence base and informed the development and generation of the research questions and subsequent research objectives. The review has since been updated to include the most recent literature.

3.2 Purpose and Review Questions

The previous chapter establishes the need to understand how clinicians undertake urine output monitoring and the factors that influence best practice. Although AKI and sepsis are recognised globally as significant patient safety issues, it became clear whilst undertaking the literature review, that there is relatively limited literature on urine output monitoring indications and processes. Before progressing to a mixed methods study to explore how and why urine output is monitored in acute cate, it was important to understand the current knowledge gaps. Therefore, this chapter provides an integrative review to analysis the available literature related to urine output monitoring.

The review aimed to synthesise and summarise the major gaps identified in the literature to determine what future research is required. However, this generated many avenues to be explored and explained. The review therefore needed to be contained by focusing

both its breadth and depth. Similarly, to Greenhalgh et al. (2004), a pragmatic and flexible approach to inclusion was implemented that took account of the availability of research in different topic areas. In order to shed light on the most prominent clinical issues, four guiding review questions were devised over time from reviewing the literature using an iterative and inductive approach.

Q1. Why is urine output monitored?

Q2. How can urine output be monitored in acute care?

Q3. What recommendations have been made on how urine output should be monitored in acute care?

Q4. What is known about current practice?

3.3 Methods

Integrative reviews have been described as particularly valuable to nursing because they answer questions about clinical practice, which guide the review, and involve a comprehensive search of the literature (Toronto and Remington 2020). The integrative review methods enable a reviewer to address: (1) the current state of evidence of a particular phenomenon, (2) the quality of the evidence, (3) gaps in the literature, and (4) identify the future steps for research and practice (Russel 2005).

An integrative review was used to investigate this topic to allow for the incorporation of literature using diverse methodologies. The lack of empirical studies meant that clinical guidelines and other relevant literature were identified as valuable sources of information on urine output monitoring best practice. This integrative review follows five steps recommended by Souza et al. (2010):

1. Formulation of a broad purpose/ guiding question(s)
2. Systematic search of the literature using predetermined criteria
3. Critical appraisal of selected research
4. Analysis and synthesis of literature
5. Discussion on new knowledge

Search Strategy

A comprehensive search strategy was used on numerous electronic databases (CINAHL, MEDLINE, EMBASE and SCOPUS). The initial literature search was conducted in 2016 prior

to the commencement of the research, followed by a review in June 2021 to include the most recent studies. The search strategy was discussed and agreed by the researcher and academic supervisors. Key word search terms are shown in Table 4. Databases were searched using a wide range of predefined search terms and combined using Boolean operators (And/Or) with assistance from a medical librarian. Keywords used to search the databases included combinations of “urine output” “hourly measurements” “oliguri*” “acute kidney injury” and “sepsis”. In addition, manual searches of relevant guidelines and references of retrieved literature were consulted. This aimed to retrieve the widest scope of relevant publications across different platforms.

The search terms used for this review are listed in Table 4.

Table 4. Literature search key words	
acute kidney injury	*non-invasive*
bladder scan	*oliguria*
fluid balance monitoring	*sepsis*
fluid intake output measures	*unnecessary procedures*
hourly measurements	*urine output*
incontinence pads	*urinary catheter*
measure	*urometer*
monitor	*weigh*

Inclusion/ Exclusion Criteria

Empirical research studies, discussion papers and clinical guidelines investigating/ describing or discussing clinical indications for urine output monitoring and methods of monitoring were included in this review. All findings were limited to the English Language and were published between 2000 and 2021. In addition, papers were excluded from the search if they had not been published in a peer reviewed journal.

Study Selection

To assess eligibility, the titles and abstracts of the studies found were initially screened, with full-text retrieved for any studies that potentially met the stated criteria. The full-text articles were reviewed and evaluated to determine the inclusion by the researcher and academic supervisors (see Figure 2 for a flow chart of the results). Eligible studies were put in the review and the reasons for excluding studies was recorded on the search flow diagram.

Articles, empirical studies, and guidelines on urine output in the healthcare literature were identified and judged for their relevance to the review. Literature was judged to be relevant if the focus of the guideline, study or discussion paper could be mapped under the four focus questions. Articles were excluded if they related to AKI or sepsis but were not directly relevant to urine output monitoring. Similarly, articles that focused on biomarkers and paediatrics were also excluded if they did not add significant value to the review.

Data Extraction and Quality Appraisal

Selected publications were read multiple times to ensure familiarity and data were extracted using a pre-prepared tool based on the data extraction table by Souza et al. (2010). The literature identified to inform this review, represented numerous study designs which included cohort studies, qualitative studies, discussion papers and clinical guidelines. Empirical studies were appraised using the appropriate Critical Appraisal Skills Programme (CASP) tool (CASP 2018).

None of the empirical studies included met all of the criteria assessed by the CASP appraisal form. However, it was not possible to assess whether the publications omitted these key components or whether it was simply not reported by the authors. Nonetheless, due to the breadth of the review, relevance, and contribution of the study to the review synthesis were prioritised over scientific rigidity (Dixon-Woods et al. 2006). Although the rigor of a study did not impact on whether the research was included in the review, a quality assessment was performed for empirical papers collected. Each empirical study was examined for methodological flaws, and strengths and/or limitations of empirical studies were highlighted (Appendices 2-6).

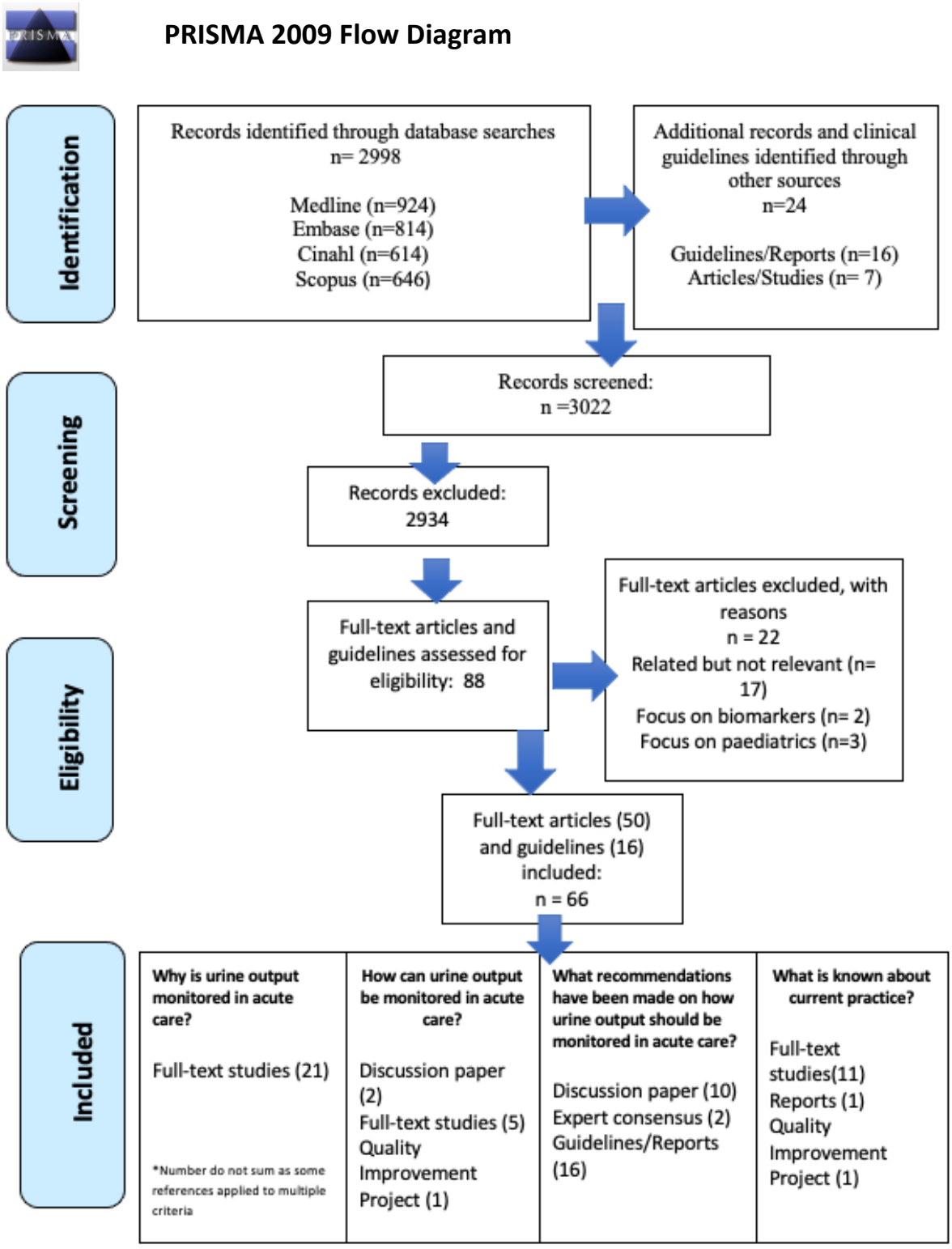
Analysis and Synthesis

Integrative reviews require a narrative analysis and integration of a large amount of existing data to generate a new perspective on the topic of interest (Torraco 2016). By synthesising research and drawing conclusions from a range of diverse sources the reviewer can gain an in-depth understanding of the phenomenon (Toronto and Remington 2020). As literature included in this review was methodologically diverse, a narrative synthesis was undertaken. Empirical studies and literature were interpreted and synthesised into meaningful conclusions to answer the review questions and share new knowledge about the topic (Toronto and Remington 2020). The four identified focus questions were used as a framework for the findings and an analysis of the literature identified two major themes related to urine output monitoring practices: (1) Lack of consensus and (2) Variations in practice. These themes are presented and explored in the discussion section.

3.4 Results

Sixteen guidelines/reports and fifty articles matching the search criteria were included in the final selection (numbers do not sum as some references applied to multiple criteria). Twenty-one articles examined why urine output is monitored, eight explored invasive and non-invasive methods of monitoring, and twenty-eight made recommendations for how urine output should be measured in practice. Thirteen articles were identified that described current practice. A flowchart depicting the selection of eligible studies is presented below in Figure 2 including reasons for exclusion.

Figure 2. PRISMA (Moher et al. 2009) diagram of search results



Literature Characteristics

In total, 50 full-text articles and 16 guidelines/reports were included in the final selection. A summary of included literature is provided in Table 5. Findings from these studies/articles are mapped under the four guiding focus questions.

Table 5	Included studies/literature		
Review question	**Author / Name**	**Year**	**Design**
Q1- Oliguria	Harrison et al.	2006	Retrospective cross sectional survey
Q1- Oliguria	Avila et al.	2009	Retrospective cohort study
Q1- Oliguria + Q2	Macedo et al.	2011a	Prospective observational study
Q1- Oliguria	Macedo et al.	2011b	Prospective observational study
Q1- Oliguria	Mandelbaum et al.	2011	Retrospective cohort study
Q1- Oliguria	Wlodzimirow et al.	2012	Prospective observational cohort study
Q1- Oliguria	Zhang et al.	2014	Retrospective cohort study
Q1- Oliguria	Harris et al.	2015	Retrospective cohort study
Q1- Oliguria	Kellum et al.	2015	Retrospective cohort study
Q1- Oliguria	Vaara et al.	2016	Prospective cohort study
Q1-AKI	Liangos et al.	2005	Retrospective cohort study
Q1-AKI	Barrantes et al.	2008	Retrospective cohort study
Q1-AKI	Kolhe et al.	2008	Retrospective cohort study
Q1-AKI	Joannidis et al.	2009	Retrospective cohort study
Q1-AKI + Q2	Prowle et al.	2011	Prospective observational cohort study
Q1-AKI	Han et al.	2012	Retrospective cohort study
Q1-AKI	Ralib et al.	2013	Prospective cohort study
Q1- Sepsis	Bagshaw et al.	2009	Retrospective cohort study
Q1- Sepsis	Suh et al.	2013	Retrospective cohort study
Q1- Fluid balance	Shum et al.	2011	Retrospective cohort study
Q1- Fluid balance	Teixeira et al.	2013	Secondary analysis of prospective cohort study

Q2	Otero et al.	2010	Discussion Paper
Q2	Palese et al.	2010	Meta-analysis
Q2 + Q3	Galen	2015	Discussion Paper
Q2 + Q4	Beuscher	2014	QI Project
Q2	Dutta et al.	2009	Comparative study
Q2	Allen et al.	2020	Retrospective analysis of two single centre observational studies
Q2	Enright et al.	2015	Prospective pilot study
Q2	Schallom et al.	2020	Prospective correlational descriptive study
Q3	NICE CG50 Acutely ill patient	2007	Clinical guideline
Q3	The Sepsis Six Care Bundle	2008	Clinical guideline
Q3	Royal College of Nursing Catheter Care: RCN Guidance for nurse	2008 updated 2019	Clinical guideline
Q3 + Q4	NCEPOD 'Adding insult to injury'	2009	Clinical guideline/report
Q3	Guideline for Prevention of Catheter-associated Urinary Tract Infections	2009	Clinical guideline
Q3	Kidney Disease Improving Global Outcomes Clinical Practice Guideline for Acute Kidney Injury	2012	Clinical guideline
Q3	NICE CG169/ NG148 Acute Kidney Injury: prevention, detection and management	2013 updated 2019	Clinical guideline
Q3	The UK Sepsis Trust	2014	Clinical guideline

Q3	NICE Scope. Sepsis: the recognition, diagnosis and management of severe sepsis	2014	Clinical guideline
Q3	Loveday et al.	2014	Clinical guideline
Q3	NHS England 'Sepsis Action Plan'	2015	Clinical guideline
Q3	Surviving Sepsis Campaign Care bundle	2015	Clinical guideline
Q3	NICE Sepsis: recognition, diagnosis and early management	2016	Clinical guideline
Q3	Think Kidneys	2016	Position statement
Q3	The UK Sepsis Trust	2019	Clinical guideline
Q3	The Sepsis 6 Care Bundle	2019	Clinical guideline
Q3	Meddings et al.	2015	Expert consensus
Q3	Mulcare et al.	2015b	Expert consensus
Q3	McConnel	2002	Discussion Paper
Q3	Scales and Pilsworth	2008	Discussion Paper
Q3	Jevon	2010	Discussion Paper
Q3	Foxley	2011	Discussion Paper
Q3	Shepherd	2011	Discussion Paper
Q3	McMilllien and Pitcher	2011	Discussion Paper
Q3	Gardener et al.	2014	Discussion Paper
Q3	McGloin	2014	Discussion Paper
Q3	Macaedo	2015	Discussion Paper
Q4	Apisarnthanarak et al.	2007	Cohort study
Q4	Fernandez-Ruiz et al.	2013	Cross sectional study
Q4	Chung et al.	2002	Prospective quantitative survey
Q4	Tang and Lee	2010	Prospective descriptive study

Q4	Perren et al.	2011	Prospective descriptive study
Q4	Diacon and Bell	2014	Retrospective audit
Q4	Vincent and Mahendiran	2015	Quality improvement project
Q4	Bonfield	2013	Prospective qualitative study
Q4	Litchfield et al.	2018	Qualitative study
Q4	Murphy et al.	2015	Qualitative study
Q4	Mulcare et al.	2015a	Qualitative study

Quality Assessment

Thirteen included publications were retrospective cohort studies (Avila et al. 2009, Mandelbaum et al. 2011, Zhang et al. 2014, Harris et al. 2015, Kellum et al. 2015, Liangos et al. 2005, Barrantes et al. 2008, Kolhe et al. 2008, Joannidis et al. 2009, Han et al. 2012, Bagshaw et al. 2009, Suh et al. 2013, Shum et al. 2011). Due to the retrospective nature of these studies, there is potential for confounding factors to have introduced bias to the findings, therefore affecting internal validity (Robson 2002).

In addition, thirteen cohort studies (Avila et al.2009, Macedo et al. 2011a, Wlodzimirow et al. 2012, Mandelbaum et al. 2013, Zhang et al. 2014, Kellum et al. 2015, Liangos et al. 2005, Barrantes et al. 2008, Han et al. 2012, Ralib et al. 2013) were from single centres which limits the external validity of the findings as they are not generalisable to other hospital populations. However, as these studies took place in real world settings ecological validity is considered high and therefore results have application to clinical practice (Robson 2002).

Sample sizes of included cohort studies ranged between 155,624 participants (Harris et al. 2015) and 40 (Liangos et al. 2005). Despite the limitations of smaller sample size Ralib et al. (2013) observed results that were consistent with Mandelbaum et al. (2013) which included a sample size that consisted of more than 14,500 participants. Consistency in results between studies increases reliability and therefore provides confidence that results are true. Implications of the results of the included cohort studies include the need to review the criteria used to determine oliguria but also improve urine output monitoring in clinical settings to ensure episodes of oliguria which are associated with increased mortality are detected and treated promptly.

A limitation of several studies (Prowle et al. 2011, Ralib et al. 2013, Harris et al. 2015,) included reported body weight was determined indirectly from the most recent body weight documented in medical records, or as reported by a patient or relative weight. Estimations of body weight may affect the interpretation of urine output/kg/hr as if the patient's true body weight differed to the estimation therefore affecting the validity of the results provided.

Assessment using the CASP (2018) qualitative appraisal tool was used to assess credibility, transferability, dependability and confirmability of the qualitative studies (Murphy et al. 2015, Mulcare et al. 2015a, Litchfield et al. 2018). In summary, the qualitative studies satisfied most of the tool criteria and were judged as high quality. The included studies provided a clear statement of the aims of the research and the qualitative methodology chosen were appropriate to address the research goals. However, despite clear descriptions on how data were collected, justifications for the research design and methods chosen were not described in sufficient detail. In addition, although favourable ethical approval had been granted for all studies, details on ethical considerations were also limited.

A strength of Murphy et al. (2015) included using methodological triangulation to enhance the process of qualitative research by gathering data using two different collection methods (semi-structured interviews and retrospective think aloud interviews). This enabled Murphy et al. (2015) to capture different elements of the same phenomenon to add greater depth of understanding which enhances the credibility of the study (Honorene 2016). In addition, analysis was was overseen by all authors and consensus achieved on the development of themes which improves confidence in the confirmability of the study.

As credibility in qualitative research is concerned with ensuring the reader has confidence that an accurate interpretation of the participants reality has been provided. Reflexivity is considered to enhance credibility (Barrett et al. 2020). Murphy et al. (2015), Mulcare et al. (2015a) and Litchfield et al. (2018) did not include any reference to reflexivity and have not provided details on the researchers own role and any bias they may unintendedly introduce to the studies. However, it was not possible to determine if the studies omitted this component or whether it was simply not reported by the authors in the publication.

All studies provided an in-depth description of the data analysis process which were significantly rigorous therefore enhancing credibility.

Murphy et al. (2015), Mulcare et al. (2015a) and Litchfield et al. (2018) were all single centre studies with sample sizes suitable to qualitative studies. Qualitative research by nature does not aim to achieve generalisable findings unlike quantitative studies. Nevertheless, the thick contextual descriptions provided in the included qualitative studies facilitate the transferability of the findings to other clinical settings with similar contexts (Creswell et al. 2009). Mulcare et al. (2015) and Litchfield et al. (2018) both refer to the discontinuation of data collection when data saturation was achieved as perceived by the researchers. However, it is debatable whether concerns around sample size justification could be attributed to positivist epistemology and the requirement for representation and generalisability. Some qualitative researchers believe participant recruitment should continue until the concept of data saturation has been reached (Mason 2010). However, it has been argued that this concept relies on understanding of meaning as transparent and obvious prior to analysis. As thematic analysis, used by both Mulcare et al. (2015) and Litchfield et al. (2018), involves identifying new patterns of meaning, and this usually happens after data collection, analysis is necessary to judge whether the information generated by participants offers something new or not (Clarke et al. 2015).

Common strategies adopted by qualitative researchers to ensure confirmability and dependability include member checking, peer debriefing and auditing. Mulcare et al. (2015a) describe using member checks within the focus groups to confirm interpretation and accuracy of findings. Whereas, Murphy et al. (2015) and Litchfield et al. (2018) describe a peer review and debriefing process which ensured their study findings were critically reviewed. All included studies report research processes which are in line with the accepted standards for that particular design.

This review highlights a wide range of quantitative and qualitative studies with overall strength of evidence considered to be of good to moderate quality. Despite the limitations discussed above, all studies have provided valuable insight which have useful implications for clinical practice. The quantitative research identified in this review has emerged primarily from the critical care arena as oliguria and AKI have predominately been studied in intensive care units. Therefore the lack of empirical studies focusing on

urine output monitoring in acute care settings suggests this phenomenon is yet to be robustly evaluated. Quantitative studies have identified an association between oliguria and higher mortality rates but further research is required to explore clinical outcomes for patients with oliguria in acute care environments. Qualitative research to date exploring clinical decision-making in regards to IUC use in acute care has provided important understanding of this clinical issue. However, a greater understanding of therapeutic decisions made from urine output measurements and the placement of an IUC compared to using non-invasive collection methods is necessary.

Q1. Why is urine output monitored?

Clinical indications for monitoring urine output identified by this review include:

1. Oliguria
2. Acute Kidney Injury
3. Sepsis
4. Fluid Balance

Although four clinical indications were identified these are not discrete and often lead into one another. For example, sepsis may cause oliguria, which can precede acute kidney injury, necessitating fluid balance monitoring. These indications may direct a clinician's decision-making on urine output monitoring and which collection method to use. When these indications overlap, it inevitably makes decision-making in practice and any interventions aimed at influencing decision-making more complex. The multifaceted nature of literature surrounding the urine output phenomena mirrors the complexities faced in practice when trying to mitigate these risks.

1. Oliguria

Urine output is monitored in acute care to detect episodes of oliguria (reduced output). Oliguria has been defined as urine volume < 400 mL/24 hr or diuresis less than 0.5ml/kg/hr (Avila et al. 2009). Ten cohort studies providing rationales for monitoring urine output to determine oliguria were identified; all found an association between oliguria and higher mortality rates (Harrison et al. 2006, Avila et al. 2009, Macedo et al. 2011a, Macedo et al. 2011b, Mandelbaum et al. 2011, Wlodzimirow et al. 2012, Zhang et al. 2014, Harris et al. 2015, Kellum et al. 2015 and Vaara et al. 2015.) (Appendix 2). Zhang et al. (2014) states transient oliguria is often caused by hypovolemia, which can be reversed with adequate fluid resuscitation. However, consistent oliguria in a patient who is acutely unwell can be an ominous warning sign that requires immediate attention and intervention (Zhang et al. 2014). If unnoticed, transient oliguria has the potential to become persistent, which is associated with increased mortality (Mandelbaum et al., 2013). Vaara et al. (2015) highlight a reduction in urine output may present before a rise in serum creatinine, providing early detection of deteriorating renal function and opportunities to prevent AKI.

2. Acute Kidney Injury

The recent focus on AKI (NHS England 2014, NICE 2019) has drawn attention to the importance of urine output monitoring and highlights the need for swift recognition of oliguria. There are three classification systems for AKI: RIFLE, AKIN and KIDGO. All provide similar definitions based on either an acute change in serum creatinine (Scr), and/or a reduction in urine output (NICE 2019). It is recognised that measuring changes in serum creatinine as well as changes in urine volume in patients who have risk factors can help identify AKI. However, seven studies identified by this review reported that oliguria may only be a fair predictor of AKI, as the urine output criteria cannot identify non-oliguric AKI (Liangos et al. 2005, Barrantes et al. 2008, Kolhe et al.2008, Joannidis et al. 2009, Prowle et al. 2011, Han et al. 2012 and Ralib et al. 2013) (Appendix 3). Furthermore, Prowle et al. (2011) found not all episodes of oliguria are followed by biochemical renal injury. An

intermittent decrease of urine output does not always prelude renal injury and can simply represent a physiological adaption (Legrand and Payen 2011).

3. Sepsis

Sepsis is characterised by a life-threatening organ dysfunction due to a dysregulated host response to infection (Singer et al. 2016). Two studies identified by this review reported sepsis as the most common contributing factor for the development of AKI, with incidence increasing significantly according to sepsis severity (Appendix 4). Bagshaw et al. (2009) found that 64.4% of patients with septic shock developed AKI within twenty-four hours and that patient survival was considerably lower for septic shock associated with AKI. Suh et al. (2013) echoed these findings stating 57.7% of patient admitted with sepsis developed AKI and 30-day survival rate was significantly associated with the severity of acute kidney injury. These studies highlight the need to monitor urine output for patients with sepsis to promptly detect oliguric-AKI.

4. Fluid Balance

Fluid balance is a term used to describe the homeostasis of the input and output of fluids in the body. In a healthy individual total fluid volume fluctuates by less than 1%, however, when a patient is acutely unwell, fluid balance can become deranged. Two studies identified by this review (Shum et al. 2011, Teixeira et al. 2013) (Appendix 5) reported positive fluid balance is associated with increased hospital mortality. This emphasises the importance of urine output monitoring in patients who are at risk of fluid balance abnormalities.

Q2. How can urine output be monitored in acute care?

Methods of monitoring urine output identified in the literature are utilising:

1. Indwelling urinary catheter
2. Non-invasive collection methods
3. Bladder ultrasound scanning

1. Indwelling Urinary Catheter

Otero et al. (2010) describes the process of measuring a patient's urine output using an IUC with attached urine metre. A Foley catheter is introduced through the patient's urethra until it reaches his/her bladder and is then attached to a collection bag. A urine metre comprises a collection chamber with measurements marked in ml(millilitre) and a hand- operated valve which releases the urine into a larger collection bag.

Urine metres are used for hourly urine output monitoring which requires the nursing staff to measure and manually record the reading of the collection chamber. Although commonly used in hospitals to monitor urine output, findings from this review emphasise how it remains unclear whether hourly measurements benefit patient outcomes as empirical evidence is limited (Prowle et al. 2011). There is currently no consensus on whether urine output should be measured using consecutive hourly readings or mean output. Macedo et al. (2011a) found no significant difference assessing urine output every hour or the total urine volume in a 6-h period for the detection of episodes of oliguria.

2. Non-invasive Collection Methods

Research studying non-invasive alternatives to IUC for urine output monitoring in adults is also scarce. Calculating a mean urine output is the only method of measuring the rate of urine output in patients without an IUC. However, no empirical studies on urine output monitoring via non-invasive collection devices were reported. Galen (2015) article provides advice on non-invasive collection methods and a sole quality improvement (QI) project was identified that focused on weighing incontinence pads for urine output monitoring in an adult population (Beuscher 2014). Dutta et al. 2009 report a comparative study which highlights that nappy weighing is common practice in paediatric care.

Urine collection via bedpan, urinal or commode

To assess accumulated urine output over time (rather than hourly), volume can be monitored non-invasively via urine collection using a bedpan, urinal, bedside commode, or a toilet with a bedpan inserted (Galen 2015). The capacity of the bladder is variable normally holding between 300-500mls of urine before voiding occurs. Therefore, frequency of micturition will differ between patients depending on bladder capacity. To date, no empirical studies have been found that test non-invasive urine output monitoring methods compared with using an IUC. However, Allen et al. (2020) retrospective analysis suggest mean urine output can overestimate incidence of AKI compared to consecutive hourly measurements post cardiac surgery. It is unknown whether a similar inflation of AKI incidence is also present when measuring mean urine output in acute medical environments.

Urethral sheaths and incontinence pad weighing

In patients who are incontinent, external urinary sheaths (for male patients) or weighing incontinence pads can provide accurate urine output measurements (Galen 2015). Weighing nappies is a commonly used strategy in paediatric and neonatal intensive care to monitor urine output (Dutta et al. 2009), as is urine collection into a potty, bedpan or urinal. Beuscher (2014) QI project reported how physicians were initially apprehensive regarding IUC removal, expressing concerns about the accuracy of urine output monitoring using alternative methods. However, a pilot trial found weighing pads and documenting urine output in millilitres was sufficient to evaluate fluid status and physicians began supporting and encouraging this technique for measuring urine output. Outcomes of this QI project led to a 33.3% reduction in catheter days over a 7-month period and a 23.9% reduction in the number of CAUTI.

3. Bladder Ultrasound Scanning

The use of bladder scanners to monitor for urinary retention is common practice in hospitals and has reduced the need for catheterisation (Palese et al. 2010). However, their use to record hourly measurements is rare. Not surprisingly, there is therefore little research in this area with limited studies evaluating bladder scanning as an alternative

method of urine output monitoring. Two prospective studies (Enright et al. 2015 and Schallom et al. 2020) in this review acknowledge bladder scanning as a potential alternative for measuring urine output when invasive monitoring or watchful waiting are not suitable options.

Enright et al. (2015) conducted a prospective pilot study to evaluate the utility of using a bladder ultrasound scanner to monitor urine production in children with dehydration attending an Emergency Department. Results concluded that an hourly rate of urine production can be objectively measured by bedside ultrasound. However, this study was limited, with a sample size of 45 and accuracy of readings was not validated. Schallom et al. (2020) evaluated the accuracy of bladder urine volumes measured with bladder scanning for patients in intensive care. The study concluded urine volume can be measured accurately with bladder scanning or ultrasound. Therefore, offering a possible alternative to catheterisation for measurement of urine volume. Nevertheless, the availability of scanners could create barriers to implementing bladder ultrasound for urine output monitoring in acute medical environments.

Q.3 What recommendations have been made on how urine output should be monitored in acute care?

Recommendations on methods of monitoring urine output identified in the literature have been mapped under:

1. Clinical guidelines and reports
2. Expert consensus
3. Discussion papers

Results of this review identified no empirical studies or systematic reviews investigating urine output monitoring via an IUC compared to non-invasive measures. However, sixteen clinical guidelines/reports (Table 2) make recommendations for urine output monitoring practice in clinical care. Furthermore, two expert consensus (Meddings et al. 2015, Mulcare et al. 2015b) and ten discussion papers (McConnel 2002, Scales and Pilsworth 2008, Jevon 2010, Foxley 2011, Shepherd 2011, McMilllien and Pitcher 2011,

Gardener et al. 2014, McGloin 2014, Galen 2015 and Macaedo 2015) offer guidance on methods of urine output monitoring.

1. Clinical Guidelines and Reports

Sixteen clinical guidelines/reports with recommendations for clinical practice have been identified on urine output monitoring and/or the use of IUC (Table 6). Within these reports, there is a lack of consensus on when and how urine output should be monitored. Although guidelines agree on the appropriateness of placing a urinary catheter to monitor urine output in critically ill patients, little guidance is offered for patients in acute care. NICE CG50 (2007) states that the consensus opinion of the Guideline Development Group was that urine output should not be a core physiological parameter recorded to assess acutely ill patients in acute care environments due to the need for catheterisation to assess urine output. This suggests that non-invasive monitoring methods were not considered as suitable alternatives.

In addition, the Think Kidneys (2016) position statement advises against urinary catheterisation to measure hourly urine output in diagnosis of AKI outside of critical care settings. However, National Confidential Enquiry into Patient Outcome and Death (2009) "Adding insult to injury" report appears to advocate the use of IUC for early identification of renal impairment. Inconsistences between guidelines makes it difficult to determine what best practice looks like and is likely to impact on patient care.

Table 6. Clinical guideline/report recommendations

Year	Guideline/ Report	Aim	Clinical recommendation on urine output monitoring:
2007	NICE CG50 Acutely ill patient **UK**	Guideline offering best practice advice on the care of adult patients within an acute care setting.	The consensus of the Guideline Development Group was that urine output should not be a core parameter because reliable assessment of urine output requires catheterisation, and this is performed only in specific clinical circumstances. In specific clinical circumstances, additional monitoring should be considered for example, hourly urine output.

2008	The Sepsis Six Care Bundle **UK**	A Care bundle has been developed for the management of sepsis to help staff comply with treatment that increases survival rates.	A IUC should be placed with an hourly bag (unless the patient is fully mobile and able to void spontaneously) and hourly measurement of urine output commenced.
2008 **2019** **2021**	Royal College of Nursing Catheter Care: RCN Guidance for nurses **UK**	To produce further clarity and depth to the six competences related to aspects of catheter care.	Clinical indications for catheterisation include: Monitoring renal function hourly during critical illness.
2009	NCEPOD 'Adding insult to injury' **UK**	To examine the process of care of patients who died in hospital with acute kidney injury, in order to remediable factors in the care received by these patients.	Whilst catheterisation may not be essential in all cases of AKI, it does enable measurement of hourly urine output and total urine volume. This information can allow early identification of renal impairment.
2009	Guideline for Prevention of Catheter-associated Urinary Tract Infections (Gould et al. 2009) **USA**	To provide guidance for prevention of CAUTI.	Appropriate indication for IUC use includes the need for accurate measurements of urinary output in critically ill patients.
2012	Kidney Disease Improving Global Outcomes Clinical Practice Guideline for Acute Kidney Injury	To provide information and assist decision-making in the management of AKI.	The influence of urinary output criteria on AKI staging needs to be further investigated. Influence of fluid balance, volume overload, diuretic use, and differing weights (actual, ideal body weight, lean body mass) should be considered. Also, it is currently not known how urine volume criteria should be applied (e.g., average vs. persistent reduction for the period specified).
2013 **2019**	NICE CG169/ NG148 Acute Kidney Injury:	Guideline offering best practice advice on the care of adults, children, and	When adults are at risk of acute kidney injury, ensure that systems are in place to recognise and respond to oliguria (urine output less than 0.5 ml/kg/hour) if the

	prevention, detection and management **UK**	young people with or at risk of acute kidney injury.	track and trigger system (early warning score) does not monitor urine output.
2014	The UK Sepsis Trust **UK**	To deliver a toolkit for the management of Sepsis in Emergency Departments.	Commence hourly urine output measurements.
2014	NICE Scope. Sepsis: the recognition, diagnosis and management of severe sepsis **UK**	To provide recommendations for recognising and treating sepsis in any person in any clinical environment.	Not given
2014	Epic3: National evidence-based guidelines for preventing healthcare-associated infections in NHS Hospitals in England **UK** (Loveday et al. 2014)	To provide comprehensive recommendations for preventing healthcare associated infections in hospital based on the best currently available evidence.	IUC may be appropriate in patients who require precise urine output measures to monitor an underlying condition.
2015	NHS England 'Sepsis Action Plan' **UK**	To drive the change required for quality improvement in the prompt identification and treatment of sepsis to occur, with the aim of improving patient outcomes and reducing mortality and morbidity currently associated with sepsis.	Commence accurate urine output measurement.

2015	Surviving Sepsis Campaign Care bundle **USA**	A Care bundle has been developed for the management of sepsis to help staff comply with treatment that increases survival rates.	Not given
2016	NICE Sepsis: recognition, diagnosis and early management **UK**	Guideline to covers the recognition, diagnosis, and early management of sepsis for all populations.	Not passing urine in previous 18 hours/ for catheterised patients passing less than 0.5ml/kg/hr of urine was identified as high-risk criteria for stratifying risk of severe illness. However, no recommendations for ongoing monitoring of urine output were made.
2016	Think Kidneys Position statement **UK**	This position statement is intended to inform how urine output measures can be used to detect AKI in clinical practice.	When evaluating a patient for oliguria, it is appropriate to use either hourly urine volumes, or to take an hourly average using total urine output over a six-hour period. Catheterisation to measure hourly urine output should not be a routine step in diagnosis of AKI outside of critical care settings. In hospitalised patients who are not catheterised, indications of oliguria (e.g., from fluid or hydration charts) can indicate patients at risk of developing AKI. Patients with long-term urinary catheters should have hourly urine output measurements if they are admitted to hospital with acute illness and are at risk of AKI. IUC inserted for measurement of urine output should be removed promptly when no longer necessary; the on-going need for catheterisation should be reviewed daily.
2019	The UK Sepsis Trust **UK**	Clinical guideline for the management of Sepsis in hospital.	It is important for practitioners to appreciate that urine output is a window for assessing the patient's circulatory system: if the urine output falls, it is likely that cardiac output has also fallen and urgent action is required.

			AKI is common in sepsis and associated with worse patient outcomes. It is therefore essential to monitor urine output closely. CAUTI are a common cause of sepsis. The risks associated with IUC use must be judiciously balanced against benefits on an individual patient basis: • IUC should be inserted for the minimal time in the minimum number of patients • IUC should not be used for routine use and never for monitoring urine output in ambulatory patients Alternative to an IUC should always be considered.
2019	The Sepsis 6 Care Bundle (updated) **UK**	The care bundle has been updated to guide the management of sepsis.	The updated Sepsis 6 now recommends monitoring more generally. Which includes: • Use NEWS2 • Monitor urine output – may require catheter • Repeat lactate hourly if initial lactate elevated or clinical condition changes

2. Expert consensus

Two studies providing expert consensus on methods of urine output monitoring were identified (Table 7). Meddings et al. (2015) used the RAND/UCLA Appropriateness Method to create criteria for IUC use in hospitalised medical patients. Specific guidance on urine output monitoring was offered, recommending IUC placement as justified for the hourly measurement of urine volume required to provide treatment, for example, management of haemodynamic instability, hourly titration of fluids, drips (e.g., vasopressors, inotropes), or life supportive therapy. However, panelists uniformly rated urinary catheters for urine volume monitoring simply because the patient is located in intensive care as inappropriate, emphasising how all patients require appropriate medical indications for catheter use. For patients not requiring hourly measurements for

treatment, non-invasive methods were deemed appropriate for collection of daily urine volume. However, it was recognised catheters may be used when daily measurement of urine volume is required to provide treatment and cannot be assessed by other strategies.

Mulcare et al. (2015b) developed a clinical protocol guiding ED practitioners in appropriate placement of IUC in older adults.The study convened an expert panel including the authors, senior practitioners, and nurses in emergency medicine and geriatrics to collaboratively design a protocol incorporating the results of the literature review and qualitative analysis of the focus groups. The panel consensus advocated for IUC use for critical illnesses that requires hourly urine output but advised that accurate urine output greater than one-hour intervals should be monitored via alternative urine collection methods. Following the implementation of the protocol, the study identified a rreduction in IUC placement in admitted older adults and a reduction in CAUTI attributable to the ED.

Table 7. Expert consensus reporting on urine output monitoring

Reference	**Method**	**Expert consensus**
Meddings et al. (2015)	RAND/UCLA Appropriateness Method used to create criteria for IUC use in hospitalised medical patients.	Specific guidance on urine output monitoring was offered, recommending IUC placement as justified for the hourly measurement of urine volume required to provide treatment, for example, management of haemodynamic instability, hourly titration of fluids, drips (e.g., vasopressors, inotropes), or life supportive therapy.
Mulcare et al. (2015b)	Focus group interviews with emergency department staff were used to develop a clinical protocol to guide appropriate placement of urinary catheters in older adults.	Advocated urinary catheter use for critical illnesses that require hourly urine output but advised that accurate urine output greater than one-hour intervals should be monitored via alternative urine collection methods.

3. Discussion papers

Ten discussion papers commenting on methods of urine output monitoring were identified by this review (Table 8). These papers allude to how and when urine output monitoring should be done, but do not define what is meant by 'critical illness' or a 'patient's condition', nor do they clarify when hourly or less frequent measurements are needed. Gardener et al. (2014) and Jevon (2010) argue a urinary catheter is necessary for accurate monitoring of urine for deteriorating patients. Whereas McConnel (2002), McGloin (2014) and Galen (2015) advocate the use of measuring collection devices (bottles/bedpans/ incontinence pads). Macaedo (2015) states urine output monitoring in diagnosing and staging AKI is essential, however the timeframe of measurements can be adjusted according to patients setting and risk.

Table 8. Discussion papers

Reference	**Discussion papers: Urine output monitoring**
McConnel (2002)	Recommends measuring urine into a calibrated container. Instructions are made to observe it at eye level and take the reading at the bottom of the meniscus. For an accurate measurement, keeping toilet paper out of the patient's urine is advised.
Scales and Pilsworth (2008)	Propose a patient's condition will dictate the frequency of urine measurement. Seriously ill patients with reduced or excessive urine output will require more frequent assessment than stable patients. They recommend patients who are acutely unwell require hourly urine measurements as regular monitoring of urine output can indicate early changes in a patient's condition and early treatment can prevent deterioration.
Jevon (2010)	Advises oliguria could indicate critical illness, therefore it is important to assess and maintain an accurate fluid balance for deteriorating patients. It is recommended that a urinary catheter is inserted to monitor urine output.
Foxley (2011)	Recommends hourly urine output volumes must be recorded, together with an accurate 24-hour fluid balance, to determine on-going appropriate care for critically ill patients.
Shepherd (2011)	Highlights it is unacceptable when recording urine output on a fluid balance chart, to record it as "passed urine +++" or "OTT" (out to toilet) as this gives no indication of how much urine is passed.
McMilllien and Pitcher (2011)	Advises frequency of urine output measurements should be dictated by the patient's condition.
	Suggests for completely accurate and regular urine output monitoring a urethral catheter is necessary. It is reported few patients pass urine hourly in a

Gardener et al. (2014)	way which can be accurately monitored and highlights how estimations and approximations are not safe and may over or under recognise deteriorations.
McGloin (2014)	Promote patients under fluid balance surveillance without a catheter should use bottles or bedpans to facilitate measuring and state it is possible, to estimate the volume passed.
Galen (2015)	Advocates weighing incontinence pads to measure urine output. It suggested a reasonable estimation of urine output could be obtained by first "zeroing" a scale with a large bucket and an unused incontinence pad. Next, a urine-soaked incontinence pad can be placed in the bucket to obtain the mass of urine present.
Macaedo (2015)	Suggest urine output assessment in diagnosing and staging AKI is a necessity. However, criteria and time frame for AKI screening and diagnosis can be adjusted according to the patients setting and risk of AKI.

Q.4 What is known about current practice?

Literature identified by this review provides insight into current urine output monitoring practices and has been mapped under four categories:

1. IUC use for urine output monitoring
2. Non-invasive collection methods
3. Fluid balance recording
4. Clinician decision-making

1. IUC use for urine output monitoring

Two studies and one safety report have been identified reporting on the use of IUC for urine output monitoring in practice. A prospective cohort study by Apisarnthanarak et al. (2007) discovered 26% of all inappropriately placed IUC were used for unnecessary urine output monitoring. Similarly, in their cross-sectional study, Fernandez-Ruiz et al. (2013) found the most common inappropriate indication for catheterisation was urine output monitoring in a cooperative, non-critically ill patient. The indication for catheterisation was defined as inappropriate is there was no real need for urine output monitoring, or a patient was able to micturate and was not critically ill.

Conversely, NCEPOD (2009) reported inadequacies in AKI management. The authors cited findings of a retrospective cohort study, which revealed that 28 patients received inadequate care due to omission of an IUC and 22% of patients who were catheterised did not have hourly urine output measurements recorded. However, the implications of less frequent measurements for the patients affected are unknown.

2. Non-invasive Collection Methods

Limited research is available on current practice surrounding non-invasive alternatives to IUC for urine output monitoring in adults. An extensive literature search revealed no empirical studies reporting on urine output monitoring via collection devices. Only one quality improvement project focused on weighing incontinence pads for urine output monitoring in an adult population (Beuscher 2014).

3. Fluid Balance Recording

Multiple studies have been identified that highlight fluid balance charts in practice are inaccurate and require improvement (Chung et al. 2002, Tang and Lee 2010, Perren et al. 2011, Diacon and Bell 2014, Vincent and Mahendiran 2015) (Appendix 6). Chung et al. (2002) found 32% of fluid balance charts were incomplete or inaccurate. Thirteen years on, Vincent and Mahendiran (2015) highlighted no improvements had been made in fluid balance chart accuracy, with average chart completion rates of 50% and average chart accuracy at 41%.

Bonfield (2013) used semi-structured interviews with registered nurses to investigate perceived influences to accurate fluid balance chart completion in acutely unwell medical patients. Five themes were identified as potential barriers to accurate fluid balance chart completion; individual insight, making time to do it, knowledge and training, making it easier to be accurate and competing ward activities. Bonfield (2013) concluded monitoring could be improved by standardising practice through the development of guidelines on fluid balance chart completion and a formal education programme.

Similarly, Litchfield et al. (2018) explored factors that influenced the maintenance of hydration in patients and found staff were aware of the importance of hydration and saw

it as a central aspect of the care they provided but competing priorities inhibited the time staff could spend providing hydration care which had an impact on the timely and accurate completion of fluid balance charts.

4. Clinician Decision-Making

Two studies have been identified reporting on urine output monitoring and clinical decision-making. Murphy et al. (2015) conducted semi-structured interviews with clinicians to investigate the decision to insert IUC. Whereas some clinicians regarded the decision as an unequivocal clinical choice, others reported it as a knee-jerk decision. Some clinicians justified their decision to insert a catheter for fear of missing reduced urine output. One physician reported how it was comforting to see hourly urine output recorded on a chart but questioned the need to monitor so closely.

Mulcare et al. (2015a) conducted focus groups within an Emergency Department (ED) to explore healthcare professionals' knowledge, attitudes, and cultural patterns surrounding use of IUCs in older adult patients. Participants reported IUC were over-utilised and one factor contributing to the use of a convenience catheter was ease of monitoring urine output relative to other collection methods. A physician assistant reported knowing a IUC was not needed for strict monitoring but regarded measuring via alternative methods as time consuming compared to looking at a IUC drainage bag. Nurses also voiced frustration that their perspective on patient care was not always included in decision-making, stating patients often have IUC requests from physicians even after a nurse suggests that urine can be successfully measured using a measuring hat or bedpan. Alternative methods of urine collection, such as access to bedside commodes, urethral sheaths, and the need for more nursing assistants to provide patient care were frequently identified as areas that could improve practice.

3.5 Discussion

The concept of monitoring urine output in order to respond to patient deterioration is a globally important clinical topic as demonstrated by the international literature accessed and synthesised in this review. However, deciding whether monitoring is required and, if it is, whether a catheter is needed is not straightforward. This is the first integrated

literature review to incorporate different components involved with urine output monitoring and related clinical decision-making.

Research focusing on recognising and responding to reduced urine output appears to have emerged primarily from the critical care arena as oliguria and AKI have predominately been studied in intensive care units. The literature acknowledges that urine output can technically be monitored using invasive or non-invasive methods. However, there is a lack of consensus as to what methods of monitoring are most beneficial to patient outcomes. The lack of empirical studies suggests that urine output monitoring in acute care is yet to be robustly evaluated. Therefore, it is currently unknown what best practice should look like.

Lack of Consensus

Disagreement in the underpinning evidence base and inconsistencies between clinical guidelines has made it difficult to determine what best practice should look like. A lack of consensus on how and when to monitor urine output is likely to present a barrier to improving care. The influence of urinary output criteria on AKI staging needs to be further investigated. Current diagnostic criteria for AKI include thresholds of oliguria to define the presence and severity of AKI, but there remains some controversy as how such definitions of oliguria should be applied in clinical practice as a specific measure of renal injury (Think Kidneys 2016).

Oliguria has been associated with increased mortality rates (Appendix 1) however the efficacy of urine output as a specific measure of renal dysfunction is debatable (appendix 2). The current diagnostic criterion for stage one AKI includes a threshold of six hours of urine output <0.5ml/kg/hr. This benchmark was devised from expert consensus and some controversy remains over its prognostic value. The criterion does not specify whether the reduction in urine output should be defined by the mean flow over six hours, or from a persistent reduction over the six consecutive hours. Think Kidneys (2016) and Macaedo (2015) state it is appropriate to evaluate a patient for oliguria by using hourly urine volumes or by taking an hourly average calculating total urine output over a six-hour period. The flexibility to record an averaged urine output helps advocate for the use of non-invasive urine collection methods in acute care environments.

The rate of patients diagnosed with AKI increases when urine output criterion is used exclusively compared to patients with AKI identified by serum creatinine (Macaedo et al. 2011a). However, Ralib et al. (2013) describes the current definition of oliguria as too liberal and states a urine output threshold of 0.3ml/kg/hr is most clearly associated with adverse clinical outcomes. Han et al. (2012) highlights that urine output criteria can only detect oliguric AKI. Urine output criteria did not detect >40% of AKI cases that were determined by serum creatinine criterion. Further research is therefore needed to determine the clinical use of urine output criteria to define AKI in acute care populations and the impact of this on clinical outcomes. If the current urine output criteria has reduced sensitivity, patients who may not necessarily develop AKI may be exposed to unnecessary medical interventions such as urinary catheterisation or fluid resuscitation. Further empirical research is therefore needed in acute care environments to validate the criteria.

Limited literature scrutinising when invasive urine output monitoring is required compared to non-invasive measures is available. Therefore, it is unknown which methods are most beneficial to patient outcomes in different clinical environments. Inconsistencies in discussion papers (Table 4) highlight the conflicting nature of guidance, which complicates the development of a strategy for urine output monitoring in clinical practice.

Guidelines agree on the appropriateness of placing an IUC to monitor hourly urine output in critically ill patients (Loveday et al. 2014, HIPAC 2009, RCN 2008). However, there is a lack of clear guidance relating to when it is beneficial to patient outcomes to know the hourly urine output compared to less regular measurements. Critical illness is often given as an accepted indication for IUC use; however, this term can be broadly interpreted. NICE (2007) states certain clinical circumstances require hourly urine output monitoring but fail to adequately particularise specific details. Different NICE guidelines (NG148) advise that healthcare professionals should ensure that systems are in place to recognise and respond to oliguria but do not stipulate methods of monitoring (NICE 2019).

Further controversies are apparent within sepsis related guidance. The international ‘Surviving Sepsis Campaign’ (SSC) care bundle was originally developed with an aim to improve early recognition and treatment of sepsis (Dellinger et al. 2012). Robson and Daniels (2008) adapted the SSC bundle to create ‘Sepsis 6’. The original ‘Sepsis 6’ care

bundle includes the requirement to monitor hourly urine output to assess renal perfusion (Robson and Daniels 2008). However, there is a lack of consensus about this internationally, with the UK care bundle being the only one of eight published care bundles to recommend this (Kramer et al. 2015). The revised SSC care bundle (2015) still does not include the requirement for hourly urine output monitoring (SSC 2015).

Additional discrepancies are made from the interchangeable use of "accurate urine measurement" and "hourly urine output measurement" in different guidelines describing the Sepsis 6 (NHS England 2015, The UK Sepsis Trust (UKST) 2014). Hourly measurements require a IUC to be placed, whereas accurate monitoring requires careful attention to ensure non-invasive monitoring. The pathway requires clarification as to which method of monitoring is favourable to patient outcomes. Interestingly, UKST (2019) has recently confirmed that catheters should not be used for routine use and never for monitoring urine output in ambulatory patients. However, it is recognised that urine output can help guide fluid therapy and determine need for intensive care referral (UKST 2019). The updated Sepsis 6 care bundle still recommends monitoring urine output and now advises that an IUC may be required but also includes monitoring more generally, including the use of NEWS2 and serial lactates (UKST 2019).

Loveday et al. (2014) state that an IUC should only be used after considering alternative management. However, it is questionable whether non-invasive methods of urine output monitoring are even considered as a viable option in clinical practice. A literature review of CAUTI prevention guidelines failed to identify any recommendations advocating non-invasive methods for urine output monitoring (Conway and Larson 2012). Indeed, guidelines appear to assume an IUC is the only feasible method for measuring output in an acutely ill patient (NICE 2007). Thus, two patient safety messages are juxtaposed: the need to accurately monitor hourly urine output whilst also reducing the use of IUC. In order to address this problem, agreeing criteria for appropriate (and inappropriate) catheterisation for urine output monitoring would be an important starting point, including guidance on when alternatives such as collection devices are suitable and when monitoring can cease.

Variations in Practice

It is a well-known principle that short-term catheterisation should be used as a strategy of last resort (Loveday et al. 2014). This is a well-established approach in paediatrics, where alternative, non-invasive methods are used for urine output monitoring in preference to indwelling catheters (Dutta et al. 2009). Similarly, in oncology, where patients have increased susceptibility to infection, non-invasive bladder management strategies are the norm. However, in adult care environments, catheterisation for urine output monitoring has become routine. Anecdotal evidence suggests nurses working in paediatrics and oncology place greater emphasis on avoidance of invasive devices due to associated risks and the issue of acceptability of a catheter for children when other methods can be used. However, in adult medicine healthcare professionals appear to view urinary catheters as a way of mitigating risk. Murphy et al. (2015) identified how clinicians believe monitoring urine output is an appropriate indication for catheterisation, offering perceived protection from the potential harms of inaccurate measurements. Furthermore, focus groups conducted by Mulcare et al. (2015a) acknowledged cultural patterns in their ED, including the use of a convenience catheter for ease of monitoring urine output relative to other collection methods. It is unclear whether catheter use would be less if patients had improved knowledge of adverse complications from IUC use.

Litchfield et al. (2018) highlights how the implementation of accurate fluid balance charting is often forgotten or neglected and has therefore become a clinical issue that requires intervention. Fluid balance charts are notoriously inaccurate (Fernandez-Ruiz et al. 2013, Vincent and Mahendiran 2015) and it is likely that a lack of consensus on best practice has led inevitably to inconsistencies. A fluid balance chart can be a valuable tool to guide therapeutic decisions if completed accurately; however, if documentation is poor and interpretation incorrect this may risk patient safety (Tang and Lee 2010).

It is apparent that urine output monitoring in clinical practice can be unreliable. This is a multifaceted problem and is independent of whether non-invasive or invasive methods are used. Murphy et al. (2015) illustrate the cautious approach taken by clinicians even in patients without recognised oliguria. It is conceivable that a lack of clinical guidance on urine output monitoring has led to poor fluid balance recording, which in turn has served to reinforce clinicians' distrust in non-invasive alternatives to IUC. Whilst it is possible that an IUC does improve the accuracy of urine output monitoring, Beuscher (2014) highlights

how non-invasive methods can provide accurate measures if professionals employ them effectively. This study indicates potential for further research exploring pad weighing as an alternative approach to urine output monitoring in acute care.

The benefits of hourly measurements outside of critical care require further investigation. Issues surrounding urine output monitoring are complex with tensions rising from different perspectives of safety. Further research exploring non-invasive methods is needed to provide empirical evidence on less regular urine output measurements in order to reduce the evidence-practice gap. Strategies to improve the assessment of urine output in a variety of clinical settings should be prioritised to ensure oliguria detection, AKI prevention and the reliable assessment of fluid balance is achieved without over-reliance in IUC. Further input from industry may be required to develop urine collection devices that are suitable and accurate for monitoring urine output.

3.6 Conclusion

Urinary catheters are thought to champion the accuracy of urine output monitoring, but it is debateable whether the drive for accuracy is jeopardising rather than improving patient safety. Indeed, the risks associated with IUCs may be outweighed by the threat of missing oliguria, particularly if clinicians place greater importance on the latter. Various guidelines consider urine output monitoring as an appropriate indication for IUC placement in critically ill patients. However, these guidelines fail to adequately particularise when hourly urine output monitoring is required and for how long. The lack of research into the justification for initial placement of IUC for urine output monitoring in acute care is likely to reduce the effectiveness of any strategies aimed at reducing unnecessary IUC use. Guidelines on reducing catheter-associated urinary tract infection (Loveday et al. 2014, RCN 2012, HICPAC 2009) have sought to address the appropriate use of IUC. However, without exploratory research into why urine output monitoring is used in acute care and how this influences therapeutic decision-making, the current impasse on catheter culture is unlikely to be changed.

3.7 Chapter Summary

This chapter presents the findings of an integrative review, which has synthesised, and summarised literature related to this phenomenon. Literature cited consists of published articles and practice guidelines which have revealed valuable insight into urine output

monitoring practices. However, both quantitative and qualitative inquiry has been limited in relation to urine output monitoring literature. Cohort studies situated in critical care and expert consensus offers insight into why and how urine output is monitored. However, empirical studies in acute care would move the topic beyond reliance on expert opinion and towards an evidence-based approach with the potential to improve patient safety.

Throughout the past three chapters, gaps in the urine output monitoring literature have been highlighted. Outstanding questions remain around how and why urine output is monitored in acute care environments. Research is needed that explores urine output monitoring practices in 'real world' conditions to validate presumptions and offer further insight into this under-researched clinical problem. There is currently no consensus in the literature regarding when an IUC should be inserted to monitor urine output nor when an IUC should be removed. In addition, the lack of agreement on when the benefits of using an IUC outweigh the risks make it difficult to determine whether catheter insertion is clinically justifiable. There is uncertainty as to when hourly versus accurate output monitoring is needed and which methods of urine output monitoring are most beneficial to patient outcomes.

There is a need for a greater understanding of therapeutic decisions made from urine output measurements and the placement of an IUC compared to using non-invasive collection methods is necessary. Furthermore, facilitators and barriers to different methods of monitoring need to be explored to help address the issues of inaccurate charting. The use of a research approach which describes how urine output is monitored in acute care settings and explores why different practices occur will help advance knowledge which in turn can be used to improve patient care.

Chapter 4 Methodology and Research Design

4.1 Introduction

This chapter presents the research methodology, philosophical approach and design of this study in relation to the research questions and objectives outlined in Chapter Two. Working from a pragmatic paradigm, both quantitative and qualitative research methods were required to answer the research questions. Therefore, integrated survey and focused ethnography methodologies were used in a mixed methods study. Data were generated from analysis of a point prevalence survey, field observations, ethnographic informal conversations, medical document analysis and semi-structured interviews with healthcare professionals. This chapter will provide justification for the methodology and research methods chosen.

4.2 Epistemology

Epistemological and ontological foundations underpin research methodologies. Ontology is the philosophical investigation of the nature of reality, the theory of what exists. Epistemology is concerned with knowledge and how it originates (Plowright 2011). Research paradigms are theoretical principles that influence our thinking about an issue. Traditionally, there have been two opposite paradigms that underpin research, positivism and constructivism, the former being the 'standard view' of science to which reality can be measured and known, whereas the latter tends to be interested in social reality which can be interpreted (Robson 2002). From a philosophical perspective these traditional paradigms are seen as incompatible, as their ontological beliefs differ. Therefore, research methodologies underpinned by either paradigm traditionally oppose each other and therefore logically cannot be mixed. However, in practical terms, integration of methodologies has proved successful (Tashakkori and Teddlie 2010).

Pragmatism has developed as an alternative paradigm, to which reality is constantly renegotiated and interpreted. Pragmatic philosophy supports using a combination of whatever methodological approaches in order to best answer a particular research question (Onwuegbuzie et al. 2009). In its simplest sense, pragmatism is a practical approach to a problem. Therefore, working from the pragmatic paradigm, it is accepted

that quantitative and qualitative methods are compatible (Howe 1988). Whilst considering these issues, pragmatism focuses on what things will make a difference, as well as connecting abstract issues on the epistemological level to the methodological level. Pragmatism breaks down the hierarchies between positivist and constructivist ways of knowing in order to look at what is meaningful from both (Biesta 2010).

Pragmatism has strong associations with mixed methods research. It is outcome-oriented and interested in determining the meaning of things (Johnson and Onwuegbuzie 2006). Importance is placed on the research question and how to create practical solutions to social problems (Tashakkori and Teddlie 2003). At the conceptual stage, the paradigmatic perspective for this study was pragmatism. Pragmatism has influenced the writing of the research questions and the development of a realistic and appropriate research design. The subject of inquiry required a research question to be developed that quantified the problem by way of generating numerical data but also required exploratory research that could provide an understanding of underlying reasons and motivations. The nature of research undertaken by clinician academics is usually highly applied and a pragmatic approach is often favoured by practitioner-researchers (Robson 2002). In this case, pragmatism allowed both quantitative and qualitative data collection to be incorporated into a mixed method study in a real world setting, which could most effectively answer the research questions.

In connecting theory to data, pragmatism uses abduction, which has been found to be particularly useful during the integration stage of mixed methods research (Shannon-Baker 2016). Induction, deduction and abduction are methods of reasoning. Deductive reasoning is usually associated with quantitative research, testing hypotheses through a series of steps to reach specific conclusions. Inductive reasoning is associated with qualitative research and typically develops general conclusions based on exploration of how individuals experience and perceive the world around them. Abductive reasoning can be understood as a process that values both deductive and inductive approaches but also relies on the expertise of the researcher. An abductive research process starts when the existing range of evidence available cannot explain the phenomena (Wheeldon and Ahlberg 2012).

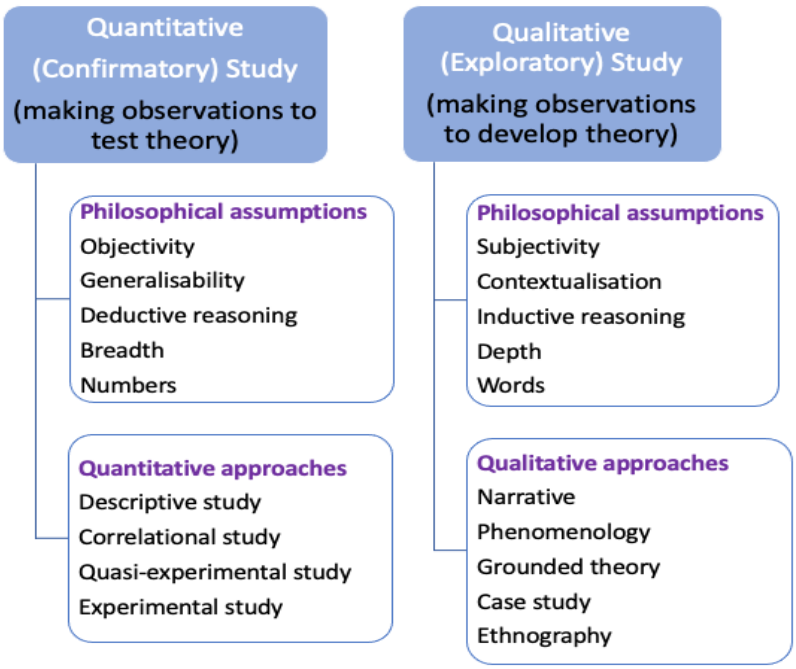
In the case of urine output monitoring little is known surrounding the phenomenon, therefore to use solely deductive logic to test a hypothesis or solely inductive reasoning

to build conclusions would limit the knowledge gained. By using a mixed method approach, knowledge can be developed using abductive reasoning, which incorporates both deductive and inductive reasoning but also utilises the expertise of the researcher to discover reasoning for phenomena based on best information available at the time, whilst acknowledging that understanding may still be incomplete (Wheeldon and Ahlberg 2012).

4.3 Methodology

Quantitative and qualitative methodologies differ in their philosophical assumptions and their approaches (Figure 3). Qualitative research if often exploratory in order to obtain insights, often unforeseeable, on a research question (Almeida 2018). Conversely, quantitative research often focuses on confirming and testing theory and can be used to quantify problems.

Figure 3. Differences in qualitative and quantitative methodology



(Adapted from Creswell 2009 and Plano Clark & Creswell 2008)

Quantitative research methods

Quantitative research relies on the collection and analysis of numerical data to describe, explain, predict, or control variables and phenomena of interest (Gay, Mills, & Airasian

2009). Nonexperimental research designs embody a group of techniques used to conduct quantitative research where there is no manipulation of any variable in the study.

Three types of nonexperimental research designs are: descriptive research (which includes observational research and survey research), correlational research, and causal-comparative research. The second category of quantitative research designs is collectively known as experimental research, a group of techniques where the researcher establishes different treatments or conditions and then studies their effects on the participants. Experimental research aims to establish the cause-effect relationship among a group of variables that make up a study (Salkind 2010).

The first quantitative phase of this study employed a descriptive research design using survey methodology. The purpose of descriptive studies is to describe and interpret, the current status of individuals, settings, conditions, or events (Mertler 2014). In descriptive research, the researcher is simply studying the phenomenon of interest as it exists naturally; no attempt is made to manipulate the individuals, conditions, or events. According to Grove et al. (2013), descriptive designs "*may be used to develop theory, identify problems with current practice, justify current practice, make judgments, or determine what others in similar situations are doing*". Two commonly used quantitative, non-experimental, descriptive research designs are observational and survey methods (Jackson 2009). Justification for using survey methods in this study and alternative methods that were considered will be discussed later in this chapter.

Qualitative research methods

Qualitative research is primarily exploratory in its nature. It can be used to gain an understanding of underlying reasons, opinions, and motivations and often provides deeper insights into a problem. Aspers and Corte (2019) define qualitative research as an "*iterative process in which improved understanding to the scientific community is achieved by making new significant distinctions resulting from getting closer to the phenomenon studied."*

As with quantitative methods, there are different kinds of qualitative research. Creswell (2009) outlines these into five groups: ethnography, narrative, phenomenological, grounded theory, and case study. While the five approaches generally use similar data

collection techniques (observation, interviews, and reviewing text), the purpose of the study differentiates them (Table 9). For the second phase of this study, focused ethnography was chosen to be the most suitable methodology to best answer the study's research question. A rationale for this choice is provided later in this chapter.

Table 9. Qualitative research methodology

Method	Focus	Sample Size	Data Collection
Ethnography	Context or culture	-	Observations & interviews
Narrative	Individual experience & sequence	1 to 2	Stories from individuals & documents
Phenomenology	People who have experienced a phenomenon	5 to 25	Interviews
Grounded Theory	Develop a theory grounded in field data	20 to 60	Interviews, then open and axial coding
Case Study	Organisation, entity, individual or event	-	Interviews, documents, reports, observations

Mixed Methods

The term 'mixed methods' refers to an emergent methodology of research that integrates quantitative and qualitative data within a single investigation (Wisdom and Creswell, 2013). Its central premise is the combining of both quantitative and qualitative approaches to provide a better understanding of research problems than would be the case by adopting a single perspective (Creswell and Plano Clark 2011).

Mixed methods research originated in the social sciences and has recently expanded into the health and medical sciences. Unfortunately, little is written in the literature with regard to use of a conceptual theoretical framework to organise and guide the phases of inquiry in a mixed methods study (Evan et al. 2011). However, researchers who choose to conduct a mixed methods study do have to consider certain methodological issues. These are:

- The priority or weight given to the quantitative and qualitative data collection and analysis in the study.
- The sequence of the data collection and analysis.
- The stage/stages in the research process at which the quantitative and qualitative phases are connected and the results are integrated.

(Creswell et al. 2003)

This study included a mixed methods two-phase approach. The first phase consisted of a quantitative survey followed by phase two, a qualitative focused ethnographic study. With little guidance for mixed methods practice and no widely accepted set of ideas on choice of design, Wisdom and Creswell (2013) proposed core characteristics of what a well-designed mixed methods study should include. The following characteristics have been considered in relation to this study and are displayed below (Table 10).

Table 10. Characteristics of a mixed methods study

Mixed methods study characteristics	This study
• Collecting and analysing both quantitative (closed-ended) and qualitative (open-ended) data.	• Quantitative data has been collected first in phase one followed by collection of qualitative data in phase two. Higher priority has been given to the qualitative data.
• Using rigorous procedures in collecting and analysing data appropriate to each method's tradition, such as ensuring the appropriate sample size for quantitative and qualitative analysis.	• Sample sizes in keeping to each method's tradition and are appropriate to the research questions being addressed. • Analytical methods used are appropriate to each method's tradition.
• Integrating the data during data collection, analysis, or discussion.	• Data from each phase analysed separately and then integrated to provide expansion of understanding.
• Using procedures that implement qualitative and quantitative components either concurrently or sequentially, with the same sample or with different samples.	• Quantitative component used sequentially to qualitative component. Results from quantitative phase used to inform the design of the qualitative phase. • Different samples were used for each phase of this study. However, the choice of samples in phase two were informed by the findings in phase one.
• Framing the procedures within philosophical/theoretical models of research.	• Pragmatism was chosen as the most appropriate philosophical position as it enabled a combination of different approaches to be used which are traditionally philosophically inconsistent. • By adopting a pragmatic position for this study, the choice of methodology and methods have been determined by the research questions and objectives, which represent a gap in evidence linked to a significant clinical problem.

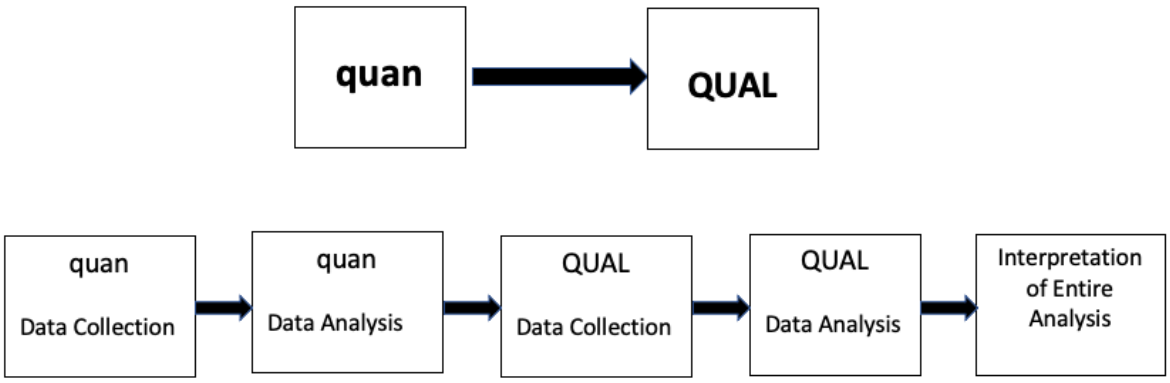
The design of mixed methods studies can incorporate a variable sequence, that is, the choice of quantitative methods, followed by qualitative methods or vice-versa (Creswell 2009). Creswell et al. (2003) found the mixed-methods sequential explanatory design to

be highly popular amongst researchers. The sequential explanatory design uses qualitative data to explore quantitative findings. This typically involves two consecutive phases within one study: (1) an initial quantitative phase, followed by (2) a qualitative data collection phase, in which the qualitative phase builds directly on the results from the quantitative phase.

In this design, a researcher first collects and analyses the quantitative (numeric) data. The qualitative data are collected and analysed second in the sequence and help explain, or elaborate on, the quantitative results obtained in the first phase (Creswell and Plano Clark, 2011). The rationale for this approach is that the quantitative data and their subsequent analysis provide a general understanding of the research problem. The qualitative data and their analysis refine and explain those statistical results by exploring the phenomena in more depth (Ivankova et al. 2006). In addition, the first phase of the study can inform or guide the data collection in the second phase. Typically, a researcher will connect the two phases by selecting the participants for the qualitative phase based on the quantitative results (Curry and Nunex-Smith 2015).

For this study a sequential explanatory design strategy was used whereby the quantitative data was collected and analysed in Phase One, which then informed the qualitative data collection and analysis in Phase Two, followed by interpretation of both datasets (Figure 4). Morse and Niehaus (2009) suggest that the core component of a sequential design should always be performed either before or concurrent to the supplemental component. However, Johnson and Christensen (2017) constructed a set of mixed methods designs without these limitations. In this study, priority and emphasis has been given to the qualitative data collected as explaining and understanding why particular urine output monitoring practices occur in the way they do was of the utmost importance to the study. Further details on the sampling design can be found at section 4.5 later in this chapter.

Figure 4. Sequential Explanatory Design (qualitatively driven sequential design)



Rationale for selecting a mixed methods methodology

Choosing a methodology that can practically address the research question and objectives is an important consideration in a study and helps to ensure that the underpinning theoretical approach and the chosen methods of data collection and analysis are consistent with its aims. With a pragmatic epistemological foundation, mixed methods approaches are uniquely suited to explore the non-linear, complex research questions that are common in health sciences (Curry and Nunex-Smith 2015).

The rationale for selecting a mixed methods approach for this study is as follows:

1) Different research questions

The research questions are exploratory in nature, seeking to understand urine output monitoring phenomena through prevalence, behaviours and experiences. There is an explicit link between the research questions and mixed methods. A mixed methods approach allowed both the qualitative and quantitative aspects of the research question to be addressed (Almeida 2018).

2) Completeness

As little is known about the research topic, an exploratory qualitative ethnographic approach was warranted in order to generate a depth of understanding. The research objectives for this study encompassed both behaviours and perspectives therefore

ethnography was deemed suitable. The quantitative approach, by means of a prevalence survey, enabled investigation of the study phenomenon across acute medical environments, thus providing breadth, as well as identifying environments where the qualitative research would be most useful and relevant. Mixed methods research focuses on the combination of numeric and narrative data and analysis. By integrating both approaches the study hoped to yield greater insight than would be achieved from using one methodology (Creswell and Plano Clark 2011).

3) Sampling

Combining two approaches allowed the quantitative data collected from the first phase to facilitate the selection of wards to participate in the second qualitative phase of data collection. This was helpful as it revealed areas that would be most beneficial to study in order to answer the research questions.

4) Explanation

Explanation refers to one set of findings helping to explain findings generated by the other. The *explanatory sequential design of this study used* the qualitative phase to directly build on the results from the quantitative phase. In this way, the quantitative results are explained in more detail through the qualitative data.

5) Enhancement

Extending the breadth and range of enquiry by using different methods for each component of the research allows findings to be enhanced by different data sets. This study has collected data using a variety of methods such as survey, observations of practice, interviews and medical document analysis. Each method has contributed to the knowledge gained which has enhanced and added depth to the findings.

6) Triangulation

Triangulation is a technique that advocates the collection of data from two or more sources. Glasper and Rees, (2017) suggest by using more than one method to gather data (surveys, observations and interviews) quantitative and qualitative findings can be compared for corroboration. However, there are mixed opinions on whether the purpose

of triangulation is to cross-validate data or rather to capture different elements of the same phenomenon to add greater depth of understanding (Honorene 2016). In the case of this work, combining multiple methods of data collection aimed to add depth to the data rather than verification for data from different sources.

Strengths of mixed methods research

Research methods associated with both quantitative and qualitative research have their own strengths and weaknesses. Quantitative research is limited in understanding the reasoning behind people's behaviour, whereas, qualitative data has potential for bias and has difficulty in generalising findings to larger groups. Combining the approaches through mixed methods studies allows their weaknesses to be offset and strengths of both approaches to be drawn upon. Triangulation allows one to identify aspects of a phenomenon more accurately by approaching it from different vantage points using different methods and techniques.

Limitations of mixed methods research

The research design for mixed methods research can be complex and therefore takes more time and resources to plan and implement.

Before deciding that a mixed method approach was the most appropriate for this study, individual quantitative (experimental, non-experimental) and qualitative (phenomenology, case study, grounded theory) methodologies were deliberated.

Alternative quantitative research methods considered

An experimental quantitative study such as a randomised control trial appeared inappropriate, as the research questions were not concerned with assessing causality. Furthermore, it appeared unethical to assign participants to a particular exposure (non-invasive versus invasive urine output monitoring) when so little is known about the phenomenon.

A non-experimental quantitative approach was appealing as it did not require control or manipulation of variables but could potentially provide large amounts of data creating a breadth of information. A cohort study was considered, but found inappropriate as the

quantitative research question was concerned with prevalence of a medical intervention rather than comparing rates of disease incidence and identifying risk factors (Jacobsen 2012). Therefore, a prevalence survey was agreed to be the best approach to answer one element of the research questions relating to prevalence and extent of variation of urine output monitoring using catheters and non-invasive methods in acute medical environment. However, as surveys are quantitative in nature, a non-experimental quantitative methodology could not fully address the qualitative objectives which included understanding the factors influence clinicians' use of urinary catheters versus alternative, non-invasive methods of urine output monitoring. Consequently, qualitative methodologies were also explored.

Alternative qualitative research methods considered

Phenomenology was appealing as it attempts to understand people's perceptions and understanding of a particular situation, which could provide insight into clinicians' beliefs regarding urine output monitoring (Jacobsen 2012). However, it was concluded that the nature of phenomenology predominately describes the lived experience of participants and therefore would not fully answer the research questions.

Grounded theory did not appear to be an appropriate strategy to use as the proposed research is not concerned with developing or generating a theory, but is focused on understanding the phenomena and prevalence.

Qualitative case study provides tools for researchers to study complex phenomena. Yin (2003) suggests a case study design should be considered when the researcher seeks to answer "how" and "why" type questions, while taking into consideration how a phenomenon is influenced by the context within which it is situated. Qualitative case study was considered by the researcher as a potential methodology however it was decided the research project required periods of time in the 'field' and there was a requirement for observational evidence that seemed to fit best with an ethnographic approach.

After concluding a mixed methods approach would be the most appropriate it was decided a point prevalence survey would be used for the quantitative phase and focused ethnography would be best suited for the qualitative phase.

Rationale for selecting a survey for the quantitative phase

Survey research is common in studies of health and health services, although it originated from applied social research. A survey is used in a variety of ways, but generally refers to the selection of a relatively large sample of people from a pre-determined population. Surveys are designed to provide a snapshot of how things are at a specific time (Kelley et al. 2003).

After reviewing the literature on urine output monitoring it was clear that a gap in the present literature existed. Although studies had acknowledged the overuse of urinary catheter to monitor urine output (Apisarnthanarak et al. 2007), it was unknown which methods of urine output monitoring were currently utilised in acute care environments and for which patients. In order to address this gap, a point prevalence survey was designed to provide a large amount of data on the topic area within a relatively short amount of time. Although data produced by the survey would provide information on prevalence, it was identified this data alone would lack the explanatory component needed to understand in depth the topic being investigated, therefore a qualitative second phase was necessary in order to achieve all of the research objectives.

Rationale for selecting focused ethnography for the qualitative phase

Ethnography can be described as the study of social interactions, behaviours and perceptions that occur within groups, teams, organisations and communities (Reeves and Hodges 2008). Traditional or classical ethnography originates from anthropological studies in the early 1990s, whereas focused ethnography has emerged more recently (Knoblauch 2005). Ethnographers essentially study situations in real time as they occur in their natural setting in order to gain in-depth understanding (Higginbottom et al. 2013).

The depth of comprehension required with traditional ethnographies usually warrants several data collection methods to be utilised including participant observation over an extended time period, interviews and documentary analysis. Ethnographic research is shaped by the researcher acknowledging the insider/outsider view and the impact this has on reality. In traditional ethnography, the researcher is usually unaccustomed with the cultural setting under study and typically enters with an undefined purpose (Wall 2015).

Alternatively, focused ethnography is characterised by short-term field visits and an interest in a specific research question. Furthermore, it is not uncommon for the researcher to have insider or background knowledge of the group being studied (Wall 2015). Focused ethnography has been used primarily in practice-based disciplines such as nursing and can offer a pragmatic and efficient way to capture data on a specific topic of importance to healthcare professionals (Wall 2015). Focused ethnographies can have meaningful and useful application in hospital settings, and can be used to determine ways to improve care and care processes (Higginbottom et al. 2013). Tarrant et al. (2016) successfully studied the implementation of sepsis six care bundles in six hospitals using focused ethnography. Furthermore, Knobloch et al. (2017) promotes the use of ethnographic studies to understand contextual factors that can support or hinder implementation of evidence-based practices for reducing healthcare associated infections.

This study's aim was to explore why and how urine output is monitored in acute care environments, using a mixed methods research design. Focused ethnography was an appropriate approach to use as the research questions, specific study population and the author's unique position as a nurse researcher made using conventional ethnographic methods challenging. Unlike traditional ethnography researchers who usually enter the field with no prior conceptions (objective outsiders); the researcher's experience as a nurse and knowledge of previous literature in this area, helped to develop specific research questions for the project that sought to help solve a clinical problem. Instead of an open-ended intent to immerse oneself in a new culture, the researcher hoped to understand what motivated healthcare professionals' decisions to monitor urine output using various methods in different clinical environments.

Goodson and Vassar (2011) highlight how from the outside, hospitals can look like they operate similarly, however, patient care and decision-making processes can differ. Ethnography can help to understand and explore the social and cultural influences on healthcare environments, including clinical reasoning differences among healthcare professionals (Savage 2000). The culture lens for this study explored the experiences and perspectives of individual healthcare professionals at a micro level in order to understand different influences and belief systems. Specifically, the researcher hoped to understand the facilitators and barriers clinicians face when making these decisions and what

knowledge, skills and experience they draw upon in making and implementing these decisions. Comparisons between traditional ethnography, focused ethnography and this research study are described in the table below (Table 11).

Table 11. Key characteristics of traditional and focused ethnographic research: (Adapted from Higginbottom et al. 2013 and Knobloch et al. 2017).

Traditional ethnography	Focused ethnography	This research study
Entire social field studied	Specific aspect of field study with purpose	Specific area of focus on urine output monitoring behaviours and perspectives
Open field of investigation as determined through time	Closed field of investigation as per research question	Closed field of two ward areas in order to compare practice in different clinical environments
Carried out in a natural setting	Carried out in a natural setting	Carried out in a natural (hospital) setting
Researcher has a participant role in observations	Researcher has a field-observer role	Researcher has a field-observer role
Participants are usually those with whom the researcher has developed a close relationship	Informants serve as key participants with their knowledge and experience	Nurses, doctors and healthcare assistants were observed and interviewed as key participants providing their knowledge and experience
Observation over extended time periods	Episodic observation	Episodic observations during short-term field visits to two ward areas
Uses inductive, interactive and recursive data collection and analysis	Uses inductive, interactive and recursive data collection and analysis	Uses abduction, which incorporates inductive, interactive, and recursive data collection and analysis
Individual data analysis	Data sessions with a gathering of researchers knowledgeable of the research goals providing heightened perspective	Due to nature of doctoral studies, individual data analysis took place under the guidance of academic supervisors
Uses context and culture as a lens to interpret study results	Uses context and culture as a lens to interpret study results	Uses context and culture as a lens to interpret study results

4.4 Data Collection

Data collection can be defined as the systematic approach to gathering and measuring information from a variety of sources that enables one to answer stated research questions, test hypotheses, and evaluate outcomes (Curry and Nunex-Smith 2015). The data in mixed methods research comes from multiple sources. Collecting data from a variety of sources increases scientific rigour as no single data collection method is advantageous over all others. The following sections describe the methods chosen to answer the research question and objectives, explaining the methods of data collection, including sampling, and data analysis. Four methods of data collection were used for this

study: a point prevalence survey, field notes from observations in practice (including ethnographic interviewing with clinical staff on their clinical decision-making), use of medical documents and semi-structured interviews.

4.4.1 Phase One: Point Prevalence Survey (quantitative phase)

Quantitative data were collected using a point prevalence survey. Prevalence signifies the proportion of a particular disease within the given population. Point prevalence is not only indicative of disease but may also determine how many people in a population are receiving a particular medicine or medical intervention. A point prevalence rate represents all instances of a disease or intervention at a particular location at a specific point in time (Bhopal 2002). This approach was therefore suitable for investigating the prevalence of urine output monitoring in different medical environments. In addition to identifying prevalence, the survey also informed the selection of suitable wards to include in the ethnographic phase of the study.

An advantage of this method was that it enabled a large amount of quantitative data to be collected, therefore offering a representative picture of the phenomenon at the particular point in time. A limitation of the survey is its use in a single centre, which is therefore not generalisable beyond the study setting. Although a multi-centre survey was preferable, it was beyond the scope and feasibility of this research project.

4.4.2 Phase Two: Focused Ethnography (qualitative phase)

The qualitative phase of the study used a focused ethnographic approach, incorporating field observations, interviews and use of documents.

Observation

Observation is commonly used in exploratory phase studies, seeking to find out what is going on in a situation (Robson 2002). Watching and recording behaviours in their natural setting allows the researcher to collect data on what people directly do, rather than relying on what people say they do (Goodson and Vassar 2011). Data obtained through observation allows disparities in self-reporting and participants' actual behaviour to be explored, offering a different perspective from other qualitative research methods (Robson 2002).

A disadvantage of using observational techniques includes researchers' preconceived ideas and prejudices, causing observer bias, misinterpretation and threatening validity (Bell and Waters 2014). Reflexivity is advocated to minimise the effects of researcher bias. Reflexive practice during the research process allows the researcher to become more aware of their influence on the study and their interpretation of the observation data (Robson 2002). Reflexive notes were maintained throughout the research process and reported in Chapter Six.

An advantage of field observation is that the naturalistic environment increases ecological validity meaning findings can generalisable to real life settings (Robson 2002). Such studies allow for rich data, otherwise unavailable, to be collected and synthesised. A disadvantage of this method is the difficulty of documenting the data. Writing down everything of interest whilst you are interacting can be problematic. Therefore, the quality of the data can depend of the diligence of the researcher to write up field notes promptly.

Observation of different clinical environments allowed variations in ward culture, routines and practices related to urine output monitoring to be explored. Due to the limitations of a doctoral study only two wards were selected for observations therefore data collected to allow a comparison of ward cultures was limited. Field notes were made from observations of behaviour, communication patterns, workflows and tasks of clinicians on study wards. Observations focused on:

- Observing how clinical areas functioned, including environmental influences;
- individual behaviours when monitoring urine output including decisions to insert an IUC for urine measurements;
- identifying opportunities for 1-1 discussions with staff;
- observing whether clinical staff acknowledge catheters, review fluid balance charts, discuss renal function/urine output and understand how urine measurements influence therapeutic decisions;
- observing the care provided for patients with oliguria and activity in response to reduced urine output.

Ethnographic informal conversations

Ethnographic informal conversations combine immersive observation and directed one-on-one interviews. Observing participants performing activities in their natural environment and asking them questions about what they are doing and why can reveal important details of the behaviour (Spradley 1979). An advantage of ethnographic informal conversations is that researchers can collect first-hand information that they cannot acquire when clinicians are out of their work environment. This allows knowledge that could be missed or forgotten in semi-structured interviews to be explored (Emerson et al. 2011).

Ethnographic interview methods have been commended for being particularly useful at providing extensive in-depth findings when there is little information known about a particular phenomenon (LeCompte and Schensul 2010). This research study used ethnographic informal conversations to gather information from clinicians in their natural work environment on therapeutic decisions, clinical objectives, environmental constraints, collaboration and workflow relating to patients requiring urine output monitoring. The data collected captured how urine output measurements were used to guide medical decisions, perceived barriers and facilitators to using different methods of urine measurement and how clinicians decided which medical conditions require urine output monitoring and which method to use. Particular attention was paid to the impact of urine output measurements on therapeutic decision-making.

Use of documents and medical records

Documents can add a further layer of detail to ethnographic insights which may contrast with observed or reported accounts of events (Grant 2017). In this study, collection of data from medical documents and records allowed an additional source of information to help reveal the reality of what was happening in practice. Fieldwork identified patients who would be suitable for medical document review and sources within the record were reviewed including nursing and physician notes, laboratory and diagnostic reports. Limitations of using data obtained from medical records include the potential for data to be incomplete, missing or the researcher may have difficulty interpreting documented information. Scott (1990) provides criteria for assessing quality when using documents in

research and advises to assess: authenticity, credibility, representiveness and meaning. The medical notes used in this study were authentic as they were written at the point of care and reviewed prospectively. Similarly, the author of the notes were identifiable and were written by registered healthcare professionals increasing their credibility. However, a recognised weakness of including medical notes in research is that the researcher cannot know what elements the author had chosen to exclude therefore limiting their meaning.

Semi-structured interviews

The final qualitative data collection method used in this study was semi-structured interviews with clinical staff. Semi-structured interviews are valuable as they can offer thick description of the phenomena; feelings, beliefs and unobservable behaviours can be explored by this qualitative approach, adding understanding, which quantitative data cannot provide (Bell and Waters 2014). Rich data revealed by clinicians in semi-structured interviews was important to the study as the research questions were interested in investigating clinicians' perspectives of factors that influence urine output monitoring practice. Data generated from the semi-structured interviews helped fill in the gaps from observations and offered further explanations.

A limitation of this approach is that its method is subjective in nature and therefore at risk of bias (Bell and Waters 2014). Bias can occur from poorly designed questions, respondent answers, the interviewer and the interview situation. The usefulness of the data relies upon the researcher avoiding bias and participants answering honestly (Adams 2015).

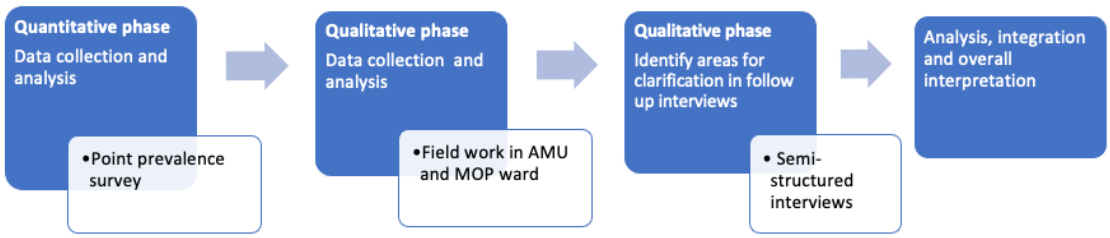
Semi-structured interviews offer a flexible design, which can be modified by the researcher. Interviews normally consist of predetermined questions; however, the order can be tailored to the individual interview. Inappropriate questions can be omitted or additional questions can be added allowing new lines of information to be probed, this adaptability is highly advantageous (Robson 2002). The main disadvantage of this approach is that it is time-consuming as it usually entails analysing a large volume of transcripts which can take many hours (Adams 2015).

4.5 Sampling Design

Mixed methods sampling involves combining well-established qualitative and quantitative techniques in order to answer the research questions posed (Teddlie and Yu 2007). Probability, purposive and convenience sampling are approaches that can be utilised in mixed method studies. Purposive and probability sampling are both designed to provide a sample that will answer the research questions under investigation. However, a purposive sample is more commonly designed to explore a smaller sample size in order to yield in-depth information about a particular phenomenon, whereas a probability sample is planned to select a large number of cases that are collectively representative of the population of interest. Convenience sampling is recognised as a pragmatic approach but there is potential for findings to be limited (Creswell 2015).

Sampling in quantitative research typically follows random sampling procedures (Creswell 2015). Researchers calculate the required sample size before beginning the study and that size remains a constant target throughout the study. However, for the quantitative phase of this study, the whole source population was selected to serve as a sample population therefore probability-based sampling methods were not required for this element of the research project. One well-known mixed method strategy is sequential mixed methods sampling (Teddlie and Yu 2007). Typically, the results generated from the first phase of data collection inform the sampling frame for the subsequent phase. Studies can either follow a QUAN-QUAL or QUAL-QUAN mixed methods sampling procedure. In this study results from the QUAN phase influenced the selection of the wards chosen for the QUAL phase (Figure 5). In addition, data collected during field work from observations of practice and conversations with staff also identified areas for clarification in follow-up interviews.

Figure 5. Sequential mixed methods sampling



The sample planned for both the quantitative and qualitative phases of this study were limited to urine output monitoring practices in acute medical care as it was anticipated that practice in surgical wards could be substantially different and addressing the phenomenon in all clinical environments would be beyond the scope of this study.

A further sampling strategy commonly used in mixed method studies is stratified purposive sampling. The stratified nature of this sampling procedure is characteristic of probability sampling. However, the small number of cases typically generated through it is characteristic of purposive sampling. In this technique, the researcher first divides the group of interest into strata (e.g., physicians, nurses and healthcare assistants) and then selects a small number of cases to study intensively within each strata based on purposive sampling techniques. This allows the researcher to discover and describe in detail characteristics that are similar or different across the subgroups (Teddie and Yu 2007).

The guiding principle of sample selection in qualitative studies is that the sample should be purposeful rather than randomised (Curry and Nunex-Smith 2015). Within ethnography, a purposive approach is justified as the nature of qualitative research is concerned with meaning and not making generalisable statements. Ethnography therefore does not favour a specific sample size. Concerns around sample size justification could be attributed to positivist epistemology and the requirement for representation and generalisability. Some qualitative researchers believe participant recruitment should continue until the concept of data saturation has been reached (Mason 2010). Data saturation is said to occur when the researcher is no longer receiving new information. However, it has been argued that this concept relies on understanding of meaning as transparent and obvious prior to analysis and therefore these assumptions may be made on potentially superficial impressions of the data during data collection. As thematic analysis involves identifying new patterns of meaning, and this usually happens after data collection, analysis is necessary to judge whether the information generated by participants offers something new or not (Clarke et al. 2015). Braun and Clarke (2016) argue sample size is most often informed by various contextual and pragmatic considerations such as the breadth of their research question, the diversity within the population of study, and the amount and richness of data collected from each participant/case.

This study used a sequential mixed method sampling procedure. For the quantitative phase of this study, the whole source population was selected to serve as a sample population therefore probability-based sampling methods were not required for this element of the research project. For the qualitative phase, purposive sampling was the sampling strategy adopted for the ethnographic informal conversations and medical document analysis. Stratified purposive sampling was the initial strategy adopted for the semi-structured interviews. However, due to challenges recruiting physicians to interviews, purposive sampling was extended to include snowball sampling. The sample size was determined using the Braun and Clarke (2016) method. Pragmatic consideration was given to what would be feasible to achieve by a sole researcher within the scope of a doctoral study when designing the study and applying for ethical approval. This was followed by the researcher assessing the richness of the data during collection. The decision to conclude the study was made by the researcher and her academic supervisors when it was believed enough data to answer the research questions had been obtained. Details of the sampling processes taken for this study will be explained in Chapter Five.

4.6 Data Analysis

Mixed methods studies use abductive reasoning a process that values both deductive and inductive approaches but also relies on the expertise of the researcher. An abductive research process starts when the existing range of evidence available cannot explain the phenomena (Wheeldon and Ahlberg 2012). In mixed methods studies, analyses are performed on the quantitative and qualitative data sets in accordance with established methods of analysis for each approach (Curry and Nunex-Smith 2015). In the case of urine output monitoring little knowledge is known surrounding the phenomenon, therefore to use solely deductive logic to test a hypothesis or solely inductive reasoning to build conclusions would limit the knowledge gained. The quantitative phase of this research study took a deductive reasoning approach using closed questions to collect the survey data, whereas the qualitative ethnographic phase used inductive reasoning to draw broad generalisations from specific observations.

Quantitative analysis uses statistical approaches with numeric data, whereas, qualitative analysis generates themes and conceptual categories to describe or explain a phenomenon. After initial independent analysis of each component, the quantitative data is integrated to create a combined data set. Integration during data interpretation is

imperative in mixed methods research (Curry and Nunex-Smith 2015). Interpreting the complimentary findings in light of each other helps to increase depth and breadth of understanding of the research questions. This study will present both quantitative and qualitative findings separately in the results chapter and narrative commentary linking major elements will integrate the results in the synthesis chapter and the discussion section.

4.6.1 Phase One: Point Prevalence Survey (Descriptive Statistics)

The purpose of Phase One of this study was to report the prevalence of urine output monitoring and the use of urinary catheters and other methods of urine collection and measurement. Descriptive statistics provide simple summaries about the research sample and the observations that have been made. Their purpose is to give meaning to the data collected in order to justify whether the intended aims of the research have been achieved. Descriptive statistics can benefit a research project by revealing large amounts of information about the collected data (McHuge 2003). Use of descriptive statistics involves summarising and organising data so it can be easily understood and helps researchers find patterns. They seek to describe the data but do not attempt to make inferences from the sample unlike inferential statistics which are used to make judgements of the probability that an observed difference between groups is a dependable one or one that might have occurred by chance. Phase one of this research project did not seek to make inferences; the aim was to describe prevalence in order to understand the clinical problem.

There are several ways to measure and report prevalence including point prevalence, period prevalence and lifetime prevalence. Point prevalence was the measure chosen for this study as the interest of inquiry was on the proportion of medical in-patients having their urine output monitored at a specific point in time. A limitation of descriptive statistics is that it only allows for summations about the phenomena measured, meaning the data collected is not generalisable. Nevertheless, descriptive statistics was viewed as the level of analysis required to answer the research question posed.

4.6.2 Phase Two: Focused Ethnography (Reflexive Thematic Analysis)

This mixed methods study followed a sequential explanatory design, therefore the purpose of Phase Two was to help explore the meaning of the data generated by the quantitative phase. The rationale for this approach is that the quantitative data and their subsequent analysis provide a general understanding of the research problem. The qualitative data and their analysis refine understanding of and explain those statistical results by exploring the phenomena in more depth (Ivankova et al. 2006).

Focused ethnography uses an inductive analytic process to reconstruct the data, in order to gain new understandings of the phenomenon. Unlike other forms of qualitative approach, such as grounded theory and interpretative phenomenological analysis, focused ethnography does not subscribe to a structured analytical step by step process. Ethnographical approaches are more flexible and allow the researcher to choose the analytical process that best suits the needs of the research.

There are several methods available to analyse qualitative data, however thematic analysis (TA) is one of the most common forms. Thematic analysis can be described as a method for capturing patterns (themes) across qualitative datasets and is often misconceptualised as a single analytic approach. Braun and Clarke (2020) promote the idea that TA is in fact an umbrella term that captures various approaches, which aim to identify themes in data. Three broad schools of TA have been identified as: a coding reliability approach, a codebook approach and a reflexive approach. Reflexive TA approaches include Braun and Clarke (2006) version of thematic analysis, which has been relabelled as reflexive thematic analysis (Braun and Clarke 2020).

Coding reliability approaches involve conceptualising coding as a process of identifying evidence of themes. Themes are typically identified as topic summaries of the most frequent things participants have said. Research subjectivity is identified as a threat to reliability which could introduce bias to the findings (Clarke et al. 2019). Therefore, coding reliability approaches use a structured approach to coding centred around a coding frame. Multiple coders will work independently to apply the coding frame to the data to which the level of agreement is measured, determining the final coding through consensus (Clarke et al. 2019). This approach was not considered suitable for this study as subjectivity is inherent to ethnography as the researcher is regarded as the 'research

tool'. Ethnographic research is shaped by the researcher acknowledging the insider/outsider view and the impact this has on reality. Therefore, an approach (reflexive TA) that favoured the analytical and interpretative work on the part of the researcher was chosen.

A codebook approach combines the structured approach to coding with the research values of reflexive TA. The use of a codebook is usually to map the developing analysis to facilitate teamwork during analysis or to identify predetermined information needs rather than to increase reliability and accuracy of coding (Clarke et al. 2019). This approach was also not considered appropriate as there were no predetermined information needs of the dataset. Furthermore, as the project was undertaken as part of doctoral studies the researcher was solely responsible for data analysis.

Reflexive TA was identified as being suitable for this research project as it is a flexible analytic method that can examine the factors that influence and underpin particular processes whilst also identifying different viewpoints. TA also offers flexibility around data collection methods, with interview and observation methods being common. Reflexive TA acknowledges researcher subjectivity as a valid resource to the analysis and emphasises the active role of the researcher during the generation of knowledge (Braun and Clarke 2013). The aim of coding and theme development in reflexive TA is to provide a coherent and compelling interpretation of the data, grounded in the data without minimalising the influence of researcher subjectivity on the analytic process (Braun et al. 2018). Braun and Clarke (2006, 2020) reflexive thematic approach will be presented alongside this project's analytical process in Chapter Five.

4.7 Assessing Quality

Evaluating the quality of mixed methods research has been the subject of much debate in the literature (Barnat et al. 2017, Halcomb 2019, Heyvaert et al. 2013, O'Cathain 2010). Traditionally, researchers conducting quantitative studies assess scientific rigor using conventional approaches to establishing internal validity, external validity, reliability and objectivity. In contrast, qualitative researchers seek to establish trustworthiness, using criteria known as credibility, dependability, confirmability and transferability (Lincoln and Guba 1985). While several approaches to critical appraisal of mixed methods research have been proposed, consensus on quality measures has yet to be reached

(Fabregues and Molina-Azorın 2016). Creswell and Plano Clark (2011) and O'Cathain (2010) argue using traditional quality assessment tools to appraise the individual quantitative and qualitative strands of mixed methods research is too limited as a mixed methods study is more than just the sum of the two components.

Although no agreed standards for assessing quality in mixed methods studies have been agreed, three approaches exist: the generic research approach, the individual components approach and the mixed methods approach (O'Cathain 2010). The generic research approach assesses the full mixed methods study using generic tools from quantitative and qualitative research. The individual components approach ensures that the appropriate quality criteria for each specific methodology (i.e., quantitative and qualitative) are met. However, Tashakkori and Teddlie (2003) emphasised how meta-inferences are drawn from the whole mixed methods study, not solely from each component. Consequently, Tashakkori and Teddlie (2008) developed a mixed methods approach model for assessing quality and introduced the concept of inference quality, which is a combination of design quality (methodological rigor) and interpretive rigor (truthfulness of conclusions from study). Since then, other researchers (Creswell and Plano Clark 2011, O'Cathain et al. 2008) have established different mixed methods models to assess quality.

Creswell and Plano Clark (2011) suggest that to evaluate a mixed methods study, the researcher needs to:

- collect both quantitative and qualitative data;
- employ rigorous procedures in the methods of data collection and analysis;
- integrate or mix (merge, embed, or connect) the two sources of data so that their combined use provides a better understanding of the research problem than one source or the other;
- use a mixed methods research design and integrate all features of the study with the design; and
- convey research terms consistent with those being used in the mixed method field.

In their guidance on Good Reporting of a Mixed Methods Study (GRAMMS), O'Cathain et al. (2008) orientate their recommendations towards the research process:

- describe the justification for using a mixed methods approach to the research question;
- describe the design in terms of the purpose, priority, and sequence of methods;
- describe each method in terms of sampling, data collection and analysis;
- describe where and how integration has occurred;
- describe any limitation of one method associated with the presence of the other method;
- and describe any insights gained from mixing or integrating methods.

Bryman (2014) proposed that in addition to the technically competent implementation of quantitative and qualitative components, mixed methods research should be transparent, linked to the research questions, have a clear rationale for the choice of the mixed methods approach, be explicit about the nature of the design, and have a clear description of the integration of components. This research project has incorporated guidance from both Creswell and Plano Clark (2011) and O'Cathain et al. (2008) to ensure this mixed methods study is of high quality. In this chapter, description and justification for research choices, design and integration of components is included to promote transparency. These guiding principles have been applied throughout this thesis. Table 12 presents the strategies identified and applied to this project to ensure that it was of high quality.

Table 12. Strategies identified to ensure quality

Quality Criteria for Mixed Methods Studies (Creswell and Plano Clark 2011, O'Cathain et al. 2008)	**Strategies Identified to Ensure Quality**
1.Collect both quantitative and qualitative data	Both quantitative and qualitative data was collected during this study. Different data sources were collected using a variety of methods such as survey, interview, observations of practice and review of documents.

2. Employ rigour procedure in the methods of data collection and analysis	Clear descriptions of methods of data collection and analysis are provided throughout this thesis and findings are supported by the presentation of appropriate graphs and quotations. The researcher kept a reflexive research diary that helped in monitoring the development of concepts.
3. Integrate or mix (merge, embed or connect) the two sources of data	Two sources of data were connected in this study as the quantitative phase guided the collection of data in the second phase. A synthesis of both quantitative and qualitative took place.
4. Use a mixed methods research design and integrate all features of the study with the design	A sequential explanatory mixed methods design strategy was followed. Clear descriptions of the design strategy and the integration of features are provided throughout this thesis.
5. Convey research terms consistent with those being used in the mixed methods field	Research terms consistent with those used in the mixed methods field have been used throughout this thesis.
6. Describe the justification for using a mixed methods approach to answer the research question	Clear descriptions for the justification for using a mixed methods approach to answer the research question have been provided in Chapter 4.
7. Describe the design in terms of the purpose, priority and sequence of methods	A sequential explanatory design strategy was used. Collecting and analysing the qualitative data sequentially was important as it helped explain the quantitative results obtained in the first phase. In this study, priority and emphasis has been given to the qualitative data collected as explaining and understanding why urine output monitoring practice occur was of the utmost importance to the study.

8. Describe each method in terms of sampling, data collection and analysis	Clear descriptions of methods of sampling, data collection and analysis are provided in Chapters 4 and 5 of this thesis.
9. Describe where/how integration has occurred and insights gained	Quantitative and qualitative results have been presented separately in the results chapters. Both data sets are then synthesised in Chapter 9 and insights gained discussed in Chapter 10.
10. Describe any limitation of one method associated with the presence of the other	The quantitative data and the subsequent analysis has provided a general understanding of the research problem. However, quantitative data was limited in providing an explanation as to why such practices were occurring. Analysis of the qualitative data helped to explain the statistical result by exploring the phenomena in more depth.

4.8 Chapter Summary

Pragmatism is underpinned by the concept that knowledge is based on experiences and one single scientific method of inquiry is unlikely to access truths regarding the real world (Robson 2002). Pragmatism was chosen as the most appropriate philosophical position as it enabled a combination of different approaches to be used which are traditionally philosophically inconsistent. By adopting a pragmatic position for this study, the choice of methodology and methods have been determined by the research questions and objectives, which represent a gap in evidence linked to a significant clinical problem. Following a comprehensive review of the philosophical, methodological and methods literature, a mixed methods approach combining survey and focused ethnography methodology was chosen. Pragmatism supports simultaneous use of qualitative and quantitative methods of inquiry to generate evidence that best answers the particular research questions. Working from the pragmatic paradigm, both quantitative and qualitative methods have been utilised in order to fully address each element of this study's research questions. Through critical discussion of the literature this chapter has provided a rationale for the choices presented and a consideration of approaches to ensure methodological rigour. The following chapter will detail the methods and processes that were undertaken to conduct this study.

Chapter 5 Methods and Research Process

5.1 Introduction

As discussed within previous chapters, there is a lack of empirical research investigating perspectives and practices of healthcare professionals in relation to urine output monitoring. The aim of this research was to explore how and why urine output is monitored. More specifically, it sought to understand the factors that influence use of urinary catheters and other strategies to monitor urine output in acute medical environments. In view of these study aims, it was evident that both quantitative and qualitative methods would need to be exploited in order to fully answer the research questions.

This study utilised a sequential explanatory design strategy whereby the quantitative data were collected and analysed in Phase One, which informed the qualitative data collection in Phase Two. Collecting and analysing the qualitative data sequentially was important as it helped to explain the quantitative results obtained in the first phase. This chapter explains the study design and the methods used to collect, analyse and interpret the data for this mixed methods study. It also explores issues surrounding sampling, recruitment and ethical considerations.

5.2 Study design

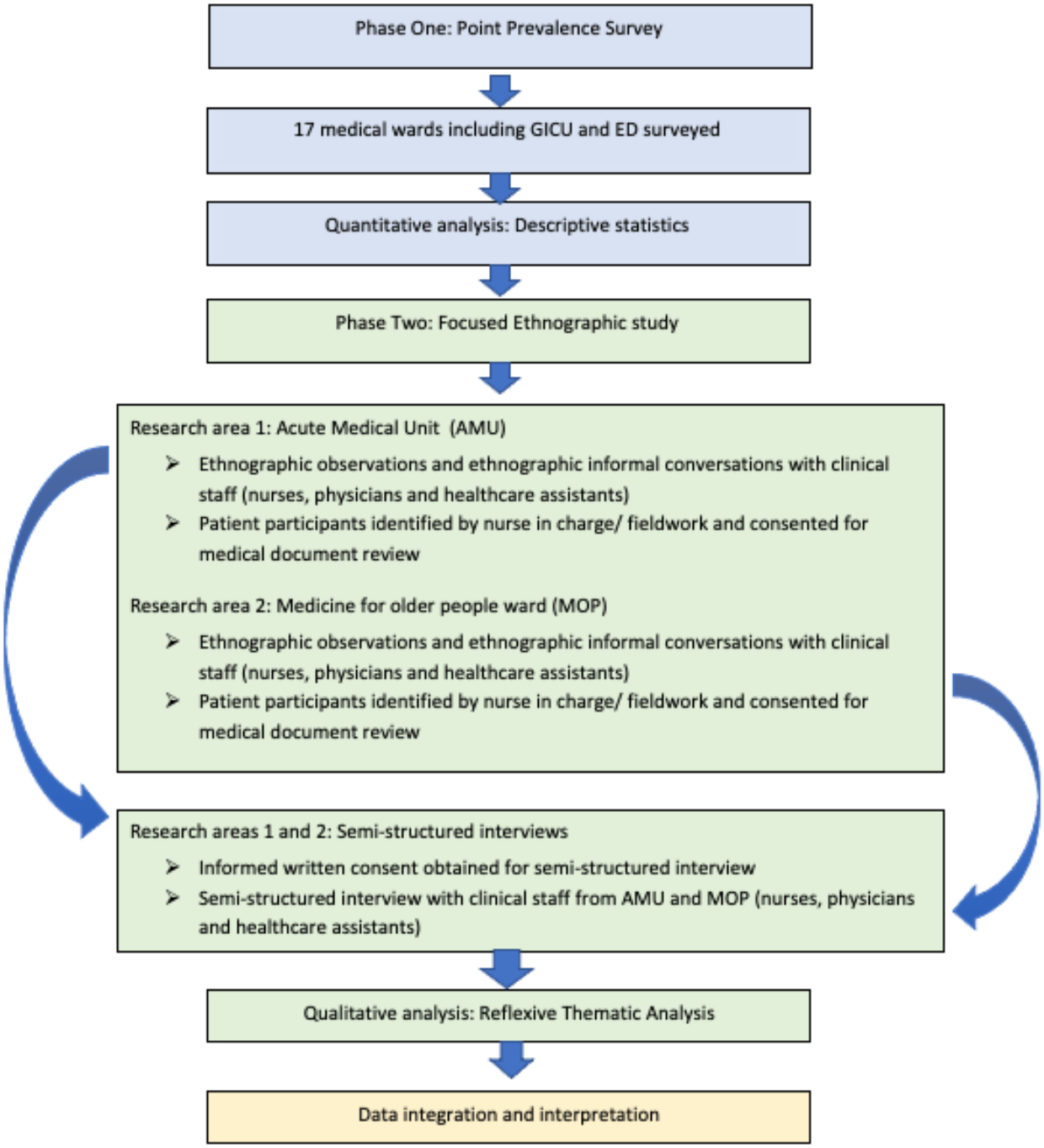
An outline of the study design is shown in Figure 6. This mixed methods study took place in a single centre, with urine output monitoring practices investigated using a two-phase approach. Phase One consisted of a quantitative point prevalence survey of medical wards, a general ICU and an emergency department, followed by Phase Two, a qualitative focused ethnography in two acute medical environments.

A point prevalence survey was the main method of data collection for Phase One. Point prevalence surveys can represent either a single point in time (e.g., all data collected on a single day) or data collected on a single occasion during a longer period of time. During this study, each ward/unit (n=17) was visited once during the data collection period, between May and July 2017. It is possible that there may have been discernible differences between wards sampled in May rather than July. However, the research team

agreed this would be unlikely and there was a need to emphasise a pragmatic approach to achieve a large enough sample over a realistic timeframe within the available resource. Four nurses participated in data collection, including two 3rd year (dual field) student nurses from the University of Southampton School of Health Sciences, who were supervised throughout. The initial quantitative component of this study was valuable as data collected established the prevalence of urine output monitoring using catheters and non-invasive methods. It provided information on how frequently and precisely urine output was measured. In addition, the findings guided the selection of wards/units for Phase Two.

Phase Two comprised a focused ethnographic study of an Acute Medical Unit and a Medicine for Older People ward. These two wards were selected as the findings from Phase One identified both as having high use of fluid balance charts with both invasive and non-invasive methods of urine output monitoring being utilised. During Phase Two, data were collected by the researcher between February and July 2019. Field observations, ethnographic informal conversations, medical document analysis and semi-structured interviews were used to generate data.

Figure 6. Outline of the Study Design



5.3 Phase One: Point Prevalence Survey

5.3.1 Study population and sampling approach

The target population for Phase One of the research included all medical patients within 17 wards in one NHS foundation trust hospital. The environments sampled included the emergency department (ED), general intensive care (GICU) and all medical wards. The source population comprised 432 beds and all of the occupied source population was surveyed. Patients in ED on trolleys awaiting transfer to an in-patient ward area were also included. GICU and ED were included to allow comparison with general and older people's medicine. As the whole source population was selected to serve as a sample population, probability-based sampling methods were not required for this research project.

5.3.2 Inclusion and Exclusion Criteria

No inclusion or exclusion criteria were set for this phase of the study. All patients within 17 wards in one NHS foundation trust hospital were included and no patients were excluded from data collection.

5.3.3 Access and recruitment

The researcher was an employed clinician at the study site and was granted access by the NHS foundation trust hospital to collect the quantitative data for this study as part of a service evaluation. The service evaluation proposal was peer reviewed by the University Ethics Committee and was also subjected to review by the Trust's divisional nursing management team, as per required governance process. Following review, permission was granted by the Trust and a letter of approval provided (Appendix 7 NHS Trust approval letter).

5.3.4 Ethical considerations

Ethical practice is an important aspect of undertaking research to ensure research participants are respected, receive anonymity and are protected from harm (Plowright, 2011). This study did not raise any significant ethical, legal or management problems but the following area required consideration for Phase One of this study.

Data protection, anonymity and confidentiality

This research project complied with the requirements of the Data Protection Act (2018) with regards to the collection, storage, processing and disclosure of personal information. Data collected was anonymously inputted by the researcher and was stored in electronic form on a password protected university computer. All data held on paper was stored in a secure locker in a locked room located in the hosting hospital's research facility. When no longer needed, paper versions of the raw data were shredded and disposed of as confidential waste.

5.3.5 Data collection process

During the first phase of data collection, researchers introduced themselves to the nurse in charge of the unit and then subsequent interaction with clinical staff was minimal. Although, an email introducing the survey to matrons and ward leaders was sent prior to data collection, this information was not always communicated to the nurses in charge (NIC) of the wards. As data collectors were in hospital uniform, with NHS ID, the letter of approval was shown to the NIC and access to review patients' notes was granted prior to data collection commencing.

A data collection tool was developed by the researcher and was piloted on two medical wards to check the feasibility and usefulness of the tool. As a result of the pilot work, minimal changes were made to the tool which included adding a mobility assessment section and a comments box. The data gathered in the pilot was included in the results with remainder of the study. An adapted data collection tool was used to record the number of patients who required urine output monitoring and the method being used for the remainder of the study (Appendix 8). For patients outside of critical care, completion of a hydration assessment is required to determine the need for monitoring using a fluid balance chart, a hydration chart or no chart. Whereas, all patients in critical care have fluid balance recorded as standard, obviating the need to complete a hydration assessment. The data collection tool also collected information on factors influencing hydration, including risk factors for AKI, in order to assess the appropriateness of the monitoring strategy used.

Reviewing medical notes and nursing notes for every medical inpatient was time consuming as required information was not always easily identifiable. In order to acquire the data (such as whether a medical request for a catheter was documented), whole medical notes often needed to be reviewed. As some patients had been in hospital for a considerable amount of time medical notes were sometimes lengthy. Other data, such as the accuracy of chart completion, was easier to collect as data recorded was for the day prior to the survey. The researcher's academic supervisor and the two student nurses who assisted in data collection were valuable assets during this process, which was likely to be unmanageable without their contribution. Data collection was undertaken in pairs, which enabled cross-checking and validation of the data. In addition, each student was paired with a researcher throughout the data collection period to ensure they were clear about their role and were well supported.

During this research project, the research site hospital was in the process of switching from paper fluid balance charts to an electronic recording system. At the time of data collection for Phase One, patients in critical care/HDU used an electronic clinical information system called 'MetaVision' to which nurses recorded vital signs, including fluid balance. All wards surveyed during Phase One were still using paper fluid balance charts, however AMU and MOP had switched to an electronic observation system called 'SafeTrack' by the second phase of this study. This organisational change will be explored further in the discussion chapter.

5.3.6 Data analysis process

The following section outlines the data analysis process for Phase One of this study. Microsoft Excel software was chosen to support the quantitative analysis as it was suitable for beginners and therefore allowed the novice researcher to analyse the quantitative data without the support of a statistician. Leahy (2004) described a five-step process for using Microsoft Excel for analysing survey data, which was used as a guide when analysing the raw quantitative data collected by the point prevalence survey.

Step 1: Create an Excel database

An excel database was created by entering column headers which were used as labels to identify each question in the survey.

Step 2: Code data

In order to use the database, every response item to the survey needed to be entered as a code. A response item is one possible answer to your survey question. For example, Is there a medical request for an indwelling urinary catheter? 'No' and 'Yes' are the response items. Figure 7 provides an example of data coding response items.

Figure 7. Example of data coding response items

J	K	L	M
AKI RISK FACTORS	HYDRATION ASSESSMENT FACTORS	REQUEST FOR UOM IN MEDICAL NOTES	REQUEST FOR INDWELLING CATHETER
Diabetes	Long term Catheter	Yes	Yes
>75yrs	Dementia/Delirium	No	No
Vacular disease	Diarrhoea/Vomiting		
Sepsis	Wound drainage		
Current AKI	Decreased appetite		
Recent AKI	Unable to pour drinks		
Hypovolaemia	IV/NG/PEG/TPN		
CKD	NBM>6hrs		
Heart Failure	Fluid restriction		
Liver failure	Diuretics		
None	Constipation		
Cognitive impairment	Mews score above 3		
	Clinical request		
	AKI		
	Sepsis		
	Short term catheter		

Step 3: Enter data

Raw quantitative data collected using the data collection tool (Appendix 8) were entered onto the Excel database by the researcher. Data were either written as free-text (for open-ended responses) or as a code from the selected response. This process took place in a clinical academic facility over the course of two weeks. Original paper versions of the data collection tool were stored in a locked cabinet until data entry and checking was complete and then shredded and disposed of as confidential waste.

Step 4: Clean data

After all the data had been entered, the data were cleaned to check accuracy. As the dataset was large, revisiting every entry was not practical therefore each column of responses was checked to ensure entries did not look unusual. If they did, the original data collection tool was checked to make sure the entry was correct.

Step 5: Analyse data

Data were analysed using frequency tables. Excel's PivotTable Wizard was used to create frequencies that were automatically formatted into a table. A pivot table is a data

summarisation tool that can be used for data processing. During this research project, pivot tables were used to summarise, sort and reorganise the data in order to extract answers to a series of questions. Figure 8 provides an example of a pivot table created to extract information on catheter insertion indications from the data.

Figure 8. Example of pivot table used in the quantitative analytical process

	A	B
1	.	IUC Indication
2	IUC dwell time (days insitu)	Urine output monitoring
3	1	8
4	2	4
5	3	4
6	4	7
7	5	1
8	6	3
9	7	2
10	8	4
11	9	2
12	10	1
13	12	1
14	14	2
15	17	2
16	18	1
17	20	1
18	21	1
19	25	1
20	>30	4
21	Grand Total	49

Descriptive statistics were used to report the prevalence of urine output monitoring and the use of urinary catheters and other methods of urine collection and measurement. Analysed data are presented in Chapter 5 as either percentages or as numbers in frequency distribution tables. The analysis of the quantitative data was completed by the end of the initial phase in order to produce insights to be operationalised as constructs in the qualitative phase.

5.3.7 Quality Issues

As discussed in the previous chapter, there is no consensus on standards for assessing quality in mixed methods studies (O'Cathain 2010). In this study, the mixed methods approach to assessing quality was used predominantly, as outlined in Table 11 in Chapter 4. However, to ensure the validity and reliability of the data collected, a two-stage validation process was conducted (ECDC 2014).

Individual data collectors can understand, interpret, and record data differently which can compromise the reliability of any study (McHugh 2012). Although the survey tool was designed to be objective, the issue of inter-rater variability was addressed by ensuring the

data collected was cross-checked between the two survey leads (the researcher and her academic supervisor) on the day of collection. The second stage validation process was conducted by the researcher after the data had been inputted into Excel to ensure reliability and completeness. Data were examined for missing data fields and mistakes before analysis. If missing data or mistakes were found in the Excel spreadsheet, the researcher returned to the paper copy of the data collection tool to verify and correct the information.

In survey research, validity considers the extent to which a survey instrument measures what it is intended to measure. In this study the survey tool was used successfully to collect the intended data on IUC prevalence and the use of non-invasive urine collections methods in acute care. The point prevalence survey results were considered to have high ecological validity as the survey contained data from a natural hospital environment. However, due to the constraints of doctoral research, data were collected from one single NHS hospital site. Therefore, findings are not generalisable to other centres. However, the contextual descriptions do at least facilitate the potential transferability of the findings to other settings with similar contexts (Creswell et al. 2009).

5.4 Phase Two: Focused Ethnography

5.4.1 Study population and sampling approach

The quantitative data collected in Phase One informed the identification of environments where qualitative research would be most useful and relevant for Phase Two. The target population for Phase Two of the research included healthcare professionals working within an Acute Medical Unit (AMU) and a Medicine for Older People (MOP) ward in one NHS foundation trust hospital. The target population for medical document analysis was medical in-patients within AMU and a MOP ward.

Ward selection

These two wards were selected as both had high use of fluid balance charts. Furthermore, they were using both urinary catheters and non-invasive methods to monitor urine output. Phase One revealed across all wards that many catheters appeared to have been inserted in AMU, therefore highlighting the unit as a key area of interest. The MOP ward was selected as results from Phase One found it used higher quantities of fluid balance

charts compared to other MOP wards and was therefore viewed as an environment of particular interest for the purpose of this study.

These two different clinical areas were studied in order to explore varying practices in urine output monitoring. Within these different clinical environments, field observations, ethnographic informal conversations and semi-structured interviews with clinical staff took place. Some patients also provided informed consent for analysis of their medical documents.

Observations of Practice / Ethnographic informal conversations

For Phase Two, purposive sampling was the sampling strategy adopted for the ethnographic informal conversations and observations of practice. A mixture of different healthcare professionals was identified, including physicians, nurses and healthcare assistants in order to allow for varying viewpoints and expertise related to the phenomenon. Due to the nature of clinical practice, it was difficult to predict how many opportunities there would be to obtain relevant conversations with staff. Therefore, there was no pre-determined number of observations/information conversations prior to data collection. It was anticipated these informal conversations could be numerous depending on the circumstances. Therefore a sample size limit was not implemented. The approach to recording data in observation studies is generally in the form of a log or field notes. In this study, the researcher made brief written notes in a research diary at the time or shortly after observations were made.

The staff sample for ethnographic conversations was identified during fieldwork. Clinical staff were approached and asked if any patients under their care required urine output monitoring. If so, clinicians were invited to provide a brief reason for urine output monitoring and any therapeutic decisions that have been influenced by urine output measurements during their shift. If the case appeared to be a data rich, fitting with the purposive sampling requirements, then the clinician was asked to spend up to 5 minutes undertaking an ethnographic informal conversation. Verbal consent for these conversations was obtained and recorded anonymously in note form when writing up field notes.

Semi-structured interviews

Stratified purposive sampling was the initial strategy adopted for the semi-structured interviews (as explained in Chapter 4). Marshell et al. (2013) recommend optimal sample size ranges for 20–30 interviews when using grounded theory to 15-30 interviews when undertaking single case projects. In this study, an upper limit of 30 semi-structured interviews was pre-determined as it was anticipated the sample size would provide sufficient data to meet the objectives of the study.

Nurses, physicians and healthcare assistants (some who had participated in the ethnographic conversation process) who were caring for patients that required urine output monitoring were invited to a semi-structured interview session. However, due to challenges recruiting physicians to interviews, purposive sampling was extended to include snowball sampling. Physicians who had already participated in a semi-structured interview referred the researcher to other physicians working within their clinical area who could potentially participate in the study. These physicians were approached via email and supplied information about the study. These challenges will be discussed later in this chapter.

Medical document analysis

A purposive sampling approach was used to identify patient participants. Any adult patient who was having their urine output monitored via an IUC or non-invasive collection methods were considered for participation. Patients were identified through discussion with the nurse in charge of their care and/or from informal conversations with patients existing clinical care team during fieldwork. The patient's existing clinical care team advised if patients had the capacity to consent and made the initial approach to patients. Once the patient provided consent to be approached, the researcher would discuss the research study and provide the necessary information sheets.

5.4.2 Inclusion and Exclusion Criteria

The following criteria were used to include or exclude clinicians and patients from the second phase of this study:

Inclusion criteria

- Any case where the patient has an IUC for urine output monitoring.
- Any case where the patient is having their urine output monitored via non-invasive methods.
- Any staff (including transient/temporary staff) who are involved in the decision to monitor urine output.
- Any staff (including transient/temporary staff) making therapeutic decisions guided by urine output.
- Any staff (including transient/temporary staff) who are involved with the process of monitoring and recording urine output.

Exclusion criteria

- Any case where the patient is under 18.
- Any case where the patient lacks the capacity to consent and lacks a consultee to consent on their behalf.
- Any case where the patient cannot read and speak English and lacks someone who can read and translate on their behalf.

Linguistic difficulty

It was beyond the scope of a novice student researcher to make arrangements for translation and use of interpreters for people who might not adequately understand verbal explanations or written information given in English. However, the research did not exclude patients who could not read and speak English if they wished to participate and had someone who could read and translate on their behalf.

Study boundaries

Focused ethnography requires the researcher to immerse themselves in the study environment (Spradley 1979). As a sole researcher, boundaries were agreed in advance to facilitate focused observations of practice and to ensure data collected was of relevance to the study. Table 13 shows the boundaries that were applied during this study.

Table 13. Study Boundaries

Study site	**Acute Medical Unit / Medicine for Older Peoples Ward**
Clinicians of interest	• Any staff (physicians, nurses, healthcare assistants) who are involved in the decision to monitor urine output. • Any staff (physicians, nurses, healthcare assistants) making therapeutic decisions guided by urine output. • Any staff (physicians, nurses, healthcare assistants) who are involved with the process of monitoring and recording urine output.
Patients of interest	• Any adult patient who is having their urine output monitored via an IUC or non-invasive methods.
Primary focus	• To explore clinical rationales for urine output monitoring and understand how urine output measurements influence therapeutic decision-making; • To investigate clinicians' perspectives of the utility of urine output monitoring using catheters and non-invasive methods.

5.4.3 Access and recruitment

In order to gain access to recruit participants to the second phase of this research project, the study protocol was peer reviewed by the university ethics and research governance board. The trust research and development department assessed the study for feasibility and a favourable ethical approval was given by the 'National Research Ethics Service (NRES) Committee South Central - Hampshire A' in December 2018 (REC reference number: 18/SC/0557, IRAS ID 226223). Following informal discussions with department managers, senior medical and nursing staff, access was negotiated to undertake research in AMU and a MOP ward in one NHS foundation trust hospital.

<u>Informing clinical staff about research study</u>

Where possible, staff were introduced to the project at meetings set up by the researcher. The research process was explained and participant information sheets (Appendix 9) and opt-out forms (Appendix 10) were distributed. As attendance to these meetings was limited, all staff were emailed with a copy of the information sheets and opt-out forms and additional forms were left in the ward's staff room. A minimum of one week was given

between providing the research information and starting data collection to allow staff time to consider the study and ask questions. As data collection was conducted in a clinical setting and involved observations of naturally occurring clinical activities, ward managers were given posters to display (Appendix 11). This was the most feasible way of alerting people of research activity, as it would have been impractical for the researcher to individually inform everyone who entered the clinical area that the study was in progress.

Recruitment challenges

Clinical staff participation

Clinical staff who participated in the research appeared interested and enthusiastic about the project and any reluctance to participate was generally attributed to time restraints. The semi-structured interviews were undertaken with twenty-six clinicians. Clinicians from both clinical areas and professional groups were represented in the semi-structured interviews, although it was noticeably more difficult to secure time to interview physicians due to their workload and intermittent presence on the wards, particularly on the MOP study ward. Due to these challenges, purposive sampling was extended to include snowball sampling in order to recruit physicians to interviews from the MOP ward.

Patient participation

Patient participants were often eager to contribute and expressed views that research was a positive activity, which they saw as beneficial to patient care. Challenges faced when recruiting patients to this study were due to the nature of the acute medical unit; potential patient participants were sometimes provided with the research information and subsequently moved to a different clinical area or discharged home before consenting could take place. Furthermore, the original plan was to be present during nursing handover meetings and by the bedside in order to capture real-time data during AMU clerking. However, research conditions set by the Health Research Authority (HRA) required patients to have consented to this beforehand due to the potential for incidental disclosure of identifiable information to occur. This was problematic as there was no practical way to consent patients to this, therefore this was removed from the protocol. However, on occasions in AMU the researcher was able to have ethnographic informal conversations with the doctors away from the bedside so real-time clinical decision-making could be captured

without exposing identifiable information. The researcher was also able to access the written documentation of clerking and ward rounds from patients who had consented to medical document analysis.

5.4.4 Ethical considerations

Similarly, to Phase One, the second phase of this study did not raise any significant ethical, legal or management problems but the following areas required consideration.

Informed consent

Participant information sheets (PIS) and consent forms were developed for clinicians and patients (Appendices 9,12,13,14). The PIS forms explained the study and the role of the patients/clinicians who choose to participate. The consent form provided a list of boxes for the patients/clinicians to initial if they consented to take part in the different aspects of the study.

Cognitive impairment

It was anticipated due to the nature of the study that some patient participants may lack capacity to consent to medical data collection. It was agreed that the clinical team would assess a patient's capacity to consent prior to the initial approach. Patients identified as not having capacity would not necessarily have been excluded from the study. In this case, the patient's clinical care team would advise whether the patient has a legally acceptable representative who could give consent on their behalf. The patient's clinical care team would make the initial approach to the consultee and if they were happy to be approached by the researcher, a consultee patient information sheet would be provided and informed written consent would be obtained. Following guidance from the HRA (2016), consultee information sheets (CIS) and consultee declaration forms were produced (Appendices 15 & 16). However, during data collection no patients recruited for medical document analysis were identified as lacking capacity by the clinical care team and therefore consultee information sheets and declaration forms were not needed.

Clinical staff participant consent

Informed written consent was required from clinicians participating in semi-structured interviews but was not required for ethnographic observation and informal conversations. Gaining consent from every member of staff who may be observed in a busy clinical environment was seen as impractical. All permanent members of staff had the opportunity to opt out before data collection began, although no staff members chose to do this. Transient/temporary staff were not excluded from participating and were given the opportunity at the beginning of the shift to opt-out of observations. Verbal consent was confirmed from all staff including transient/temporary staff before ethnographic conversations took place.

Patient participant consent

The clinical care team advised if patients had the capacity to consent and made the initial approach to patients. Patients who had given initial consent to be approached by the researcher were provided with the patient information sheet and the research project was explained. All questions were answered by the researcher and if the patient was happy to participate, informed written consent was gained for medical document review and in order to record anything of relevance to the study that they may report.

Data protection, anonymity and confidentiality

This research project complied with the requirements of the Data Protection Act (2018) with regards to the collection, storage, processing and disclosure of personal information. Ethnographic field notes were anonymously recorded in a notebook and typed up onto a word document at the end of the observation period. Transcribed field notes were stored in electronic form on a password protected university computer. All data held on paper was stored in a secure locker located in a locked room in the hosting hospital's research facility. When no longer needed, paper versions of the raw data were shredded and disposed of as confidential waste.

Anonymised interview audio files were sent to a local service provider for transcription. Once the files were transcribed, the manuscripts were returned directly to the researcher using a secure server. Confidentiality was adhered to by both the researcher and the transcription service provider.

During depersonalisation of data, participants' identifying information were replaced by an unrelated sequence of numbers. Linking codes were stored in a separate location from the data using encrypted digital files within password-protected folders. As outlined in the participant information sheets, anonymity was explained as 'linked anonymity', meaning there was a chance that participants could be linked to the data, however the 'key' to this link was stored securely with restricted access. A master file of signed informed consent forms was maintained in a locked cabinet within a secure room in the university research facility at the research site.

Avoiding harm

The principle 'to do no harm' is fundamental to all research studies; researchers have a responsibility to ensure potential risks to themselves and participants are minimalised. In order to ensure that neither the researcher nor the participants were harmed during the study, risk assessments were undertaken and reviewed by the researcher's academic supervisors and university ethics board (ERGO2).

Respondent Burden

It was not anticipated that there would be any burden or risk to patients during the medical document collection and analysis as the commitment on the part of the patient was generally minimal. There were also no foreseen costs or expenses to participating. However, clinicians were required to give their time during the ethnographic conversations and during the semi-structured interviews. Therefore, efforts were made to minimise any interruption to their working day and it was made clear that they were under no obligation to meet if it was inconvenient or for any other reason.

Unexpected events

In the unlikely event practice was observed that was considered dangerous or potentially life threatening, it was agreed confidentiality would be terminated in the interest of patient safety and details of any incidents would be escalated to the ward manager.

As a registered nurse conducting ethnographic observation in a hospital setting, it was acknowledged that it may be necessary to adapt to a variety of uncontrolled situations. In the case of being present at a clinical emergency, as a registered nurse the Chief

Investigator agreed to respond within the scope of their competence and training. However, fortunately, during the data collection period, no dangerous practice or clinical emergencies requiring assistance were observed.

Infection prevention and control

It was not anticipated that there would be any substantial risk to the researcher. However, as the research was taking place in a clinical environment, the researcher agreed to follow the recommended infection prevention guidance. During the second phase of data collection, the MOP ward was closed due to a norovirus outbreak. Data collection ceased during this time and recommenced once the ward was re-opened.

Benefits

Individuals participating in the study were not offered any form of inducement or compensation. Participants may have benefited from engaging in the study, by contributing to knowledge with relatively little inconvenience to themselves. While this study was unlikely to offer direct benefit at the time of their involvement, information gained may be used to improve future care.

5.4.5 Data collection process

By undertaking the research in two different clinical areas (AMU and a MOP ward), knowledge on urine output monitoring practices was captured during the acute phase of a patients care (usually on admission) and during the patients care journey to recovery (the ward environment). In addition, data collected during field work from observations of practice and conversations with staff also identified areas for clarification in follow-up interviews.

Observations of Practice / Ethnographic informal conversations

During Phase Two of the study, interaction with clinical staff was greater. Clinicians in both clinical areas were enthusiastic about the research, however many made comments on how urine output monitoring was notoriously inaccurate. Staff appeared comfortable sharing their views and any reluctance to participate was generally attributed to time restraints. It is possible this may have been an 'acceptable' way to decline participation, although the impression was that these were genuine circumstances. When participants

were able to speak to the researcher, staff were generous with their time and conversations spanned across approximately 5-10 minutes. These conversations took place within the clinical environment normally at the shared nursing/medical station. The AMU environment provided more opportunities for relevant observations and informal conversations to occur, likely due to the increased number of patients on the unit and their requirements for output monitoring compared to the MOP ward.

Data from observations and ethnographic conversation were collected in the form of hand-written field notes, which at the end of every observation day, were transferred to a word document onto a password protected computer. Staff were asked to recall their decision-making process, provide information on clinical objectives, environmental constraints, collaboration and work flow relating to patients on urine output monitoring. The schedule presented in Appendix 17 was used during the ethnographic conversation session. The ethnographic conversation schedule was developed by the researcher and consisted of an explanatory introduction followed by probe questions which looked to capture the thought processes of the participant in relation to urine output monitoring practices and clinical decision-making.

Data were mainly collected between 9am to 5pm during weekdays, although in AMU data collection was also undertaken at night. During the course of the data collection period it became apparent that the most productive time for collecting field data was in the morning and early afternoon when there was a lot of clinical activity. Late afternoon often provided the best opportunity for staff to participate in semi-structured interviews.

It was anticipated that staff may feel cautious about the observation process and may potentially feel uncomfortable about the thought of being 'watched'. Every effort was made to assure staff that the focus of the project was to understand current urine output monitoring processes and no judgements would be taking place about care provided by individual clinicians. Verbal consent was gained in order to observe a particular bay and clinicians were reassured that all data collected was anonymous. Whilst data collecting for the second phase of this project, the researcher did not wear a uniform and referred to themselves as a PhD student. Physicians being interviewed were particularly interested in the researcher's clinical background compared to other clinical groups and when asked the researcher revealed she was a nurse.

Semi-structured interviews

The semi-structured interviews with clinical staff lasted between 15-40 minutes and took place in a variety of settings. Interviews with ward nurses and healthcare assistants mainly took place closer to the clinical environment, in empty examination or store rooms. These interviews tended to be shorter as it was apparent staff were concerned with leaving their patients for too long. Interviews with physicians and nurse specialists were pre-arranged and tended to last longer, taking place in their office or a pre-booked room. The nature of the data collected using conversations versus interviews also differed. Data elicited using the conversational approach tended to focus on the individual care plans of patients they were looking after at that point in time, whereas clinicians were often more reflective during semi-structured interviews and discussed their practice more generally. The schedule presented in Appendix 18 was used during the interview session.

Literature on urine output monitoring and the study research questions/objectives were used by the researcher to develop the semi structured interview schedule. The schedule consisted of an explanatory introduction, background questions and topic areas, which were reviewed by the researcher's academic supervisors to ensure leading questions had not been used which could have introduced bias. Topic areas were devised to explore individual experiences regarding urine output monitoring practices and clinical decision-making. During the semi-structured interviews, the order of which the topic areas were discussed varied, however, the tool itself did not require any changes or additions.

Medical document analysis

Medical document analysis of patient's care allowed the researcher to understand how urine output was recorded and used in different environments. Fieldwork and discussions with the nurse in charge of a patients care identified patients requiring urine output monitoring with data rich cases. Patient consent was obtained and medical notes of identified patient were reviewed for numeric and non-numeric data: diagnosis, past medical history, request for urine output monitoring, vital signs, renal function blood results, fluid balance charts (Appendix 19). If appropriate, patient perspectives on their understanding and involvement in their care was also documented.

5.4.6 Data analysis process

The following section outlines the data analysis process for Phase Two of this study. During the qualitative analytic process, NVivo 12 was used for data management to aid analysis in conjunction with manual analysis. Computer assisted qualitative data analysis software, such as NVivo, can be useful during the process of coding and analysis as they can allow convenient storage and organisation of large amounts of data. To assist the researcher with using NVivo, a two-day course facilitated by Qualitative Data Analysis Services (QDSA) was attended.

Braun and Clarke (2006, 2020) six phase approach to reflexive thematic analysis was followed when analysing the qualitative data. The reflexive thematic analysis process is complex by nature which was challenging for a novice researcher and took a considerable amount of time to complete. The process for analysing each data set was iterative and as codes were devised, it was necessary to move back and forth through each phase to ensure an in-depth and interpretive analysis was achieved. The researcher constantly read and reread the data, analysing and theorising before revising the concepts accordingly, it was during this process that the analysis moved beyond description to more of an interpretive level.

Phase 1: Familiarisation with the data

This phase involves reading and re-reading the data to become immersed and familiar with its content. Familiarisation requires the researcher to engage with the data to look for interesting possibilities and connections without attaching formal labels (Braun & Clarke 2020). Familiarisation gave the researcher the opportunity to closely read the data whilst also allowing for reflexivity.

Data from field notes of observations and informal conversations:

During the familiarisation stage, written field notes collected during observations of practice and informal conversations were typed into a Microsoft Word document within hours of the data being collected. Initial thoughts, codes and impressions were recorded.

This data was then re-read before being formatted and transferred to NVivo for coding. Figure 9 provides an example of typed field notes.

Figure 9. Example of typed field notes in Microsoft Word

Date, Time, Who, Where:	Field notes from observations and informal conversations:	Initial impressions/ potential themes:
11.02.19 9.45am AMU2 Conversation between Critical care outreach nurse (ONS) and AMU ward registered nurse (RN). 10.30 RN interaction with patient 10.35 ONS interaction with patient 10.40 ONS and Doctor conversation 14.00	ONS questions RN if the unit are doing fluid balance monitoring electronically on the Ipads or on paper charts. RN responds they are using the Ipads but some people still do it on paper too. ONS says to RN "She needs a fluid balance chart. I think she is dry." ONS states to doctor during discussion about diagnosis "the patient is septic but I have no idea about fluid balance as nobody overnight recorded it but we are going to start doing that now". Visual observation of patient shows no catheter in place. Patient given intravenous fluids and nurses regularly take observations (vital signs). RN puts patient on bedpan. RN opens curtains and requests to HCA to get a clean sheet as urine has leaked. RN proceeds to take bedpan and incontinence pad to sluice and weighs incontinence pad on weighing scales. ONS tells patients " you need to drink a lot more water. You are really dehydrated." ONS proceeds to take blood cultures as patient has increased temp up to 38.3. ONS states patient has a chest infection and is receiving the maximum oxygen therapy available on AMU. ONS discusses with doctor the best types of IV fluid to give patient and they discuss potential referral of patient to GICU. Visual observation of patient shows a catheter with a urometer has been inserted.	Uncertainty about where urine measurements are documented. Fluid balance chart not maintained overnight. Variations in practice. Attempts made to use non-invasive collection methods. Accuracy a potential barrier to non-invasive methods (urine leakage). Medical concerns regarding hydration and patient acuity.

Data from medical documents:

Raw data collected using the patient medical document collection tool (Appendix 19) were typed into a Microsoft Word version of the tool within hours of the data being collected. In order to familiarise with the content, the researcher re-read the data and initial thoughts and impressions were recorded in memos. The data collection tool format was not compatible with NVivo therefore key data was re-formatted to allow transfer to NVivo.

Semi-structured interview data:

To familiarise with the interview data, the researcher listened to the audio interview files whilst waiting for the transcribed interviews to be returned from the transcription provider. Once the interviews had been transcribed, the researcher checked for errors by re-listening to the audio files whilst reading the transcripts. This enabled the researcher to engage with the content prior to coding.

Phase 2: Coding

Phase 2 involved identifying important features of the data that might be relevant to answering the research question and labelling them with codes. Codes are generated by systematically identifying meaning to the dataset. It involves coding the entire dataset and collating all the codes and relevant data extracts to use in later stages of analysis (Braun & Clarke 2006, 2020). Braun and Clarke (2020) describe both inductive and deductive coding; during inductive coding the researcher identifies meaning without importing existing theories and ideas. Whereas, deductive coding may approach the data with a codebook and various concepts which are then used as a reference to label the dataset. Coding inductively can be described as working from the "bottom-up" with the starting point of analysis within the data (Terry et al. 2017). Braun and Clarke (2020) also advise considering the level at which the "meaning" of the data is captured and coded. Semantic codes identify explicit meaning remaining close to the participants language whereas latent codes focus on a more implicit or conceptual level of meaning.

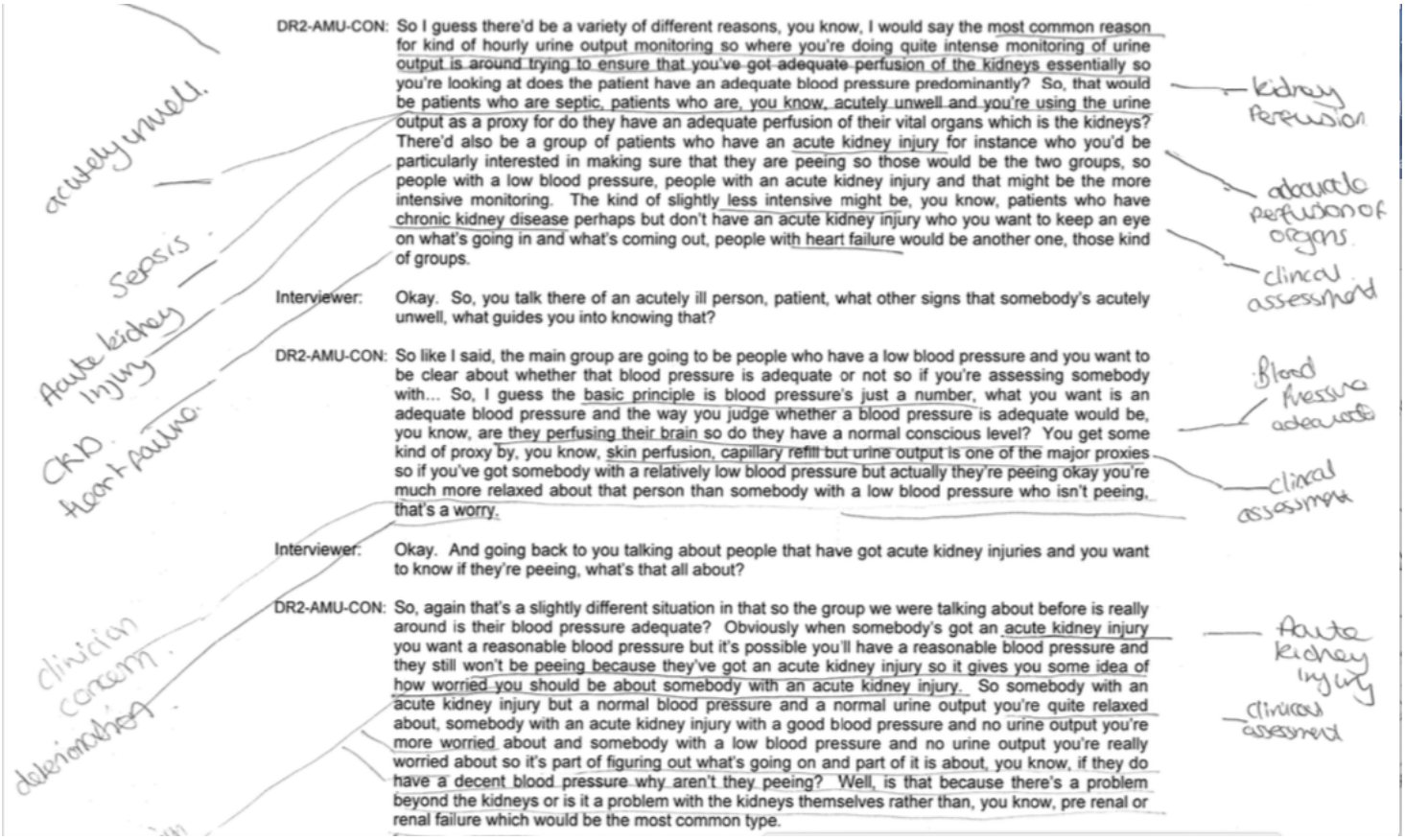
Following Braun and Clarke (2006, 2020) approach, the entire dataset was coded after all data had been collected. Initially, all interview transcripts were manually coded on paper (Figure10). This allowed the novice researcher to gain experience coding and to become familiar with the analysis process before using computer assisted qualitative data analysis software (NVivo 12).

The researcher took an inductive approach to coding as little was known about the research phenomenon. Semantic codes, retaining the participants language, were used to label all data that could potentially be relevant to the research. This generated a wide variety of codes to be refined during the second cycle of coding in NVivo. In addition to coding, a file of memos was created in NVivo that enabled the researcher to ask questions of the dataset and to make notes on the phenomenon being explored throughout the analytical process. An advantage of simultaneously recording memos alongside coding allowed for surprising concepts and thoughts to be recorded, which helped the researcher to make conceptual sense of the data. For example, during semi-structured interviews and observations of practice, the term "pop a catheter in" was frequently used

by nursing staff. Memoing alongside coding helped the researcher to think about the language nurses use and how this relates to risk perception.

The whole dataset was re-coded in NVivo 12 (Figures 11 & 12). During this iterative stage, codes were revised/removed and additional coded were created. Data was coded semantically and then latently in order to interpret the data and focus on the deeper more implicit meaning. As codes were revised, the iterative process of re-reading transcripts and further coding continued.

Figure 10. Example of initial manual coding on semi-structured interview transcript



DR2-AMU-CON: So I guess there'd be a variety of different reasons, you know, I would say the most common reason for kind of hourly urine output monitoring so where you're doing quite intense monitoring of urine output is around trying to ensure that you've got adequate perfusion of the kidneys essentially so you're looking at does the patient have an adequate blood pressure predominantly? So, that would be patients who are septic, patients who are, you know, acutely unwell and you're using the urine output as a proxy for do they have an adequate perfusion of their vital organs which is the kidneys? There'd also be a group of patients who have an acute kidney injury for instance who you'd be particularly interested in making sure that they are peeing so those would be the two groups, so people with a low blood pressure, people with an acute kidney injury and that might be the more intensive monitoring. The kind of slightly less intensive might be, you know, patients who have chronic kidney disease perhaps but don't have an acute kidney injury who you want to keep an eye on what's going in and what's coming out, people with heart failure would be another one, those kind of groups.

Interviewer: Okay. So, you talk there of an acutely ill person, patient, what other signs that somebody's acutely unwell, what guides you into knowing that?

DR2-AMU-CON: So like I said, the main group are going to be people who have a low blood pressure and you want to be clear about whether that blood pressure is adequate or not so if you're assessing somebody with... So, I guess the basic principle is blood pressure's just a number, what you want is an adequate blood pressure and the way you judge whether a blood pressure is adequate would be, you know, are they perfusing their brain so do they have a normal conscious level? You get some kind of proxy by, you know, skin perfusion, capillary refill but urine output is one of the major proxies so if you've got somebody with a relatively low blood pressure but actually they're peeing okay you're much more relaxed about that person than somebody with a low blood pressure who isn't peeing, that's a worry.

Interviewer: Okay. And going back to you talking about people that have got acute kidney injuries and you want to know if they're peeing, what's that all about?

DR2-AMU-CON: So, again that's a slightly different situation in that so the group we were talking about before is really around is their blood pressure adequate? Obviously when somebody's got an acute kidney injury you want a reasonable blood pressure but it's possible you'll have a reasonable blood pressure and they still won't be peeing because they've got an acute kidney injury so it gives you some idea of how worried you should be about somebody with an acute kidney injury. So somebody with an acute kidney injury but a normal blood pressure and a normal urine output you're quite relaxed about, somebody with an acute kidney injury with a good blood pressure and no urine output you're more worried about and somebody with a low blood pressure and no urine output you're really worried about so it's part of figuring out what's going on and part of it is about, you know, if they do have a decent blood pressure why aren't they peeing? Well, is that because there's a problem beyond the kidneys or is it a problem with the kidneys themselves rather than, you know, pre renal or renal failure which would be the most common type.

Figure 11. Example of re-coding semi-structured interviews in NVivo

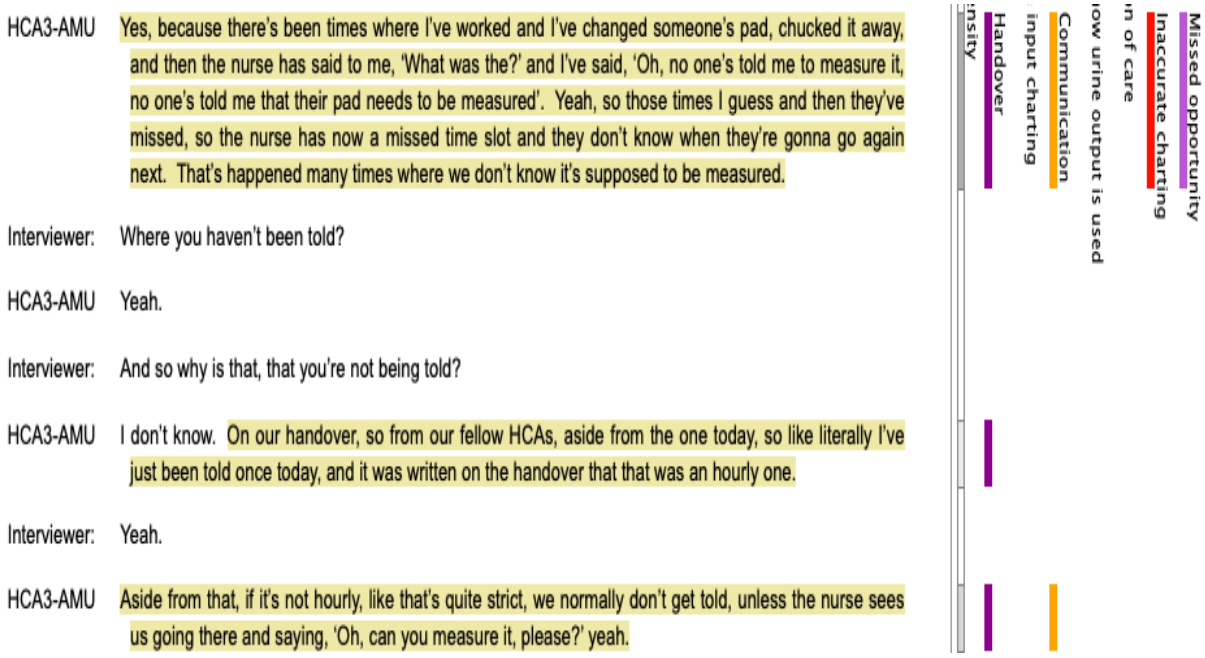
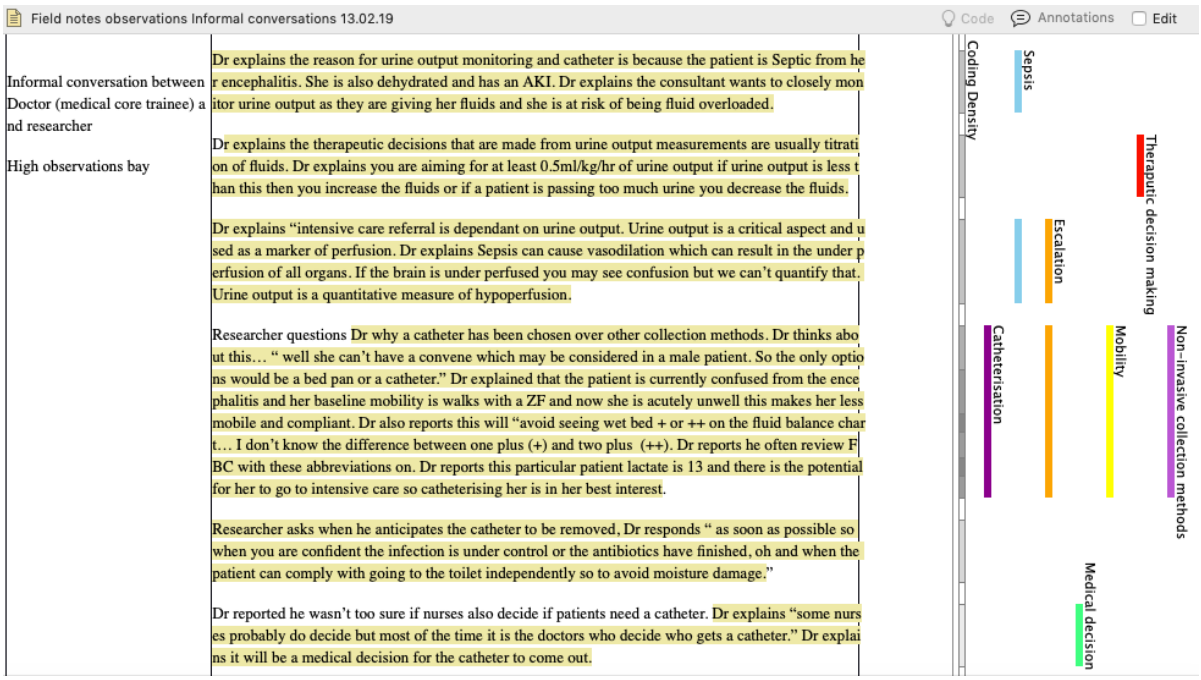


Figure 12. Example of re-coding field notes in NVivo



Phase 3: Generating initial themes

Phase 3 involved examining the codes and collated data to identify significant broader patterns of meaning which could be generated into potential themes. Relevant data collated to each candidate theme was reviewed for viability. Braun and Clarke (2020) describe theme construction as an active process and disagree with the concept of

themes emerging fully-formed from the data. Themes are built and given meaning by the analytic work and intersection of the data alongside researcher experience, research questions and subjectivity (Braun and Clarke 2020).

Following this approach, the researcher collated similar codes together with their associated data to produce coherent clusters of meaning that told a story about a particular aspect of the dataset. During this process, certain codes were deemed as substantial enough to be promoted to a theme. For example, during the coding process frequent references were made to monitoring urine output to detect deterioration in relation to AKI, sepsis and oliguria. This data was coded as 'detecting deterioration'. On examination, this code identified a recurring pattern across the dataset. The code was viewed as substantial enough to be a theme as it contained codes that had a common point of reference and captured the central organising concept.

The researcher worked mostly independently during these stages of theme construction, but meetings with academic supervisors took place to discuss candidate themes. It was during this process that the analysis moved beyond description to more of an interpretive level. This process was undertaken manually using flip chart paper and post-it notes so that the data could be easily visualised. This technique was helpful for sorting through the unstructured themes and enabled more space to explore and examine commonalities and differences. This process also allowed for interrogation of the themes arising from each data set, which was useful in determining whether data collected using different methods told a similar story or whether any contradictions could be identified.

Phase 4: Reviewing themes

Phase 4 involved checking the candidate themes against the dataset to ensure they answered the research questions and produced a meaningful story of the data. Themes were refined during this process which typically involves them being split, combined or discarded (Braun and Clarke 2020). During this process, the researcher focused on how each theme related to each other to assess how they told the overall story and to ensure themes did not overlap. When comparing the definitions of each candidate theme, some of the relationships between themes were stronger than others. Thinking more deeply about the central organising concept for each theme led to the creation of overarching themes which acted as an "umbrella" to incorporate themes that offered meaning but

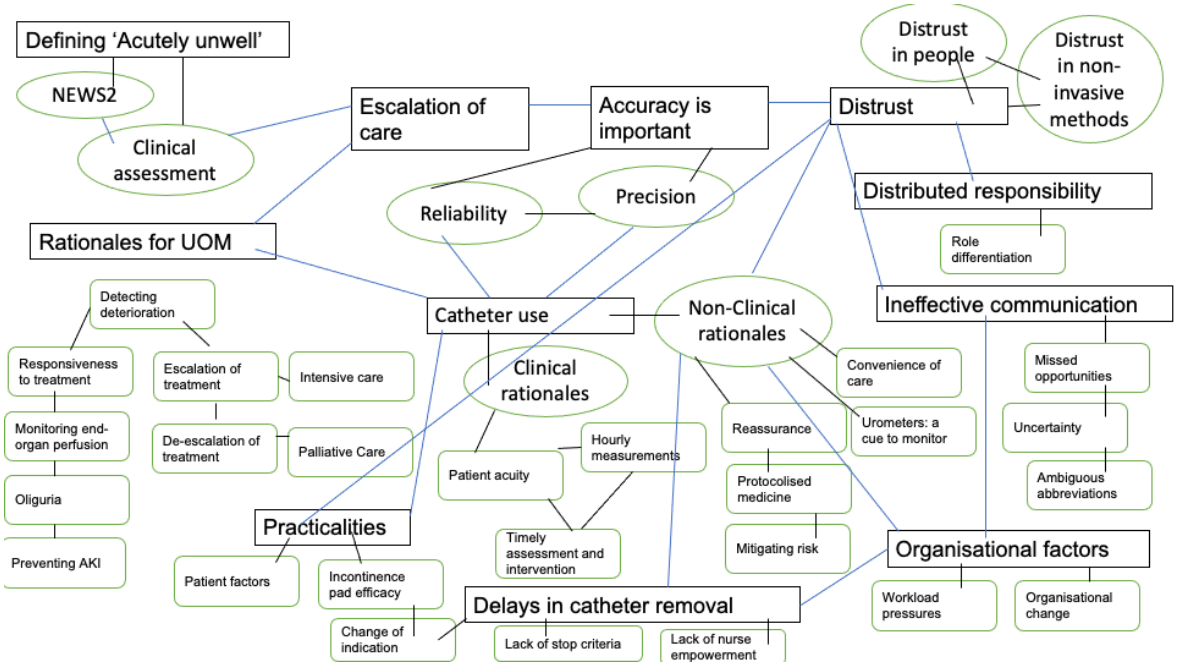
appeared too closely linked. These themes were labelled as sub-themes as they provided further in-depth understanding to the central organising concept.

Overarching themes were reviewed further after presenting the study and analysis to other PhD students and academic supervisors at the University. Following discussion and peer review, two overarching themes, namely 'Accuracy is important' and 'Distrust', were demoted to sub-themes as they shared the same central organising concept (perceived justification for IUC insertion) as the other overarching themes 'Clinical Rationales' and 'Non-clinical Rationales' but focused on one notable specific element of each. 'Accuracy is important' was demoted to the overarching theme of 'Clinical Rationales' and 'Distrust' was demoted to a sub-theme under 'Non-clinical Rationales'.

Phase 5: Defining and naming themes

The defining phases seek to ensure that themes and theme names capture what is meaningful about the data in a succinct way. This phase involved developing a detailed analysis of each theme which determine their scope and focus. Mind maps (Figure 13) were used as suggested by (Braun and Clarke 2013) to provide a visual representation of how the themes relate to each other and to identify which were main themes and subthemes. During this process, the themes were continuously reviewed with ongoing referral back to the initial codes and transcripts. In addition, the wider literature was consulted, in conjunction with regular discussions with supervisors for conclusion-drawing. After a number of reiterations, the final conceptual themes and subthemes were arranged and verified with the researcher's academic supervisors.

Figure 13. Example of Thematic Mind Map



Phase 6: Writing up

Once all themes were defined, the final phase involved creating an analytic narrative that was compiled from data extracts. A written report of the findings was completed during the development of this thesis.

5.4.7 Quality Issues

As previously discussed, this research project has incorporated guidance from both Creswell and Plano Clark (2011) and O'Cathain et al. (2008) to ensure this mixed methods study is of high quality. Table 11 in Chapter 4 presents the strategies identified and applied to this project.

5.8 Chapter Summary

Working from a pragmatic paradigm, this research project developed a sequential explanatory mixed method study integrating quantitative (survey) and qualitative (focused ethnography) methodology. Pragmatism places importance on creating practical solutions to social problems. The purpose of this study was to generate meaning in relation to this under-researched phenomenon and to shed new light on this complex,

clinical issue. The data collection methods employed were consistent to their underpinning methodology and were most appropriate for answering the research questions. Details of how recruitment, data collection and data analysis were undertaken have been provided. The following chapter will explore reflexivity and the role of the researcher as a 'research tool'. The results of this study are presented in Chapter Seven (point prevalence survey analysis) and Chapter Eight (focused ethnography analysis). Findings will be integrated and synthesised in Chapter Nine and discussed in Chapter Ten.

Chapter 6 Reflexivity

6.1 Introduction

Ethnographic research is shaped by the researcher acknowledging the insider/outsider view and the impact this has on the researcher's perspective of reality. During focused ethnography, it is not uncommon for the researcher to have insider knowledge of the group being studied. However, this factor has provided a basis to criticise ethnography, with concerns that researcher's own preconceptions have potential to create bias within the data. Maykut and Morehouse (1994) describe the researcher's perspective as paradoxical, as researchers are required to be acutely tuned-in to the experiences and meaning systems of others but at the same time need to be aware of how one's own biases may influence what one is trying to understand. In order to promote transparency and increase trustworthiness, ethnographic researchers seek to be reflexive (Palaganas et al. 2017).

Reflexivity is viewed as a critical process for enhancing the quality of qualitative research (Barrett et al. 2020). It is described as an ongoing process that involves reflection to construct our understanding, and challenges the status quo through a continuous process of questioning and articulating our assumptions and roles (Barrett et al. 2020). Contrary to the positivist view, validity in qualitative research can be defined as how accurately the findings represent the participants' experiences (Creswell & Miller 2000). However, it is acknowledged by qualitative researchers that despite attempts to practice reflexivity, it is not possible to objectively describe reality, as there will always be some form of bias and subjectivity (Holmes 2020). Ormston et al. (2014) promotes the idea of 'empathetic neutrality', to which conscious and systematic bias are avoided and researchers strive to be as neutral as possible when collecting and analysing data recognising this aspiration may never fully be obtained.

Explicitly describing the intended and unintended consequences of these influences and assumptions is considered to be a reflexive approach to the research process which enhances methodological rigour. Despite its limitations, practicing reflexivity is now a common component to qualitative research and can consist of either personal reflexivity and/or epistemological reflexivity. Personal reflexivity can be described as a process by

which researchers explore how their own involvement influences, acts upon and informs their research (Haynes 2012). Positional reflexivity acts as a further form of self-reflexivity which encourages researchers to recognise themselves as an integral part of the research project (Alvesson and Skőldberg 2009). Positional reflexivity can be enabled by considering questions such as:

- What is my role as the researcher?
- What effects does my role have on how the research is conducted?
- What are my relationships with research subjects/participants?

(Cassell et al. 2005, Cunliffe 2011)

This next chapter will provide a personal reflexive account on the role of the researcher, their experience of collecting data in the field and how their role has influenced the study.

6.2 Role of the Researcher

Personal Background

I am a White British, working class, 30-year-old female. I have lived in the South East of England since birth but would describe myself as well-travelled. Prioritising relationships is important to me and I have close bonds with family and friends. I consider myself to be open minded with a friendly and approachable persona, these personality traits have likely influenced the successful collection of data, particularly during the ethnographic stage where relationships with participants needed to be formed quickly in order to put the patients and/or clinicians at ease. In addition, I believe my open minded nature enabled me to establish a good rapport during the semi-structured interviews which allowed participants to provide an honest account of practice.

James and Vinnicombe (2002) suggest our philosophical assumptions influence our understandings of what counts as data, and how data are 'collected', interpreted and presented. I have always had an inquisitive mind and been curious to seek out new knowledge and answers to questions. In my personal life I have always taken a pragmatic

approach to facing problems and challenges, this is likely to have influenced my study approach and reflects my ontological position as a researcher.

Professional Background

Jacoby (2016) highlights the significance of professional background and insider knowledge in nursing ethnographic research. As a nurse researcher studying urine output monitoring practices in a familiar healthcare setting, reflexive practice was important to how I collected and interpreted the research findings. The following chapter provides details of my professional background and how I believe my identify as nurse has influenced the study.

I am registered adult nurse with six years post-qualification experience. During my undergraduate studies, I worked as a part time healthcare assistant. I enjoyed both the academic and clinical components of my undergraduate course but I was often left questioning nursing rituals that were common in practice yet appeared to lack an evidence base. I was keen to pursue a career that promoted evidence- based nursing and to help bridge the gap between research and clinical practice. My experience as a newly qualified nurse on an admissions ward where catheters were frequently inserted, sparked my initial interest in the use of IUC in acute environments and motivated me to undertake this research project.

After consolidating my nursing skills working clinically in an Acute Medical Unit for one year, I applied for a clinical doctoral research fellowship (CDRF). The CDRF scheme provided a funded opportunity for registered health professionals to gain experience within a clinical service area in conjunction with academic doctoral research. On successfully obtaining a CDRF, I transferred to the research site hospital to work as a staff nurse for two days a week in a Respiratory High Dependency Unit whilst undertaking research activity for my PhD for three days a week. Prior to the ethnographic data collection phase of this study, I was seconded for six months to the Infection Prevention and Control team for professional development and to prevent role confusion, which will be discussed later in this chapter. During the writing up stage of this thesis, I worked part time as an infection prevention clinical educator before taking up a full-time post as an infection prevention nurse in December 2020.

Professionally, I have been described as conscientious with good interpersonal skills that allow me to build effective working relationships with both patients and colleagues. I believe this skill was valuable during the ethnographic data collection phase as I was able to build trust and relationships quickly. Healthcare assistants in particular appeared to be more nervous during interviews than other healthcare professionals, I wanted to avoid any clinicians feeling judged for their beliefs. Adopting an informal, conversational approach appeared to help participants relax and therefore allowed a more open discussion to occur. This enabled greater access to knowledge and provided a deeper understanding of how participants made sense of the phenomenon under investigation.

6.3 Insider Knowledge

Research is always influenced by a number of factors, including those related to the research process as a whole and the researcher's position and influence in this context (Barrett et al. 2020). One strength of the insider position is the depth and breadth of understanding of the particular phenomenon and the context in which it occurs (Kanuha, 2000). This can be an advantage in connecting the theoretical and the empirical parts of the study which may not be available to an outsider researcher (Barrett et al. 2020).

The nature of research undertaken by clinician academics is usually highly applied and therefore a pragmatic, action-oriented approach is often favoured by practitioner-researchers. My paradigmatic perspective has therefore likely been influenced by my personality and my nursing background. As a qualified nurse with previous practice experience and an awareness of literature in the topic area, the research questions and research design were developed from this viewpoint. My understanding of the clinical problem have been informed by my experience as a nurse. I believe this positively impacted on the research as this insider knowledge helped to successfully develop a project that was feasible and relevant to addressing a pressing clinical problem that has been highlighted as a priority area in healthcare.

Field Familiarity and Cultural Awareness

Bonner and Tolhurst (2002) describe how ‘insider’ knowledge can provide a researcher with a privileged understanding of normal clinical practices. However, it is also

acknowledged that familiarity within a setting carries the risk that assumptions could be made about the meaning of events without clarification being sought. Allen (2004) examines the insider–outsider relationships in nursing ethnographies and promotes researcher reflexivity as an important way of accessing processes and making them visible.

Due to previous experience working as a newly qualified nurse in an AMU and the occasional shift covering staff sickness in AMU at the study site, I was familiar with the AMU culture and routine. Ward familiarity was useful during fieldwork as it allowed me to navigate different areas on the unit with ease and enabled me to locate relevant staff and patients of interest. Having an awareness of AMU clinical routines meant I determine the opportune times to engage clinicians in conversation. Having no previous experience working on a medicine for older peoples unit, the ward routines and culture were less familiar to me. The impact of this meant I initially spent more time observing and familiarising myself to the ward environment and routines before focusing on urine output monitoring practices specifically.

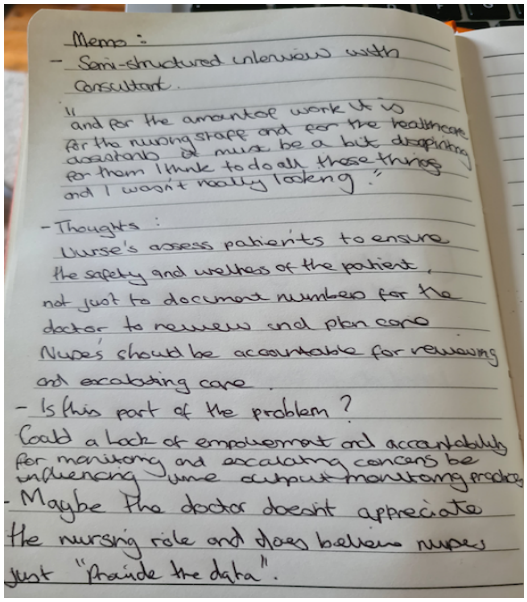
Hall (2005) highlights how different professional groups can have differing viewpoints on particular problems and issues which develop from their professional training. My previous experience working as a healthcare assistant and as a registered nurse gave me an in-depth understanding of the issues related to roles, responsibilities and routines as voiced by the participants during the interviews. However, I was less familiar with the 'medical culture' of doctors and it was only through observation and interviewing that I could understand their viewpoint.

Saidin and Yaacob (2016) suggest a disadvantage to insider knowledge, is that researchers may be blindsided to important issues in their research, which can lead to properties lost due to familiarisation. Outsiders may be more sensitive to clinical activities of research interest that may not appear interesting to a researcher within an organisation. To reduce the problem of overfamiliarity, strategies were employed which included not working clinically in AMU or MOP wards during data collection and actively recording field notes to capture clinical activities which could be viewed as routine.

Lisi (2016) states by using the practice of memo writing, insider researcher can be mindful of their own subjectivities. Memo writing in a research diary aided this reflexive approach

and was used throughout the process to monitor assumptions and improve the quality of the research (Bonner and Tolhurst 2002). There was no intention to incorporate the memos into any analysis but I found them useful to help make sense of the data during the research process. An example of a hand written memo is displayed in Figure 14. This particular example displays a comment made by a consultant regarding nursing staff working hard to record urine output and the medical team not looking at it. During the interview I was surprised by this comment, as the nursing role is to monitor patients and act on any concerns, not to just record information for the medical team to look at. Initially, I felt frustrated that this was the doctors view of nursing. On reflection, I realised these emotions were being driven by my background as a trained nurse and my expectations of my own practice. Memo writing helped me to be mindful that perhaps not all nurses practice in the same way and the doctor was reporting his own experience of how nursing staff practice. This led me to think more deeply about nurse empowerment and responsibility and how this influences urine output monitoring practices.

Figure 14. Research memo



During this research project insider knowledge was viewed as useful as it facilitated my ability to ask relevant clinical questions relating to the phenomena under investigation. It also enabled me to have an awareness of potential expected responses and to be weary of believing all information provided at face value. For example, during a semi-structured

interview, a consultant discussing fluid balance charts described the nursing note 'OTT' as meaning 'over the top'. Due my insider knowledge as a nurse, I was aware that 'OTT' in fact meant 'out to the toilet'. Without this priori knowledge of nurse language/jargon, I would not have discovered that doctors reviewing nursing paperwork can misinterpret common abbreviations used by nurses.

In addition, my joint role as a clinical academic allowed the investigation to be more inquiring. My clinical experience helped me to tell when a participant was giving a socially desirable response which is a key advantage to being a clinical academic/insider researcher. During a semi structured interview, a healthcare assistant was asked whether urine output monitoring worked well on the ward. Their initial response was that it worked fine and there no problems or barriers to monitoring. This was likely to be a socially desirable response as my clinical experience and interviews with other staff on the ward had identified urine output monitoring as a significant problem.

However, a disadvantage of insider knowledge is assumptions that can evolve from individual nursing experience. For example, due to working in a high dependency environment that encourages nurse led decision-making, I was initially surprised by nurses' reluctance to make IUC related decisions on other medical wards. An explanation for this difference could be that on HDU, nurse to patient ratios are lower and therefore patients are well known to the nurses which can aid nurse decision-making. Although insider knowledge offers an advantage of minimalising 'culture shock', this can still occur if practice observed is different to what is known to the researcher.

A further disadvantage of having insider knowledge is the potential for pre-conceived ideas to introduce bias (Bonner and Tolhurst 2002). As a nurse with an interest in infection prevention, I was careful to monitor my own influence when designing and undertaking the ethnographic and semi-structured interviews. Through reflection, I aimed to ensure any priori assumptions related to the use of urinary catheters to monitor urine output did not influence the research. In addition, I often asked staff to elaborate on their answers to ensure there was enough data to formulate findings.

Role Confusion

Dwyer and Buckle (2009) reflect on whether qualitative researchers should be members of the population they are studying, and the impact insider researchers have on their

research participants and study. The complexities between role confusion when a researcher studies an area they also work in can cause challenges in creating space for their research role to emerge, with roles often intertwining. In light of this, a decision was made to do a secondment to the Infection Prevention Team (IPT) to help address the potential problem of role confusion if I was required to work on the study wards. This helped avoid situations to which clinicians would find it confusing to identify me as a researcher rather than a Staff Nurse. During my secondment to the IPT, I did not visit AMU or the MOP ward whilst undertaking data collection. Despite this, some nursing staff did recognise me as a RHDU nurse and questioned why I was not in uniform, however once I explained I was on the unit in a research capacity there did not appear to be any confusion and this did not appear to have impacted on the data collected. When introducing my research to both patient and staff participants, I was always clear that my role was as a researcher and not a clinician (Hoeyer et al. 2005).

6.4 Engaging with Participants

Within ethnography, researchers have close and regular engagement with their participants. The nature of ethnographic research means participants are watched, listened to and asked questions. This can raise practical and ethical challenges related to intrusion and relationship boundaries, particularly if the research is sensitive in nature. Fortunately, this research project did not focus on any sensitive topics so these ethical challenges were less relevant. Yet due to field work taking place within a hospital setting, I did need to be mindful of managing any emotional impacts caused by seeing patients discomfort and suffering whilst unwell. This was particularly important when I became aware a patient participant who had sadly died in hospital. As a nurse, I was accustomed to experiencing the death of patients, however this was my first experience of a research participant dying. In order to reflect on this experience, I discussed this with colleagues and my academic supervisors.

At first, engaging with clinicians and patients as the new role of a researcher was nerve wracking. I was initially concerned that clinicians would find my presence intrusive, or they would not have time to engage. However, it soon became apparent that many clinicians were willing to actively participate in the study because they wanted “to help” and also share their views on the issue. This impacted on data collection as I was able to

recruit a wide range of staff and therefore gain varied insight. Patient participants were also keen to participate when they were informed of the minimal requirements on their part. Many patients voiced how important research was to help improve healthcare.

Researcher Absence

As a clinical academic I was only able to participate in research activity for three days a week, dedicating two days a week to my role within the Infection Prevention Team. Limited time and juggling participant priorities sometimes made it difficult to arrange a convenient time to undertake the interviews. Field work continuity was also affected by the dual role. To mitigate these difficulties, I worked in my clinical role for two consecutive days at the end of the week to allow a three-day period for field work and data collection. I was also sensitive to the time constraints of the clinician participants so on an occasion the researcher met with staff prior to or after my clinical working day. On these occasions, I would change out of nursing uniform into casual wear and display my university ID badge to undertake the interviews to avoid role confusion which could influence the findings.

Field work continuity was also affected during data collection on the medicine for older peoples ward due to a Norovirus outbreak closing the ward to visitors for a week. At the time, I felt frustrated about the delay in data collection. However, on reflection this break allowed me more time to review the data already collected and discover what avenues needed further exploration.

6.5 Chapter Summary

The aim of this study was to explore how and why urine output is monitored in acute medical environments. Using focused ethnography for the qualitative phase, I was able to immerse myself into two different ward cultures to gain understanding of the beliefs, values and experiences of the participants. I was encouraged through positional reflexivity to recognise myself as an integral part of the research. Rather than separating myself from my identify as nurse, I allowed my nursing-informed observations and inferences to be part of the ethnographic data. Reflexivity has allowed me to explore how as the research tool, I influenced the study with particular consideration given to insider knowledge and engaging with participants. I have endeavoured to provide an account of the personal and professional influences on this study thereby allowing the critical reader

to assess the relationship between these influences and the aims and objectives of this research. The following chapter will present the quantitative findings from Phase One of this study to shed light on the prevalence of urine output monitoring and the use of urinary catheters and other methods of urine collection.

Chapter 7 Point Prevalence Survey Quantitative Results

7. 1 Introduction

This chapter presents the quantitative results from Phase One of this research project. A prevalence survey was a significant first step into understanding how and why urine is monitored in acute care and has helped to identify areas of practice which require improvement. The purpose of Phase One was to report the prevalence of urine output monitoring and the use of urinary catheters and other methods of urine collection in acute medical environments. This survey was necessary to understanding the scale of this pressing clinical problem. In addition, the sequential design of this mixed methods study meant the quantitative findings were used to guide the selection of wards for the ethnographic work.

7.2 Study Site

Phase One of the study took place between May and July 2017 within a large teaching hospital and designated major trauma centre in the South of England. The hospital serves a local population of around 1.9 million people and admits up to 8000 patients each month. At the time of undertaking the study, there were seventeen medical wards/units (including the Emergency Department and GICU) within the hospital.

During the summer of 2016, medical grade digital weighing scales were purchased for use on all medical wards at the study site to enable accurate urine output monitoring without the need for a catheter, as is standard practice in Child Health. In addition, a new hydration assessment chart (Appendix 20) was launched to improve the monitoring of patient hydration and to reduce over-reliance on fluid balance charts for patients who do not require strict monitoring. The chart recommends all inpatients to be assessed for their hydration status within 6 hours of admission and to review daily to assess if a hydration chart, fluid balance chart or no monitoring is required.

7.3 Sample

The whole source population was selected to serve as a sample population in this study. Percentages were calculated from the denominator (total number of patients surveyed) unless otherwise stated. 389 patients were included in the survey, of whom 176 (45%) were male and 213 (55%) were female. The rate of bed occupancy was 389/432 (90%) beds (including 9 ED trolleys). 8/17 (47%) wards/units were mixed gender, whereas 5/17 (29%) were female and 4/17 (24%) were male.

7.4 Key findings

Prevalence of catheters

A total of 107/389 (27.5%) medical patients were reported to have an indwelling urinary catheter, of whom 80 (74.7%) were outside of critical care/HDU. The utilisation of catheters was higher in this study than the prevalence reported in Shackley et al. (2017), which identified 18.6% of inpatients were catheterised across 253 NHS trusts. However, Shackley et al. (2017) dataset includes surgical patients and other clinical environments where catheters may be used less. Nevertheless, the data in this study represents a subset of safety thermometer data collected at the trust which has been higher than other centres. Catheter prevalence in this study ranged between medical wards the from 0% to 95.5%. Table 14 displays the details of IUC prevalence across the 17 medical wards/units. The highest prevalence was in critical care, where 95% (22/23) of patients had a catheter in situ. In HDU, prevalence was lower with 55% of patients catheterised, indicating that it is possible to use non-invasive collection methods for acutely unwell patients.

Overall, of the ward specialities, MOP wards had the highest catheter prevalence ranging from 21.4% to 34.6%. This was a higher prevalence than the HPA (2012) English prevalence survey recorded which identified the use of catheters in medicine for older people as 20%. Shackley et al. (2017) also identified patients in hospital over the age of 70 were more likely to be catheterised than patients aged 18-70 (20.8% vs 17.5%). This suggests that over the past 10 years, reliance on urinary catheters in older peoples medical wards might have increased, highlighting the pressing nature of this clinical problem.

Table14. IUC prevalence on medical ward/unit

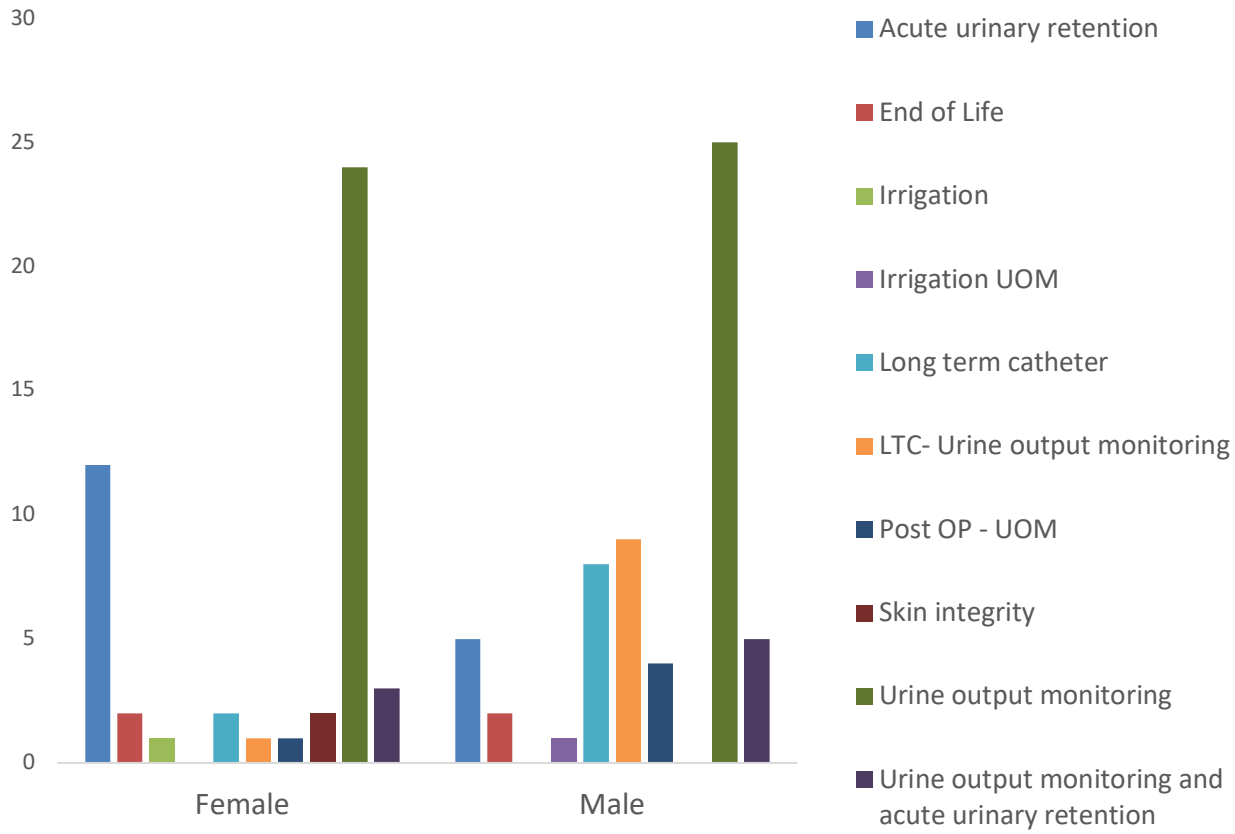
Ward	**Number of Patients**	**Number of Patients with an IUC**
Infectious diseases	14	0 (0%)
Female Renal Medicine/Gastroenterology/Hepatology	20	2 (10%)
Mixed Gastroenterology/Hepatology	30	3 (10%)
Isolation Unit	18	2 (11.1%)
ED	9	1 (11.1%)
AMU	45	7 (15.5%)
Mixed MOP	14	3 (21.4%)
Male Respiratory	34	9 (26.4%)
Female MOP	28	8 (28.5%)
Female Respiratory	27	8 (29.6%)
Male MOP	23	7 (30.4%)
Male MOP	25	8 (32%)
Male Gastroenterology, Hepatology and Renal	26	9 (34.6%)
Female MOP	26	9 (34.6%)
HDU	9	5 (55.5%)
GICU	23	22 (95.5%)

Demographic data

Gender

A higher proportion of men were catheterised (n=59/176; 33.5%) compared to women (n=48/213; 22.5%) in this study. The rationale for this is unclear, however when looking at gender difference in hospitalised patients, the findings are similar to other studies (Shackley et al. 2017, Jansen et al. 2012). Figure 15 displays catheter indications according to gender. Of note, a higher proportion of women (24/48; 50%) had a catheter inserted solely for urine output compared to men (25/59; 42.3%). However, long term catheters were more common in men (17/59; 28.8%) than women (3/48; 6.2%).

Figure 15. Catheter indications according to gender



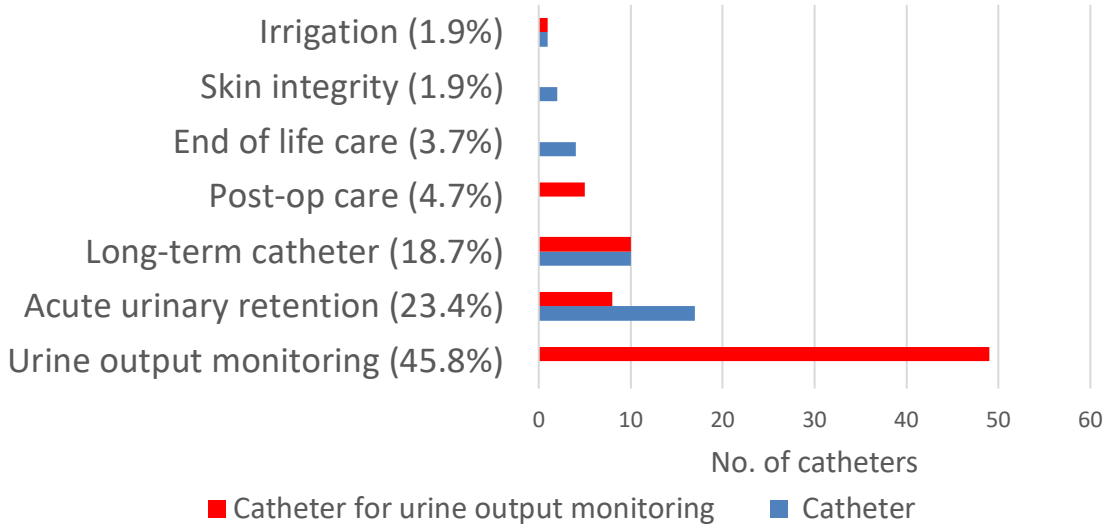
Age

The age of catheterised patients ranged from 27 to 97, with a mean age of 72. For patient with catheters inserted solely for urine output monitoring, their age ranged from 41 to 97 with a mean age of 70.

Indication for catheter

Of the 107 indwelling catheters, 100% were urethral. In total, 49/107 (45.8%) catheters were placed solely for the purpose of urine output monitoring making it the most common indication. Moreover, a further 24/107 (22.4%) were being used for urine output monitoring in addition to another indication. The recorded rationale for all other catheters included a clinical reason such as acute urinary retention or post-operative care. Detail of the documented indications for catheter use can be seen in Figure 16.

Figure 16. Indwelling urinary catheter insertion indications



Of note, urine output monitoring was the most common indication for catheterisation across all wards surveyed in this study, apart from the delayed discharge and gastroenterology, hepatology and renal wards to which acute urinary retention was the most frequent indication. 52.9% (9/17) of catheters in patients on the respiratory wards were inserted solely for urine output monitoring and 12/34 (35%) in medicine for older people. The second most common indication for catheter insertion in medicine for older people was acute urinary retention (5/34; 14.7%). 14.7% (5/34) of catheters inserted had dual indications which included both urine output monitoring and acute urinary retention.

Duration

In this study, 37/49 (75.5%) of catheters inserted solely for urine output monitoring had a dwell time over >48 hours and 4/49 (8.1%) had been in place for over 30 days. This

illustrates having a catheter for urine output monitoring can lead to prolonged duration of use and raises a question about criteria for review and removal.

Medical Requests for Urine Output Monitoring

Within critical care units, recording hourly urine output is usually routine practice for every patient therefore medical requests for monitoring is usually implicit. However, outside of critical care, urine output monitoring requirements for patients is more varied. In this study, 76/366 (21%) of patients outside of critical care areas had a documented medical request for urine output monitoring. The most common diagnosis of patients with a medical request for urine output monitoring was acute kidney injury 38/76 (50%) and sepsis 21/76 (27.6%). These indications reflect the most common rationales for output monitoring discussed in the literature. The remaining patients 17/76 (22.4%) had conditions such as pneumonia and gastrointestinal bleeding therefore considered to be acutely unwell and at risk of deterioration.

In total, 39/49 (80%) patients with a catheter inserted solely for urine output monitoring had a documented medical request for a catheter and urine output monitoring. Therefore, 10/49 (20%) patients with catheters inserted solely for urine output monitoring had no documented medical request for a urinary catheter. However, 45/49 (91.8%) of patients with a catheter inserted for urine output monitoring did have a medical request for urine output measurements. Currently, there is not a requirement for catheters inserted in hospital to be prescribed by a physician, therefore it is possible these catheter insertions were nurse-led decisions or verbal requests from the medical team. It is unknown whether these requests were clinically appropriate, however, without clear criteria for use, there is potential for catheters to be overused for the purpose of urine output monitoring.

Frequency of Urine Output Monitoring with a Catheter

Most (87/107; 81.3%) catheters were attached to a urine meter. However, only 22/87 (25%) of these were used to record hourly urine measurements, mostly in critical care/HDU. These results indicate a heavy reliance on urine meters, which are costly collection bags that are only required when hourly measurements needed.

Table 15 shows the frequency of urine output measurements recorded for catheterised patients outside of critical care/HDU (n=80).

Table 15. Frequency of urine measurements recorded for catheterised patients outside of critical care/HDU

Frequency	Urine meter	Standard 2-litre/leg bag/catheter valve	Total
1-2 hourly	7 (12%)	0	7 (9%)
3-6 hourly	38 (63%)	6 (30%)	44 (55%)
>6 hourly	9 (15%)	3 (15%)	12 (15%)
Not monitored	6 (10%)	11(55%)	17 (21%)
Total	60 (75%)	20 (25%)	80

Outside of critical care, 60/80 (75%) catheters had a urine meter attached, of which only 7/60 (12%) were used to record 1-2 hourly measurements on a fluid balance chart. The other 53/60 (88%) urine meters were not being utilised on a frequent basis. Out of the 60 patients with urine meters, 29 (48%) were inserted for urine output monitoring. Therefore, a urine meter may initially have been indicated but was no longer being utilised. Despite the recommendation for urine meters to only be placed for output monitoring, it appears urine meters were frequently being attached to catheters inserted for other indications.

Of the standard drainage systems, most 18/20 (90%) were leg bags, there being only one 2-litre drainage bag and one catheter valve in use. Of the 6 catheterised patients with a urine meter whose urine output was not being monitored, 2 had urine output monitoring documented as the reason for catheter use. This indicates that urinary catheters inserted for output monitoring are left in place for longer than clinically necessary. The other 4 patients had no requirement for a urine meter; however, 3 patients did require a fluid balance chart due to having a short-term catheter which is recommended indication for monitoring.

Of the 11 catheterised patients with a standard drainage system whose urine output was not being monitored, 6 had a short-term catheter, necessitating a fluid balance chart. The other 5 patients did not require urine measurement, 4 having a long-term catheter and 1 receiving end of life care.

Hydration Assessment

Most (314/357; 88%) patients outside of critical care/HDU met the hydration assessment criteria for some form of urine output monitoring (see Appendix 20 for criteria). Of these, 160/314 (51%) required a fluid balance chart and 154/314 (49%) required a hydration chart. In practice however, a hydration assessment chart had been completed for only 225/357 (63%) patients outside of critical care/HDU, indicating not all patients were having their hydration status assessed daily. Missed assessments could result in patients not receiving the appropriate output monitoring which may put patients at risk of dehydration.

In addition to missed assessments, there were also discrepancies between the outcome of hydration assessments conducted by the project team with those charted by the nursing team (Table 16). It appeared that hydration assessments sometimes took place as a 'tick box' exercise, where the information from the previous day was used to complete the next day's assessment. Often patient indications for monitoring would fluctuate within a day, such as receiving intravenous fluids. This meant a patient's monitoring requirement could move from needing a hydration chart to a fluid balance chart in a short period of time.

Despite these challenges, 182/225 (81%) of completed hydration assessments were found to be accurate, there being 43/225 (19%) hydration assessments charted incorrectly by nursing staff. The most common discrepancy was missing the requirement for a fluid balance chart. When combined with those patients who were not assessed but who met the requirements for a fluid balance chart, this gave 87/160 (54.4%) patients with no recorded assessment of the need for a fluid balance chart. Conversely, only 6 patients were assessed incorrectly by nurses as needing a fluid balance chart (FBC) when either a hydration chart (HC) or no chart was required.

Table 16. Accuracy of hydration assessments					
		Hydration assessment required			Total
		FBC	HC	No chart	
Correct hydration assessment recorded		73	83	26	182
Incorrect hydration assessment recorded	Assessed as needing a HC when FBC required	21	-	-	
	Assessed as needing a FBC when HC required	-	4	-	
	Assessed as needing a FBC when no chart required	-	-	2	
	Assessed as needing no chart when FBC needed	5	-	-	
	Assessed as needing a HC when no chart required	-	-	1	
	Assessed as needing no chart when HC required	-	10	-	
	Sub-total	26	14	3	43
Assessment not done		61	57	14	132
Total		160	154	43	357

Similarly, 83/154 (54%) patients who met the criteria for a hydration chart were assessed correctly, whereas 14 (9%) were assessed incorrectly as needing a fluid balance chart or having no requirement for a chart. The remaining 57 (37%) patients who met the criteria for a hydration chart were not assessed.

Of note, only 12% (43/357) patients outside of critical care/HDU met the requirements for no form of urine output monitoring. Of these, 26 (60.5%) were assessed correctly, there

being 14 (32.6%) patients who were not assessed and 3 (7%) who were assessed incorrectly as requiring a fluid balance chart or hydration chart. The high proportion of patients requiring some form of hydration monitoring may be impacting on the workload of nursing staff and their ability to record measurements accurately.

Charting of Urine Output

Charting of urine output is important to provide indication of kidney function, haemodynamic stability and to monitor fluid balance. Inaccurate monitoring can compromise patient safety, reduce quality of care and can result in signs of patient deterioration not being recognised or acted upon.

In this study, 160/357 (44%) patients met the requirements for a fluid balance chart. Of these, 116/160 (72.5%) patients had a fluid balance chart in use. Similarly, 154/357 (43%) patients met the requirements for a hydration chart, of whom 96/154 (62%) had a hydration chart in use. 21 patients had both a fluid balance chart and a hydration chart in use on the same day when only a fluid balance chart (n=14) or hydration chart (n=7) was required. 43/357 (12%) patients were assessed as not requiring a chart, whereas in practice there were 104/357 (29%) patients with no chart in use.

Table 17 compares charts required (as assessed by the project team) with those in use on the day prior to the survey.

Table 17. Chart required versus chart used in practice

		Chart used				Total
		FBC	HC	HC & FBC	No chart	
Chart required	FBC	102	17	14	27	160
	HC	13	89	7	45	154
	No chart	5	6	0	32	43
Total		120	112	21	104	357

Accuracy of Fluid Balance Charts

The quality of fluid balance monitoring across the hospital varied. Overall, fluid balance monitoring was undertaken for 173/389 (44.5%) patients, of whom 90/173 (52%) had an indwelling urinary catheter. 3/173 patients were using intermittent catheterisation. Of note, 80/173 (47.4%) patients were having their urine output monitored using non-invasive collection methods.

Table 18 below, shows the accuracy of fluid balance charts recorded for patients within and outside of critical care/HDU.

Table 18. Accuracy of fluid balance charts

		Catheter	No catheter	Intermittent catheter	Total
Critical care/HDU	Completed in full	27	5	-	32
Other wards/units	Completed in full	6	1	1	8
	Mostly completed	38	10	-	48
	Completed in part	17	17	1	35
	Inadequate	2	47	1	50
Sub-total		63	75	3	141
Total		90	80	3	173

For patients in critical care/HDU an electronic clinical information system called 'MetaVision' was used to which vital signs, including fluid balance were recorded. All 32 fluid balance charts in critical care/HDU were completed in full (input, output and fluid balance recorded) using Metavision. However, outside of critical care/HDU, only 8/141 (6%) fluid balance charts were completed fully (input, output and fluid balance recorded), although just 2/141 (1%) had a target urine output/ml/hour recorded.

On the medical wards, 48/141 (34%) fluid balance charts were mostly completed, missing only one component such as calculation of fluid balance or recording of IV/oral input. 35/141 (25%) fluid balance charts were completed partially, missing two components such as input and regular urine output measurements. In addition, 50/141 (35%) fluid balance charts were completed inadequately, with no urine output entries recorded or use of abbreviations such as "wet" and "OTT" (out to toilet) in place of an estimated volume. Most of these (47/50; 94%) patients had no catheter. Of the 50 fluid balance charts assessed as inadequate, 1 had no recording of IV fluid administration, together with urine output recorded only twice in 24 hours despite a urinary catheter being placed for urine output monitoring. Therefore, highlighting how IUC inserted for urine monitoring are not always fully utilised.

Of the 80 patients with no catheter, but an intention to employ non-invasive monitoring of urine output, only 31/80 (39%) had numerical urine output measurements recorded. These results emphasise how urine output monitoring is often inaccurate when non-invasive methods are used. It is therefore necessary to understand the challenges healthcare professionals face when trying to utilise these methods to gain insight into how improvements are to be made.

Accuracy of Hydration Charts

In this study, hydration charts were used for 133/357 (37%) patients, of whom 20/133 (15%) had an indwelling urinary catheter. Hydration charts are required for patients at risk of dehydration but who do not meet the criteria required for a fluid balance chart. Examples of the risk factors include patients with dementia, those requiring thickened fluids and patients taking oral diuretics. The intention is to note that a patient has had an adequate amount to drink and has frequently passed urine, without the need to measure accurate numbers.

Table 19, shows the accuracy of hydration charts recorded for patients outside of critical care/HDU.

Table 19. Accuracy of hydration charts

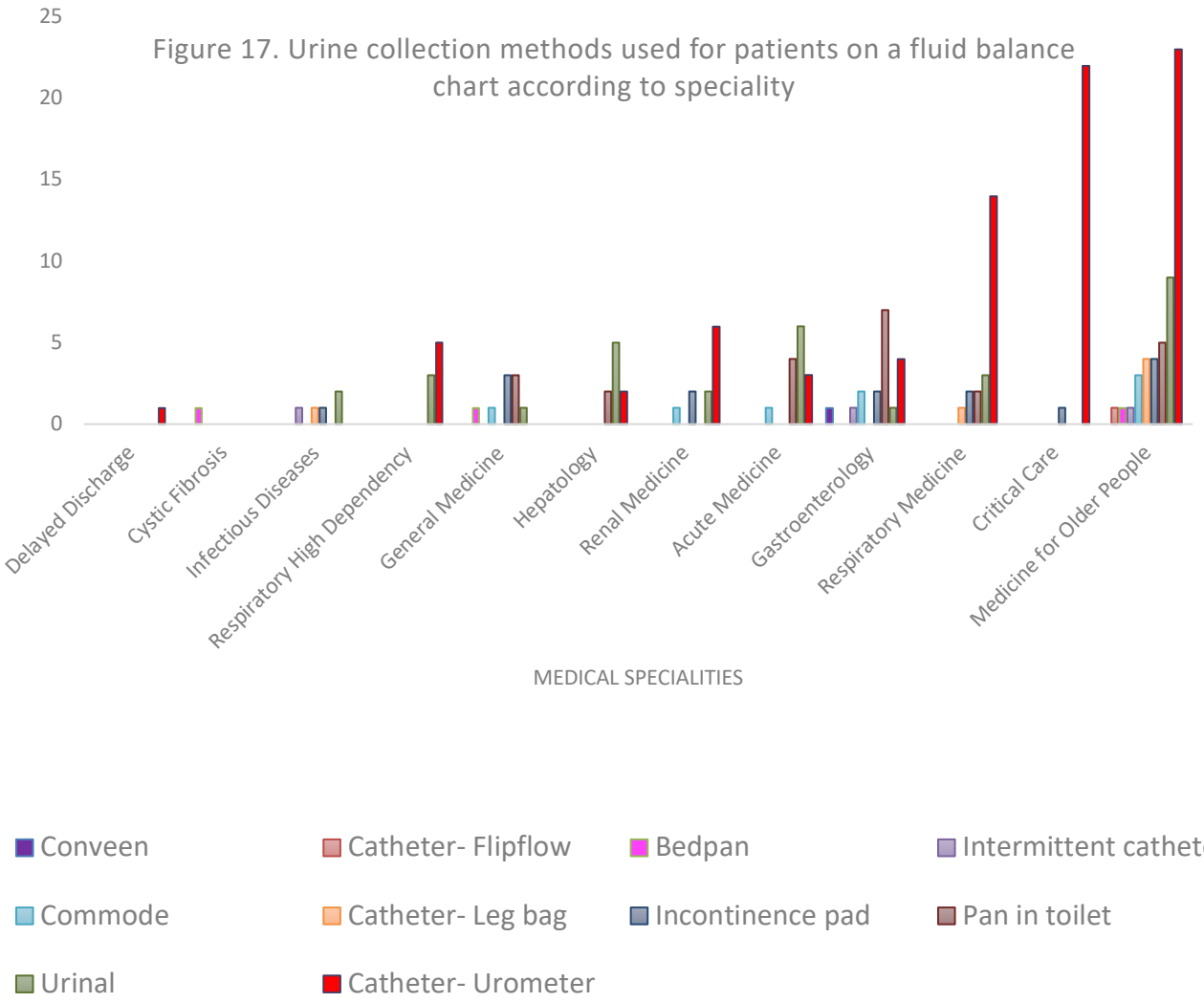
	Catheter	No catheter	Total
Completed in full (3/3)	2	32	34
Completed in part (2/3)	9	33	42
Inadequate (1/3)	9	37	46
Not completed	0	11	11
Total	20	113	133

Overall, 34/133 (25%) hydration charts were completed in full (i.e., completed for the morning, afternoon and night). 42/133 (32%) hydration charts were completed partially, with no record of urine passed for one of the three periods of time and 46/133 (35%) hydration charts were completed inadequately, with no record of urine passed for two of the three periods of time.

In addition, 1/133 (8%) hydration charts were not completed at all, with no record of urine passed for three time periods despite fluid intake being recorded. Of note, the presence of an indwelling urinary catheter appeared to have little effect on hydration chart accuracy, with only 2/20 (10%) catheterised patients having a fully completed chart.

Methods of Urine Collection

For patients on a fluid balance chart there was variation between specialties in the urine collection methods used and the extent of reliance on indwelling catheters and urine meters. Figure 17 shows the urine collection methods used in each speciality for patients whose urine output was being monitored on a fluid balance chart.



Outside of critical care, specialties that used more indwelling catheters than non-invasive alternatives for urine measurement included Medicine for Older People, and Respiratory Medicine. Conversely, Gastroenterology/Hepatology, Acute Medicine, General Medicine and Infectious Diseases used a higher proportion of non-invasive urine collection methods. Amongst specialties with catheterised patients, urine meters were used more frequently than standard drainage bags in all but Infectious Diseases. The wide variation in methods of monitoring found in this survey is notable and may reflect differences in nursing and medical team practices across the hospital.

Figure 18 shows the non-invasive urine collection methods used across all wards for patients whose urine output was being monitored on a fluid balance chart. Alternative urine monitoring strategies had been utilised, with urinals the most commonly used non-invasive collection method 31/80 (38.7%), followed by a pan in a toilet 23/80 (28.7%), incontinence pads 14/80 (17.5%) and commodes 8/80 (10%). Bedpans 3/80 (3.7%) and urinary sheaths 1/80 (1.2%) were utilised the least.

Figure 18. Non-invasive collection method use

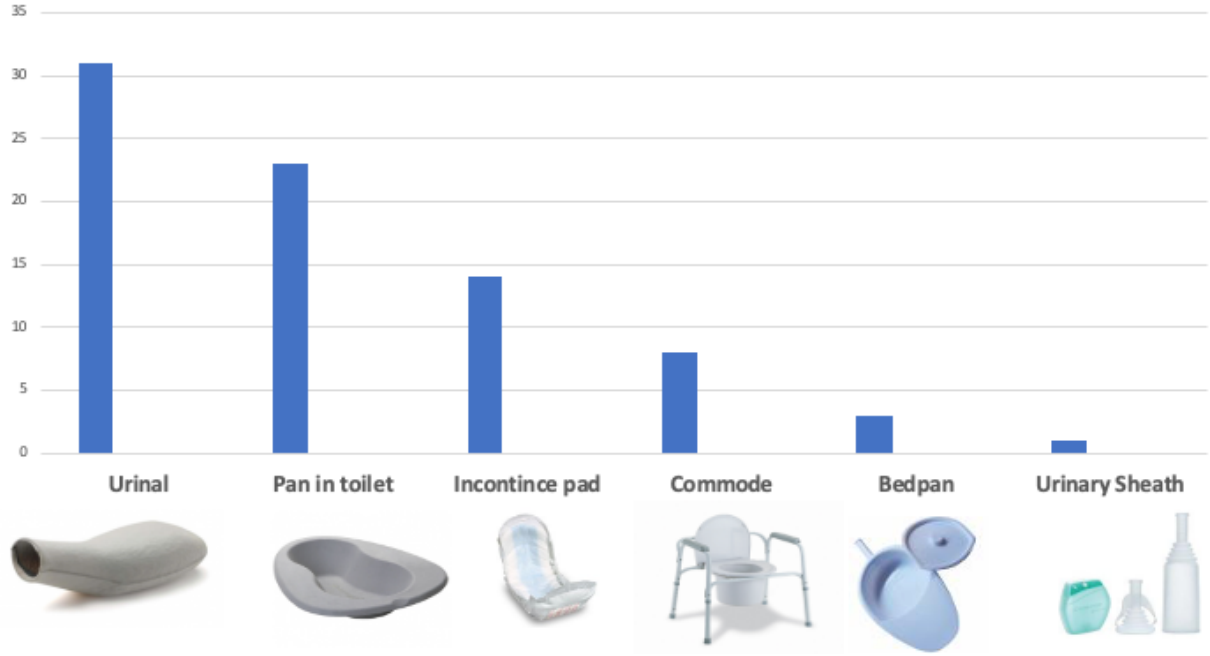
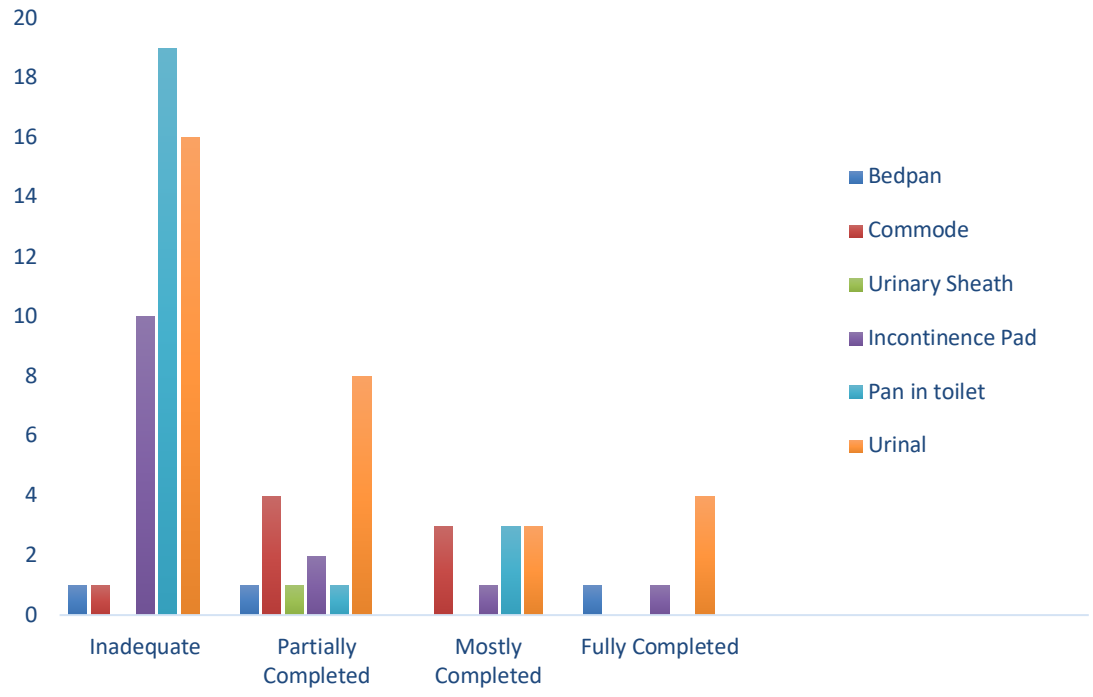


Figure 19 shows the accuracy of fluid balance charts when non-invasive collection methods were utilised. Fluid balance charts were predominately either partially completed or inadequately completed when non-invasive collection methods were used. It is clear from these findings that further investigation is required of the facilitators and barriers to different methods of monitoring to help understand the issues of inaccurate charting affecting clinical practice.

Figure 19. Fluid balance chart accuracy when non-invasive collection methods utilised

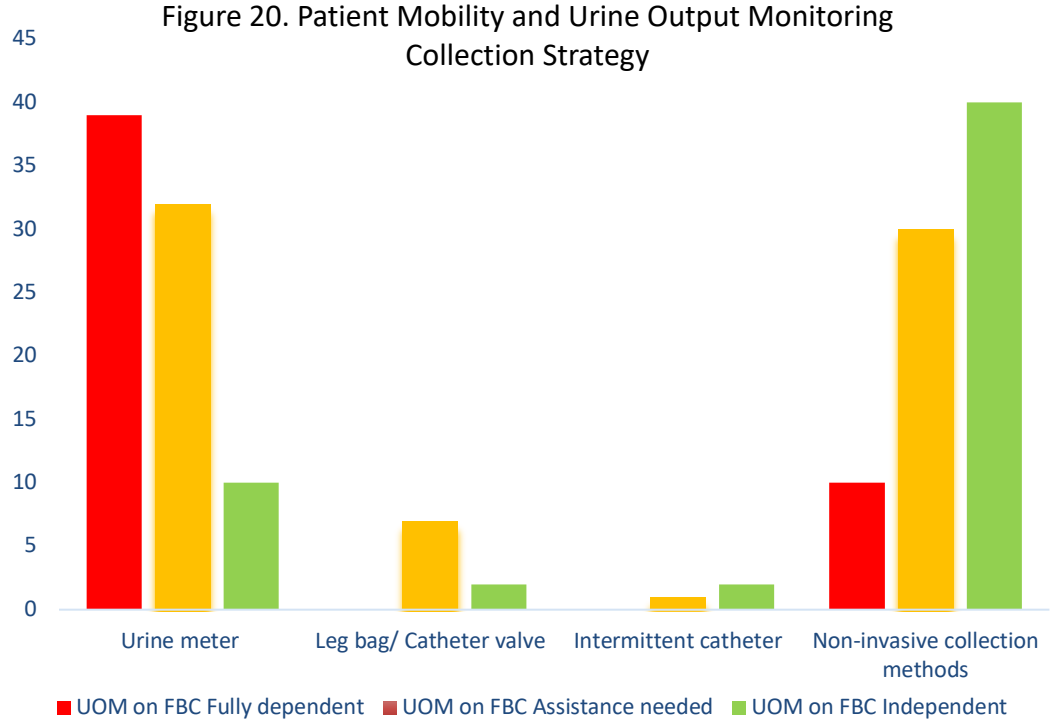


Mobility and Methods of Urine Collection

Reduced mobility is not recognised as an appropriate indication for catheterisation. However, the data revealed how urine meters were used more frequently for patients who were fully dependent (n=39/49; 80%) than for those who were independent (n=10/54; 19%). Conversely, non-invasive urine collection methods were used more frequently for patients who were independent (n=40/54; 74%). Whereas both urine meters (n=32/70; 46%) and alternatives (n=38/70; 54%) were used for patients in need of some assistance with mobility. It remains unclear as to why patients with reduced mobility had a higher catheter prevalence rates for output monitoring, however possible explanations include ease of monitoring, staff convenience and higher levels of acuity in this patient population.

Figure 20. below shows the method of urine collection used for patients whose urine output was being monitored on a fluid balance chart (FBC), according to the extent of their mobility.

Figure 20. Patient Mobility and Urine Output Monitoring Collection Strategy



Availability of Equipment for Urine Output Monitoring

An assessment of the availability of equipment on wards and units to support alternative approaches to urine measurement revealed ready access to most equipment. All wards and units had medical grade digital weighing scales. However, only half of these (n=9/17; 53%) had an information poster in the sluice room with the dry weights for each urine collection device (e.g., urinals, bedpans, incontinence pads).

Over half of wards and units (n=9/17; 53%) had a bladder ultrasound scanner and wards without a scanner could access one on a nearby ward. However, only 1 of the 9 scanners had ultrasound gel available, as recommended by the manufacturer, to ensure accurate measurement. All other scanners had a water-based lubricant as a substitute, which is not recommended due to the unreliability of readings.

Most wards and units (n=16/17; 94%) stocked insert incontinence pads. Fewer (n=6/17; 35%) stocked more substantial wrap-around pads. Most male wards (n=11/13; 85%) stocked external (sheath) catheters. In relation to urinary catheter drainage systems, most wards and units had a supply of urine meters (n=15/17; 88%), leg bags (n=15/17; 88%) and night bags (n=13/17; 76%). However, only 59% (n= 10/17) of wards stocked 2 L drainage bags which can be used as an alternative to urine meters.

Table 20. Availability of equipment for urine output monitoring

	88%	Most wards (15/17) had a supply of urine meters. The only medicine for older peoples ward to not stock urine metres was an enhanced dementia care ward. No patients staying on this ward had a urine metre in place.
	76%	Three quarter of wards (13/17) stocked night bags which can be connected to leg bags for overnight drainage.
	59%	Only 59% (n= 10/17) of wards stocked 2 L drainage bags which can be used as an alternative to urine meters.
	88%	Most wards (15/17) had a supply of leg bags. The two units who did not stock leg bags were the intensive care unit and respiratory high dependency.
	47%	Almost half of wards and units stocked catheter valves but they did not appear to be commonly used.
	100%	All wards and units had medical grade digital weighing scales.
	53%	Over half of wards and units had a bladder scanner. Wards without a scanner could access one on a nearby ward.

	94%	Most wards and units stocked insert incontinence pads. The only ward area not to stock insert incontinence pads stocked wrap around pads.
	35%	Over one-third of wards stocked wrap-around incontinence pads. These were predominately stocked on medicine for older peoples wards compared to medical wards.
	86%	Urinary Sheaths were available on most wards and units with male patients.

7.5 Limitations of Survey

Due to the constraints of doctoral research, data were collected from one single NHS hospital site. In addition, as a point-prevalence study, findings are from a single point in time and are therefore reliant on the days surveyed being representative of standard activity and care. Due to these limitations, findings from this study are not generalisable to other clinical areas or other hospital populations.

7.6 Chapter Summary

The point prevalence survey conducted as part of this research investigated the prevalence of IUC and non-invasive collection methods used for urine output monitoring in an adult inpatient population. The findings revealed the prominence of urine output monitoring across a population of hospitalised medical patients and the frequency of use of IUC for this purpose. Whilst it remains unclear how many catheters inserted for output monitoring were clinically justifiable, the findings related to the frequency of measurements recorded for patients with catheters inserted for output monitoring suggests over-reliance on catheters for this purpose. Strategies to improve the assessment of urine output need to be prioritised to ensure patients receive the safest care without over-reliance on IUC.

Prolonged catheterisation is the most modifiable risk factor for CAUTI (Maki and Tambyah 2001). Further guidance is therefore needed to provide clarity for clinicians on the insertion and removal indications of catheters. There is a need for a greater understanding of therapeutic decisions made from urine output measurements and the placement of an IUC compared to using non-invasive collection methods. Furthermore, facilitators and barriers to different methods of monitoring need to be explored to help address the issues of inaccurate charting. Phase Two of this study aimed to explore these issues, the findings of which are presented in the next chapter.

Chapter 8 Focused Ethnography Qualitative Findings

8.1 Introduction

This chapter provides the findings from the analysis and interpretation of the focused ethnographic phase of this study. Using reflexive thematic analysis (Braun and Clarke 2006, 2020), field notes recorded from observations of practice, informal conversations with staff and medical document review, together with semi-structured interview transcripts with clinicians (n=26) were examined. Findings from these analyses were handled separately then combined through triangulation to capture different elements of the phenomena investigated. These findings build on the results of the prevalence survey in Phase One of the study by providing greater insight into and understanding of urine output monitoring practices in acute medical environments.

The chapter starts with an overview of each source of data, including details of the clinicians and patients who participated in each element of data collection. The findings are then presented under each of the main themes and subthemes that arise from the analysis. Verbatim quotations from the informal conversations and semi-structured interviews have been included to illustrate the perceptions, views and experiences of participants.

8.2 Clinical Environment Overview

Phase Two of the study took place within a large teaching hospital in the South of England between February and July 2019. This ethnographic phase focused on the acute medical unit (AMU) and one medicine for older people (MOP) ward.

Acute Medical Unit

The AMU is a gateway between the emergency department (ED) and the medical inpatient wards, serving as an admission unit for medical patients in ED and a point of entry for those patients referred to hospital by a General Practitioner (GP). Within AMU, patients receive multidisciplinary specialist assessment, care and treatment, typically for

24-72hours prior to discharge or transfer to a medical ward. Often patients admitted to AMU are physiologically unstable and can require resuscitative measures, while other patients are less unwell but still require diagnostic investigations and therapeutic interventions.

The AMU at the study site had 53 beds, including 11 side rooms and 42 beds arranged into bays in one of three open plan areas. The unit was almost always at full bed occupancy with around one third to a half of patients in the unit moving to a medical ward or being discharged home each shift/24-hour period. Staff appeared to be under pressure to either discharge patients or move them downstream to a ward in order to facilitate patient flow from the emergency department.

AMU Staffing

There was a higher ratio of physicians available on AMU than on other medical wards, with a constant medical presence. AMU was considered a high-pressure area for junior doctors due to the wide variety of clinical presentations among patients.

Despite a higher patient to RN ratio on AMU (1:6 for day and night shifts) compared to MOP wards (1:9 during the day, 1:10 at night), nursing staff frequently seemed to be 'rushed off their feet' and worked at a fast pace in tending to patients' care needs. There were healthcare assistants (NHS Agenda for Change (AfC) band 2) and nursing associates (AfC band 4) working alongside the registered nurses (AfC bands 5-8). The environment often felt highly pressurised and staff discussed how workload pressures and staff shortages could be detrimental to patient care. Urgent demands on staff could arise rapidly and therefore work could be unpredictable. As a result, staff often appeared to be stretched between the needs of a number of patients at the same time.

This picture resonates with patterns of nursing recruitment and retention difficulties in hospitals across the UK (NHS Improvement 2016). The fast paced, relentless workload and staffing shortages have been cited as being the most morale reducing and de-motivating factors for nurses in such units (Lees et al. 2013). On the study site, there was a high vacancy rate in the AMU, which resulted in reliance on agency nurses and the requirement to frequently move nurses from other ward areas to cover the unit.

Medicine for Older People Ward

MOP wards specialise in older person's medicine, providing services to those who are aged 80 and older and treating a range of conditions. The MOP ward that participated in the ethnographic phase of this study was a female 26-bedded unit. The majority of patients being cared for were brought into hospital via the emergency department and moved through AMU before being admitted onto the ward. The length of stay for patients often varied and could range from one week to several months, usually depending on a patient's social situation. Patients had often recovered from their acute illness and were deemed medically fit. However, delays in care packages or care home placements resulted in prolonged hospital stay.

The atmosphere on the MOP ward was calmer than AMU, with fewer members of the multidisciplinary team present at any one time, making the ambience of the ward feel less chaotic. In the morning, the ward environment was busier, with doctors completing their ward rounds. However, by the afternoon most patients had been reviewed. Many patients on the ward appeared frail with functional and cognitive impairment. Nursing staff assisted with washing, toileting, eating and mobilising as the majority of patients were unable to care for themselves independently.

MOP Staffing

The medical team on MOP consisted of consultants, registrars and house officers working in teams defined by the locality of patients' General Practitioners. This ensured patients returning to hospital would be looked after by the same consultant, thereby improving continuation of care. Prior to this, a member of the medical team would be present on each ward throughout the day for nurses to seek advice and escalate concerns to. However, this newer locality model of working resulted in multiple medical teams working across all MOP wards. This appeared to impact on working relationships making communication more difficult between nursing and medical teams.

The nursing team on the MOP ward consisted of one AfC band 7 manager, together with registered nurses (AfC band 5 and 6), nursing associates (AfC band 4) and healthcare assistants (AfC band 2), supported by a matron (AfC band 8) with leadership responsibility across all wards within the MOP care group. The ward manager reported a 40% band 5 vacancy rate, necessitating a heavy reliance on agency staff. At the time of data

collection, this was reflective of the national nursing staffing crisis to which nursing vacancies within the NHS were estimated at 12% with a shortage of over 43000 nurses (Royal College of Nursing 2019).

8.3 Overview of observations and ethnographic informal conversations participants

The researcher conducted a total of 50 hours of immersive observations in the AMU and MOP ward, which included 50 directed one-on-one informal conversations with staff. Fieldwork was conducted in two 2-month long blocks from February to March 2019 in AMU and June to July 2019 in MOP. The researcher visited each ward multiple times to conduct observations of front-line clinical practice. Observation periods covered daytime and late evenings and each data collection period spanned from 2-5 hours. When observing for longer time periods, breaks were taken after 2 hours as to maintain concentration and not impact on the quality of observations undertaken. The initial intention was to spend equal time observing each ward environment, however during this study more time was spent observing care in AMU as there was more activity to see of relevance to the study. The researcher observed day-to-day patient care, with a particular focus on the management of patients who required urine output monitoring.

The researcher was able to observe behaviours as well as question clinicians about their decisions and practices relating to urine output monitoring close to the time of such activities. Compared to the MOP ward, the AMU environment provided more opportunities for relevant observations and informal conversations to occur, likely due to the higher number of patients on the unit and their stricter requirements for urine output monitoring. Nurses, physicians and health/medical assistants were represented in these conversations although interactions with staff nurses in the AMU were more frequent owing to the availability of nurses on a 53-bed unit compared to a ward. It was noticeably more difficult to secure time to speak informally with physicians on the MOP ward due their varying availability. Fortunately, the views of consultants and registrars were able to be captured during the semi-structured interviews. Table 21 provides a summary of the participants involved in the ethnographic informal conversations.

Table 21. Summary of ethnographic informal conversation participants

Profession	**Acute Medical Unit**	**Medicine for Older People Ward**	Total
Advanced Nurse Practitioner	1	0	1
Senior Sister	0	1	1
Sister	3	1	4
Staff Nurse	24	3	27
Healthcare Assistant	2	5	7
Band 4 Nursing Associate	4	0	4
Student Nurse	0	1	1
Junior Physician	4	0	4
Medical Assistant	1	0	1
Total	**39**	**11**	**50**

8.4 Overview of semi-structured interview participants

In conjunction with field observations and conversations, 26 semi-structured interviews were conducted. In total, 12 registered nurses, 7 healthcare assistants and 7 doctors participated in semi-structured interviews. Table 22 provides a summary of the healthcare staff interviewed.

Table 22. Summary of healthcare professionals interviewed

Profession	Working across both areas	Acute Medical Unit	Medicine for Older People Ward	Total
Matron	0	0	1	1
Senior Sister	0	0	1	1
Sister	0	0	1	1
Staff Nurse	0	3	2	5
Healthcare Assistant	0	5	2	7
Advanced Nurse Practitioner	2	1	0	3
Clinical Nurse Educator	1	0	0	1
Consultant Physician	0	2	2	4
Registrar	0	0	2	2
Junior Physician	0	1	0	1
Total	**3**	**12**	**11**	**26**

8.5 Overview of data collected from medical document review

9 patients (7 females and 2 males) were recruited for medical document review. Although ethical approval was provided to review medical documentation for up to 15 patients, during data collection it became apparent that information obtained from these medical document reviews was similar to the data gathered from the quantitative phase. Conversations with clinicians and patients were deemed more valuable in addressing the qualitative aims of the study and so interviews and ethnographic conversations were prioritised. 5 patients were recruited in AMU and 4 patients in MOP. Relevant data were extracted from the medical notes of consented patients during opportune times when they were not being accessed by clinical staff. The extracted data allowed an additional source of information to help confirm what was happening in practice. Table 23 provides a summary of relevant data collected.

Table 23. Summary of medical document review

Ward	**Gender**	**>75years**	**Diagnosis**	**Catheter insertion/ indication**	**AKI**	**Fluid balance chart accurate?**
AMU	Female	Yes	Lower respiratory tract infection	Yes – dual indication Urine output monitoring and retention	Yes - Stage 1	No
AMU - MOP	Female	Yes	Pneumonia Decompensated heart failure Hyponatremia	Catheterised on MOP ward for retention	No	No- repeated requests by doctors documented in medical notes for urine output monitoring
AMU	Male	No	Urosepsis Septic shock	Yes (pre-hospital in ambulance) Urine output monitoring	Yes Stage 2	Yes hourly in Resus (ED) 3-6 hourly once transferred to AMU
AMU	Male	No	Urosepsis	Yes Urine output monitoring	Yes Stage 1	Yes hourly on admission for 6 hours then 6 hourly measurements
AMU	Female	No	COPD exacerbation Hyponatremia	Yes Urine output monitoring	Yes Stage 3	Partially 2- 4 hourly (day one) 4-6 hourly (day two) No measurements (day three)
AMU - MOP	Female	Yes	Sepsis	Yes Retention	Yes Stage 1	No
AMU	Female	Yes	Sepsis	Yes	No	Partially

- MOP				Urine output monitoring		1-2 hourly (day one) Once a day (day two and three)
AMU - MOP	Female	Yes	Urosepsis	Yes Urine output monitoring	Yes	Partially Hourly (day one) No recordings on MOP ward for 12 hours
AMU - MOP	Female	Yes	CAUTI Hydronephrosis	Yes – Inserted previous admission, plan for TWOC in community	No	Partially 1-2 times a day

8.6 Contribution of methods to findings

Each method of data collection contributed to the findings as a whole in different ways but not all methods contributed equally. The most beneficial findings were derived from the ethnographic informal conversations and the semi-structured interviews as these offered explanations for the practices observed and decisions made. These methods complemented each other as the ethnographic informal conversations tended to focus on a specific patient's care whereas the semi-structured interviews followed up on issues raised at a general level, allowing participants to discuss their opinions and reflect on past experiences. The majority of excerpts included in the results chapters were derived from semi-structured interviews as they were substantially longer than the ethnographic conversations and therefore provided greater insight.

The main focus of the observations of practice was the work of nursing staff in relation to urine output monitoring and the care that patients were receiving. An advantage of data collected through observations was it allowed the researcher to observe nursing care in the natural environment, which revealed interesting insights that would have been unavailable through other research methods. An example of this included observing the frequent request of a patient to use the commode, which led to the patient being catheterised for comfort by a nurse. It is unlikely this information would have been captured using any other data collection method. In addition, observations such as

seeing a healthcare assistant searching across the different AMU areas for a portable bladder ultrasound scanner, voicing her frustration that the equipment is never available, provided a first-hand account of the challenges faced by staff. Although observations of practice were not the predominant source of data that contributed to the findings, they did provide contextual information relating to similarities and differences between the two clinical environments involved in the research and provided valuable assistance in directing the ethnographic informal conversations and the semi-structured interviews.

As previously discussed in the overview of data collected from the medical document review, analysis of medical notes contributed the least to the qualitative findings. This was due to the information obtained being similar to the data gathered from the quantitative phase. Nevertheless, by consenting patients for medical document analysis this also enabled an ethnographic informal conversation with the patient to take place, and although this interaction was usually brief, the patient's perspective was able to be included.

8.7 Section Summary

This section has provided an overview of each data collection component, including details of the clinical environment and the clinicians and patients who participated in the research. Whilst this description does not form part of the data analysis or interpretation, it does provide context for the reader. The next sections will introduce findings from the analysis and interpretation of the focused ethnographic phase of this study. The findings are presented under main themes and subthemes, which address the research questions and objectives of the study. Verbatim quotations from the informal conversations and semi-structured interviews have been included to illustrate the perceptions, views and experiences of participants.

8.8 How is information about urine output used by clinicians to provide treatment?

To gain a deeper understanding of how urine output measurements influence therapeutic decision-making irrespective of catheter use, this section presents the findings from a focused ethnography across two medical environments. The findings in this section are presented under three main themes and seven sub-themes that were developed using reflexive thematic analysis.

Main themes	Sub-themes
Detecting Deterioration	• Monitoring end-organ perfusion • Oliguria: an indicator to review • Preventing acute kidney injury
Assessing Response to Treatment	• Fluid management • No action needed
Escalation/De-escalation of Care	• Intensive care referral • Palliative care

Figure 21 represents how urine output monitoring can influence clinicians' decision-making. Although each theme and sub-theme are distinct, they did not influence decisions in isolation from one another. Rather, there was often influence of more than one theme or sub-theme in decision-making. For example, urine output could be

monitored to assess end organ perfusion following a fluid bolus to determine if a patient required escalation to intensive care.

Figure 21. Urine output monitoring influences of decision-making

8.9 Detecting Deterioration

Clinicians reported detecting deterioration as a key motivator in the decision to start urine output monitoring on a patient. There was no variation in opinion on this across the different units. However, patients were usually more clinically unstable on AMU compared to patients on the MOP ward and therefore deteriorating patients were more common in this environment. Field work and semi-structured interviews revealed that both nurses and physicians had a clinical responsibility to identify patients who required their urine output to be monitored. However, nursing staff were usually responsible for implementing monitoring.

Sepsis and AKI were considered to be clear examples of a medical condition requiring urine output monitoring, which was intended to achieve early detection of deterioration as well as assessing response to treatment. In the absence of sepsis or AKI, identifying patients who were acutely unwell and who would benefit from urine output monitoring appeared more nuanced. Patient assessment was identified by physicians and nurses as important in helping them decide whether a patient required urine output monitoring. Physicians and nurses reported how they relied upon physiological track and trigger systems and clinical judgement to identify patients who could be at risk of clinical deterioration and therefore may benefit from urine output monitoring.

> "So, there can be lots of different ways in which we assess how patients are acutely unwell. I tend to use the National Early Warning Score, so I look at their physiology so if they're pyrexial and tachycardic or tachypnoeic that might be a sign that they're potentially septic, in which case you would adopt a closer monitoring of the patient's urine output." **SS AMU CONSULTANT**

Physicians frequently identified patients who were "cardiovascularly unstable" as a priority for urine output monitoring. This appeared to be a colloquial term for describing haemodynamic instability. Clinicians (nurses and physicians) identified reduced urine output as the body's response to a failing circulatory system. All clinicians were in agreement that this deterioration would require medical treatment and therefore it was considered important that urine output was monitored alongside other physiological signs.

Monitoring End-Organ Perfusion

Both physicians and nurses frequently expressed how monitoring urine output allowed them to quantify organ perfusion. By ensuring the kidneys had good mean arterial pressure this gave assurance that all other organs were being perfused. Urine output was described as the only direct observation to show end-organ perfusion, which appeared to be more important to clinicians in AMU compared to those on MOP.

> "Urine output is a really good indication of kidney health and kidney happiness and that is really what we should be looking at, end organ perfusion. Are your kidneys, which are the organs that need the most mean arterial pressure to work, are they working? Because if they're working, everything else will work…." **SS AKI NURSE PRACTITIONER**

In patients who had low blood pressure, clinicians appeared to worry less if they were passing adequate amounts of urine. In these cases, clinicians seemed to be less likely to give intravenous fluids to improve the blood pressure as they were reassured that end organ perfusion was sufficient.

> "I guess the basic principle is blood pressure is just a number, what you want is an adequate blood pressure and the way you judge whether a blood pressure is adequate would be, you know, are they perfusing their brain so do they have a normal conscious level? You get some kind of proxy by, you know, skin perfusion, capillary refill but urine output is one of the major proxies so if you've got somebody with a relatively low blood pressure but actually, they're peeing okay you're much more relaxed about that person than somebody with a low blood pressure who isn't peeing, that's a worry**." SS AMU CONSULTANT**

Sepsis was one of the most frequently cited conditions that was considered to require urine output monitoring. It was clear that clinicians viewed urine output monitoring as particularly beneficial for this group of patients, particularly in the first 24 hours of admission when patients may receive 'aggressive' fluid resuscitation to maintain an adequate blood pressure.

> "I would say the most common reason for kind of hourly urine output monitoring so where you're doing quite intense monitoring of urine output is around trying to ensure that you've got adequate perfusion of the kidneys essentially so you're looking at does the patient have an adequate blood pressure predominantly? So, that would be patients who are septic, patients who are, you know, acutely unwell and you're using the urine output as a proxy for do they have an adequate perfusion of their vital organs which is the kidneys**." SS AMU CONSULTANT**

A reduction in urine output in a patient with sepsis prompted concern that they could be developing septic shock, a life-threatening condition. Oliguria was viewed as an early warning sign that the patient was deteriorating.

> "So… patients who are septic usually is taken in conjunction with the entire clinical picture so obviously if they're pyrexial and tachycardic, if they're oliguric as well then that's a first sign that they're heading towards sepsis because if they've got established sepsis it's the first sign they may be heading into shock because they're not perfusing their kidneys." **SS AMU CONSULTANT**

Preventing Acute Kidney Injury

Preventing the development of AKI in patients was highlighted as a priority. Monitoring urine output was viewed as a useful tool to assess whether a patient's renal function was recovering or deteriorating. There was concern that AKI increases a patient's risk of mortality and length of hospital stay. A proactive approach to prevention was therefore considered justifiable.

> "we can't solely rely on one measure alone so if their patient has got an acute kidney injury but they're passing good volumes of urine then that's usually a sign that their renal function will generally recover but obviously if their renal function is relatively preserved but they're oliguric then obviously it means that they could head into acute kidney injury if that's not pre-empted." **SS AMU CONSULTANT**

Observations of practice in AMU revealed that urine output monitoring featured in the care plans of many patients. An informal conversation with an AMU staff nurse revealed this was to ensure patients were passing accurate amounts of urine based on their weight and target volume (0.5ml/kg/hr). When the researcher probed if a particular patient's renal function was currently deranged, a doctor replied that the renal function was normal on their bloods. The staff nurse continued to explain the monitoring was pre-emptive in order to prevent an acute kidney injury.

For patients with a known AKI, monitoring urine output was viewed as part of a jigsaw puzzle in assessing the severity of the AKI and the likely cause. Consultants in both AMU and MOP discussed pre-renal, post-renal and intrinsic AKI and how urine output can assist

in diagnosis. For example, if a patient is not passing urine but a bladder scan reveals a full bladder, the likely problem is post-renal, whereas a patient with AKI and oliguria was a cause concern and could be an indication for filtration. This was significant as it would indicate renal failure, which would require admission to intensive care for organ support. It also illustrated the value of assessment using a bladder scanner to assist in distinguishing the cause of AKI.

Oliguria: An Indicator to Review

Field work and interviews revealed how urine output measurements provided both information on a patient's current clinical status but also acted as a trigger to prompt further action if required. Nursing staff frequently reported that oliguria (reduced urine output) was an indicator to request a medical review for the patient.

> "I've had patients that have been poorly and they've had lower output so I've escalated it to the doctors and they've done a fluid resuscitation challenge and their blood pressure's gone up and they've started passing more urine so, you know, they were happy with that. And I've also had the other way around where they haven't responded and after, you know, lots of other things the doctors have decided to kind of reduce the care." **SS AMU STAFF NURSE**

A Sister on MOP explained how reduced urine output in a patient often leads to a process of elimination that guides their decision-making. A series of checks would be made to ensure oliguria was not due to a non-clinical problem, for example a blocked catheter, before escalating concern to a doctor.

> "So, it'll be things like if the urine output's trailing off, so my first thing was if the urine output's trailing off, I would quickly do a bladder scan just to check the catheter wasn't blocked or anything like that, I might do a bladder flush out because I want to check is there resistance?...At that point I will do a set of observations so I can see is their blood pressure dropping? Is it that they are so dehydrated that, you know, they're clinically now not stable and then I would be escalating it to the doctor straight away to say, okay, because once they start going below a certain level on their urine their NEWS score would start coming in

so then they would be NEWSing which means they then go onto hourly observations." **SS SISTER MOP**

It was common for nursing staff to refer to the therapeutic urine output goal of 0.5ml/kg/hr. There was an awareness that if a patient's urine output fell below this target it was a nursing responsibility to escalate this to the medical team.

> "Urine output is based on a weight target 0.5ml/kg/hr so roughly 25-30mls/hr for most patients. If a patient has an hourly output of 10mls I would escalate to the doctors and see if the patient needed more IV fluids or I would push oral intake." **IC AMU STAFF NURSE**

A staff nurse and registrar in MOP described the challenges in fluid management for some patients. They described the difficulty striking a balance between volume overload and dehydration, each patient demanding careful consideration of their individual fluid needs which can impact on decision-making.

> "It was like 3mls, a very tiny amount of urine per hour. But then I was always communicating with the doctor and reporting to her, so she ended up giving her IV fluids to try to see. On the other hand, it was a patient that was overloaded a few days ago, so it was one of those cases that was very tricky to do, and she was really poorly as well. So, it was very tricky, so the doctor was a bit unsure. She didn't want to give her too much fluids because she was already overloaded in the past, but she gave her just a small amount of 250 and she ended up improving slightly, you started to see the changes, it went up to 10, then 15, so we saw the difference." **SS MOP STAFF NURSE**

> "So, heart failure is one thing and then the other is the kind of opposite, where you have, well, very little urine output and then you have to actually decide whether the patient is hypovolaemic or whether they are overloaded because obviously that's different treatment. And that's not always very easy in our patients. I think the kind of assessing fluid status in an older person is quite a challenge actually sometimes. And sometimes it's kind of trial and error." **SS MOP REGISTRAR**

8.10 Assessing Response to Treatment

In principle, urine output was reported by clinicians to be used for assessing response to medical treatment. However, medical staff expressed that outside of when a patient was "critically unwell" it was often difficult to make decisions based on fluid balance monitoring as this was often inaccurate. Blood results, physical assessment and clinical experience were reported to be used for ongoing decision-making. However, it was clear there was an expectation of nursing staff to escalate oliguria. Consultants also expressed that patients who were unwell enough to require hourly output monitoring should be under a regular medical review process where urine output should be assessed. However, in practice it appeared that hourly urine output was often requested by the medical team, and it was a nursing responsibility to escalate concerns. Nurses were in agreement that monitoring urine output was part of clinical observations and therefore a nurse's responsibility to escalate.

Fluid Management

Fluid management was acknowledged as an essential part of care for any patient admitted to the hospital. If possible, it was preferable for patients to take fluids orally since this is the natural route of fluid intake. However, alternative routes of administration, such as intravenous fluids delivered directly to the vascular system, were often used. There were differing view between medics regarding the usefulness of urine output to guide fluid management.

One AMU consultant questioned the need for accurate measurements and theorised whether knowing a patient has passed some urine would suffice.

> "So, with the exception of the really critically unwell patient where it is really important, I think the larger group of patients who we ask for fluid output, input/output monitoring really what you're interested in is are they actually peeing or not? And the actual amount, as long as they're peeing and their renal function's getting better, you're actually not that bothered about, you know, there will be certain groups of patients, heart failure, renal failure, where it is really important to know how much fluid they've got onboard but again weighing them

every day is much simpler than trying to work that out from input/output monitoring and so what real benefit do you have?...You need to know that they're definitely peeing and they're not, not peeing, but the actual numbers themselves maybe aren't as important as we think they might be." **SS AMU CONSULTANT**

However, a different consultant in AMU described urine output measurements as being useful to guide both immediate treatment and an overall 24-hour fluid balance.

"So, I think it does guide first of all immediate treatment in terms of giving more fluid or fluid boluses or they're clinically overloaded giving furosemide but also it guides the overall 24-hour measurement of the fluid balance because if there is a negative positive balance then we often have to adjust the sort of fluid replacement accordingly to that." **SS AMU CONSULTANT**

Although there was evidence that urine output monitoring did lead to therapeutic decision-making in some cases, it was also acknowledged that often therapeutic decisions related to fluid management were not always guided by urine output measurements even when nursing staff had accurately recorded output.

"I think if it is really important to us then we need to show that it's really important by basing decisions off it and saying actually, it would have been really helpful if I had a clearer idea about this but I think often the reverse is true, you know, the nurses are putting a great deal of effort into it and we're not even looking at it, you know, we're just going right, increase their furosemide it'll be alright." **SS AMU CONSULTANT**

However, the medical team expressed how they hoped a reduction in urine output would prompt nursing staff to review a patients ongoing fluid requirement.

"I mean you would hope though that, you know, if we were monitoring somebody's urine output perhaps not hourly because we were concerned that they were dehydrated and they had an acute kidney injury, that a low urine output would get the nurses to think about, well, how much fluid is going in, you know?" **SS AMU CONSULTANT**

No Action Needed

During field work clinicians were asked daily by the researcher if any therapeutic decisions from monitoring urine output had been made. Frequently nursing staff would report that they had made no changes to therapeutic decisions from monitoring urine output. Often this was due to adequate amounts of urine being passed.

> "No, all the decisions have already been made; monitoring is just to check more fluid is coming out than going in." **IC AMU SISTER**

> "No therapeutic decisions have been made today as the patient is passing good amounts of urine so there is no concern." **IC AMU STAFF NURSE**

One registered nurse explained,

> " I haven't made any therapeutic decisions today that have been influenced by urine output measurement but this is due to my patient passing urine regularly and large amounts (as per goal)…in general if a patient on diuretics has not passed urine for 3-4 hours, I would do a bladder scan as this is quick so you might as well check. If I did a bladder scan and there was only a little urine output this would trigger me to tell the doctor and take bloods to check the patient's renal function. If a patient is having diuretics and not producing urine, I would be concerned that the patient had deteriorating kidney function." **IC AMU STAFF NURSE**

Often nurses reported that patients had been catheterised in ED to monitor urine output but they were meeting their target volume therefore no further action was required. When questioned whether this would lead to the removal of the catheter in AMU, nursing staff reported this usually happens when the patient has been transferred downstream to a ward.

8.11 Escalation/De-escalation of Care

Intensive Care Referral

During field work and semi-structured interviews, clinicians commonly reported urine output as integral to whether a patient would need to be escalated to intensive care. If despite ward-based interventions urine output remained low this would be an indicator that a patient should be referred to intensive care.

> "Intensive care referral is dependent on urine output. Urine output is a critical aspect as it's used as a marker of perfusion…sepsis can cause vasodilation which can result in the under perfusion of all organs. If the brain is under perfused you may see confusion but we can't quantify that so urine output is a quantitative measure of hypoperfusion." **IC AMU DOCTOR**

> "If you're getting to the like sepsis patient who's had 7 litres in and they're still not fluid responsive the blood pressure's low… they're still hypotensive with oliguria then you might need to think about intensive care for vasopressors, to keep their blood pressure up to be able to perfuse the kidneys" **SS Critical Outreach Advance Nurse Practitioner**

A staff nurse explained how despite boluses of fluid a patient's urine output remained low, which led to an intensive care referral.

> "the lady that went to intensive care, that we ended up putting the catheter in, that gave us a good idea of how systemically she was working, because we could see that her urine output wasn't great, and the intensive care nurses would come back and review her fluids and giving her boluses of fluid to try and keep that up. And she was reluctant at first to have the catheter, but I think once it was explained that she was quite poorly and needed it, she was on board with having it done. But yeah, that definitely helped my clinical decision-making of her care and escalating her to the intensive care unit." **SS STAFF NURSE3 AMU**

Palliative Care

Urine output was also seen as a prognostic tool for patients who would not be appropriate for admission to intensive care. If despite ward-based interventions urine output remained low this would be an indicator that a patient was becoming more unwell and would need a palliative care approach.

> "Obviously if it's a patient who isn't for intensive care and, you know, if they stop passing urine and start developing pulmonary oedema and things despite the fluid then you'd know that they're becoming more unwell and about having discussions about end of life care and things like that so we'd guide that, yeah." **SS MOP CONSULTANT**

8.12 Section Summary

This section has presented the findings of this study with regard to how urine output measurements influenced therapeutic decision-making irrespective of catheter use. It has built on the quantitative findings by offering insight into how urine output measurements were used by clinicians to provide treatment. Three main themes were identified: detecting deterioration, assessing response to treatment and the escalation and de-escalation of care. The findings demonstrate the reported reality of how urine output measurements influence clinician decision-making. However, in practice urine output monitoring is often overlooked and therefore cannot impact on decision-making. Urine measurements appear to be scrutinised less when a patient enters a period of stabilisation, for example, a patient's urine output may be closely monitored when receiving fluid boluses on admission for low blood pressure but then frequent monitoring may cease and urine output may not be taken into consideration for subsequent prescribing and administration of maintenance fluids.

The findings highlight that urine output measurements appear to influence care most when a patient is unstable. Urinary catheters are generally inserted for monitoring when a patient is critically ill and less so when monitoring is being done as routine but there is a grey area around when monitoring with a catheter or non-invasive methods can be stopped. Routine monitoring appeared less of a clinical priority and would therefore be recorded less accurately. The next section will discuss factors that were found to influence a clinician's decision to insert a catheter for urine output monitoring.

8.13 Factors influencing clinicians to insert an IUC for urine output monitoring

The previous section provided insight into how urine output measurements influence therapeutic decision-making in medical environments which provided evidence to help understand why urine output monitoring in seen by clinicians as valuable. The following findings provide an explanation as to why clinicians view catheters as necessary for urine output monitoring. The findings are presented under two main themes and ten sub-themes.

Main themes	Sub-themes
Clinical Rationales	• Accuracy is important • Hourly measurement requirement (adhering to 0.5ml/kg/hr urine output criteria) • Patient acuity • Timely assessment and intervention
Non-Clinical Rationales	• Providing reassurance • Protocolised medicine • Mitigating risk • Urometers: a cue to monitor • Convenience of care • Distrust

This findings revealed clinical and non-clinical rationales that influence a clinician's decision to insert a catheter for urine output monitoring. There are inter-relationships and overlap between many of the sub themes highlighting the complex array of

influences and motivations behind a decision to insert a catheter for urine output monitoring.

8.14 Clinical Rationales

The findings exposed clinical rationales for inserting a catheter for urine output monitoring. These included the requirement for accuracy and hourly measurements which depended on the patient's acuity and the need for timely assessment and intervention.

Accuracy Is Important

One clear finding was the agreement among healthcare staff that when it comes to urine output monitoring, accuracy is important. Clinicians and guidelines often reported the requirement for "accurate urine output monitoring". Accuracy can be defined as being "the fact of being exact or correct" and/or " the ability to do something without making mistakes." The majority of clinicians identified catheters as integral to achieving accuracy for two reasons: the ability to provide precision and increasing the reliability of measurements being recorded.

Precision

Precision was viewed as important in order to adhere to the 0.5ml/kg/hr urine output target criterion, especially in acutely unwell patients who had potential to deteriorate clinically.

> "If a patient meets criteria for fluid balance monitoring then it is important to be accurate, if a patient is clinically unwell, 15mls can be the difference between meeting their urine output target and not." **IC AMU STAFF NURSE**

The ability to monitor and react on an hourly basis was viewed as a priority and a catheter with an attached urine meter (urometer) enabled staff to do this precisely.

> "Well, it's not really easier it's more about precision, the urometer chamber has marked measurements that you can see for example 5mls, 10mls. It also makes it easier to know if somebody has already charted it as you can see the top chamber is

full if they haven't, whereas a leg bag all mixes into one and you can't tell." **IC AMU STAFF NURSE**

Reliability

Catheters with an attached urine meter were also seen to increase reliability. Clinicians believed urine output measurements were more likely to be recorded correctly if a catheter was in place. Many clinicians commented on how notoriously inaccurate fluid balance charts were and reported distrust in using non-invasive collection methods. Catheters were inserted in order mitigate these risks even when hourly monitoring was not necessarily required.

> "So, even though there are other ways of measuring fluid output, urine output, if you want to accurately measure really, it needs to be with a catheter, because otherwise it's just not particularly reliable and when you come to look at the fluid balance, you're never really sure if you can rely on it or not." **SS AMU SENIOR HOUSE OFFICER**

> "I think if it needs accurate measurement, I think catheters are the best solution I would say, because they provide exactly what it is with no doubts" **SS MOP STAFF NURSE**

Hourly Measurement Requirement (Adhering to 0.5ml/kg/hr urine output criteria)

Clinicians acknowledged that for patients without a catheter, urine output can be measured as volume of urine produced over a period of time, from which mean hourly urine output can be calculated. However, catheterisation allowed clinicians to record hourly output, making it possible to identify when a patient's urine output fell below the 0.5ml/kg/hr threshold in a more timely manner. Although there is currently no medical consensus on whether urine output should be measured using consecutive hourly readings or average output clinicians frequently referenced the ability to monitor hourly urine output as a legitimate clinical rationale for inserting an IUC.

An AMU consultant described the benefit of hourly urine output monitoring in the scenario below.

> "For very sick patients, so patients that may have an acute kidney injury stage 3 or patients who are profoundly septic…The benefit of hourly urine output monitoring, enables us to keep a very close eye on their fluid balance so say for example if they got a profound acute kidney injury where we have to monitor the fluid balance very closely so we want to maintain a degree of euvolemia then hourly urine output monitoring often becomes very important because say if they're oliguric that can be the first sign of being unwell, acutely unwell, then we have to often give fluid boluses if they're hypovolaemic." **SS AMU CONSULTANT**

Conversely, a consultant in MOP questioned the requirement for hourly monitoring in older people but acknowledged their benefit for younger patients.

> "It's probably trying to adhere to 30mls per kilogram per hour, you know, and that's kind of it, but we know from experience, a lot of older people don't produce 30mls per kilogram per hour, for various reasons, because of physiology of ageing, you know, the renal concentrating system, so actually, I don't think any of us geriatricians would be too hot on that. Get a 25-year-old, obviously we'd need to be really hot and if they've got vasculitis, have they got any kind of hypovolaemic, any conditions causing hypovolaemia, then it'd be critical." **SS MOP CONSULTANT**

An AKI Nurse Practitioner agreed with the recommendation for hourly urine output monitoring in cardiovascularly unstable patients but emphasised how measurements should be influencing therapeutic decision-making.

> "So, they're only really useful if your patient is very sick, cardiovascularly unstable and requiring treatment to support that. So, for example you have a patient who's got a very low blood pressure and you're having to give them a lot of fluid, quickly, not eight-hourly, ten-hourly bags, and you're giving them fluid and you're assessing the responsiveness of them to that fluid, in which case all you need to do is 'in this hour I gave my patient 500mls and they peed out X mls'…If you're giving them an eight hourly bag, they probably don't need hourly urine outputs because what are you doing with that information? What is that changing?" **SS AKI NURSE PRACTITIONER**

The above excerpt expresses the view that the requirement for hourly measurement is justified when used to provide treatment, for example, management of haemodynamic

instability and hourly titration of fluids. The clinician also acknowledged that requirements for urine output monitoring change over time, usually as a patient's condition stabilises and improves and this is not always something that is reflected in a patient's care plan. Findings suggest that IUC are often left in situ considerably longer than when hourly measurements are required for decision-making.

> "In the first day, they need hourly, urine output, and hourly obs, but in the second day they need less. I also get really cross by, they want eight hourly obs and two hourly urine outputs, because that doesn't really go hand-in-hand, so what are you treating? If their urine output is low you don't know what their blood pressure is or is it because their blood pressure is low and that's why the kidneys aren't working… it's a mismatch, if they're on two hourly urine outputs they should be on two-hourly obs. And if they don't need two hourly obs they don't need two hourly urine outputs, that's kind of the clue! The trick." **SS AKI NURSE PRACTITIONER**

Multiple clinicians identified a benefit of hourly urine output monitoring was the ability to identify trends. However, it is unclear when clinicians view the risks of catheterisation outweighs the benefit of hourly urine trends and at what point catheter removal would occur.

> "I suppose the only benefit with hourly is that if you do have that decline it goes like, I don't know, 40 40 10 you can see a trend and get on top of that quickly rather than wait, say, the four or six hours, that would be the only benefit." **SS CRITICAL CARE OUTREACH NURSE**

> "I think we sometimes ask for hourly when two hourly would probably be sufficient. I think it gives you an idea of the way things are going, so if they've been a bit oliguric, very dehydrated and then you can see the urine output picking up over the course of a few hours that's helpful. Equally, if it's tailing off that's helpful as well. And also, you can tell sort of when it is that someone's got worse rather than they've peed, I don't know, 300 mls over 6 hours, was that all at the same time or have they peed 50 mls an hour for 6 hours?" **SS MOP REGISTRAR**

Patient Acuity

Within AMU, it appeared the default action for many acutely ill patients was to make the decision to place an IUC, with little consideration given to how important it was to know precise measurements or the potential for using alternatives. Critical illness was often given as an accepted indication for IUC use; however, this term can be broadly interpreted. Clinicians frequently expressed that if a patient's acuity was high, they would need a catheter, particularly if they expected the patient to be transferred to intensive care.

> "If you're thinking 'at some point in the next 24 hours I wouldn't be surprised if they ended up in intensive care' they probably need a catheter, because someone's going to come and ask you to do it anyway." **SS AKI NURSE PRACTITIONER**

> "So, generally catheters are for patients who we're very worried about, who are very unwell, particularly from a sepsis point of view, especially if they're maybe not responding initially to treatment then we'd want to catheterise them to get an accurate understanding of their fluid balance." **SS AMU SHO**

Physicians in medicine for older people expressed that a more balanced approach to catheterising acutely unwell older patients was needed, particularly for frail patients who were unlikely to be escalated to intensive care.

> "I think, yeah, there's no one method that is great, I think with catheters it's about not asking for the same thing in everyone because it is a risk but it's about picking that patient that you want to know about, they're poorly, you would want them to go to intensive care or perhaps be considered for a filter acutely so you need to know." **SS MOP CONSULTANT**

> "I mean if the patient was critically unwell for very active management, even possibly escalation to ITU, then obviously we would do all the normal, you know, catheter and so on. But if somebody has been, you know, ill for a while and they're frail and, you know, we're not going to go beyond the ward base care then possibly we would think without the catheter if possible, yeah." **SS MOP REG**

One consultant described how catheterising older patients for urine output monitoring is justified if you are planning to escalate their care however for patients whose ceiling of care is ward based, pad weighing is acceptable.

> "So, in terms of, you know, escalating to intensive care, if it was a patient that was really poorly, I mean you may get a period where, you know, the nursing staff say gosh she's had a dry pad for a number of hours or and she'd usually go and then you'd do a bladder scan and if they had no urine in their bladder and their kidney function's going off, I think you'd probably still catheterise them and work out what was going on. If it was someone that wasn't going to intensive care, I suppose weighing pads or knowing if they've had dry pads and things would help you know whether they were deteriorating further if it wasn't someone you were going to catheterise. Yeah, it's a difficult one, I think if it's someone that you're going to do something about I would catheterise them and work out but if it's someone you're not, you know, that's perhaps having a more palliative approach then I think the other methods of knowing if they're dry in terms of bladder scanning them with pads and things are acceptable." **SS MOP CONSULTANT**

Timely Assessment and Intervention

Many clinicians viewed catheters as a beneficial tool to provide timely information on whether a patient was responding to treatment. Findings highlighted, when a patient is acutely unwell, clinicians want to be able to respond to signs of deterioration and intervene promptly.

> "From the patient's perspective, if it's closely and regularly monitored it offers the opportunity to pick up on any deterioration, any reduction in kidney function that you might have, in a very timely, prompt fashion. Without a catheter, without an intervention in terms of catheterisation, you wait several hours to see if they've passed enough urine over that average of their hourly urine output, whatever their micrograms per kilo per hour might be. The advantage of catheterisation is that micromanagement, being able to respond in a timely fashion, and prevent the deterioration." **SS CLINICAL PRACTICE EDUCATOR**

Watchful waiting for a patient to pass urine was not seen as proactive enough amongst clinicians and there was concern that this could lead to deterioration being missed.

> "It's just more accurate. You can keep track of exactly what's going in in that hour and what's coming out in the hour. Whereas a patient may not urinate for three hours which could be normal, but with the catheter, it's constantly coming out, so you've got hourly, and you can just see if there's going to be… If there's a decline, you can catch it quickly. So, if every hour they've had roughly 80/90mls, but all of a sudden, it's dropped down to 20mls for the next two hours, you know something's not quite right there that… Have they been asleep and not drinking? You've got to weigh everything up, but you can quickly tell if there's been a decline in the kidney function or not." **SS AMU STAFF NURSE**

> "Catheters enable measurements to be known sooner otherwise you could be waiting till the afternoon for a patient to pass urine to know their fluid status." **IC AMU STAFF NURSE**

One nurse commented junior doctors preferred a pre-emptive approach to monitoring urine.

> "I think our junior doctors are especially more veered towards catheters than they are just towards almost a 'watch and wait' approach." **SS AKI NURSE PRACTITIONER**

Some medical colleagues justified the requirement for a catheter by explaining how kidney perfusion changes can happen quickly.

> "Kidney perfusion changes happen quickly, so the benefit of hourly measurements are that they allow you to see this. If urine output drops the patient may not be doing too well so you could give them some more IV fluids. If urine output then increases it is a good prognostic sign." **IC AMU DOCTOR**

8.15 Non-Clinical Rationales

Alongside clinical rationales for IUC insertion, non-clinical rationales influenced clinicians' decision-making. Identified sub themes included providing reassurance, mitigating risk, protocolised medicine, convenience of care and urometers as a cue to monitor.

Providing Reassurance

During interviews, clinicians reported being comforted by hourly measurements but questioned how clinically necessary these were in acute medicine.

> "I think there is something comforting in somebody with an acute kidney injury that has a catheter in and that you're measuring the urine output every hour and it's good but I guess the majority of cases you probably don't need it." **SS AMU CONSULTANT**

Paradoxically physicians seemed to "err on the side of caution" when deciding catheterisation was necessary. Although risks of catheterisation were frequently acknowledged by clinicians, these risks seemed to be trivialised by the threat of missing oliguria, and greater importance was placed on the latter.

> "I think people will always generally err towards the side of caution so I think that happens a lot so people will be more cautious particularly if they're on overnight when there's no sort of resident consultant on call cover, so often if there's no resident on call cover and they don't know what to do then they will err on the side of caution and say, no, these patients need hourly urine output monitoring when actually they probably don't need it so much." **SS AMU CONSULTANT**

One advanced nurse practitioner described when a patient has a history of renal failure, even if recovered, clinicians remain anxious regarding the patient's urine output and renal function. IUC are used to avoid adverse events and provide comfort and reassurance to the clinician.

> "The other day I had somebody who had to go up to ITU for filtration, then go on to our local dialysis hospital and their kidneys were terrible and then they made a really good recovery and they've come back in, so for me although their blood tests showed that everything was fine, I was really concerned about their urine

output because I didn't want that to happen again." **SS AMU ADVANCED NURSE PRACTIONER**

One consultant physician commented how it was reassuring to see urine output measurements frequently recorded but was unsure whether routine monitoring impacted on clinical decisions.

> "I think it goes back to I think people like to see numbers on a chart that are reassuring so that they can look at a chart and be reassured and it's a bit more difficult to be reassured and you have to take a bit more on faith when you're not really sure how accurate the chart is…I think the biggest thing is if we're asking people to do it we ought to be showing them why it matters in terms of actually basing some decisions on it rather than just using it as reassurance because I think that's what it is a lot of the time, it's just oh I can look at this chart and it makes me more reassured but I'm not really going to make a lot of decisions based on it." **SS AMU CONSULTANT**

Mitigating Risk

When weighing up the decision to place an IUC for urine output monitoring, the clinician's assessment of risk undoubtedly played a role. Since therapeutic interventions have become more complex, their risk/benefit ratios have become more difficult for healthcare professionals to assess. Avoiding harm and the need to keep patients safe through the reduction of risk is at the forefront of many clinicians' minds. Findings from this study revealed many clinicians were concerned by reduced urine output and a lack of trust in the accuracy of fluid balance charts due to poor record keeping was reported frequently by all groups of staff.

> "But it's a big problem that people's fluid balance isn't monitored accurately and that does make it quite difficult to make decisions about patients. And that's generally not the patients that are really, really unwell because everyone recognises that, it's the more stable patients that need treatment decisions made; that's quite difficult." **SS AMU SENIOR HOUSE OFFICER**

> "If you absolutely need to know your ins and outs to within a millimetre kind of thing then the catheter is the only way because if you are not using a catheter then you are basically just in God's hands; you're just hoping… the best method unfortunately will always be catheters because it is literally front sourced; there's no – unless someone is really stupid and opens the tap and bleeds it all over the floor or drops it or something; but generally you shouldn't be able to make mistakes with the amount whereas every other method is open to misinterpretation or being missed." **SS MOP MATRON**

In patients who were at risk of renal injury, catheterisation was viewed as a way to mitigate these risks and improve the chances of accurate documentation. The desire to avoid harm being caused to a patient by missing reduced urine output, appeared to sway clinicians to make the decision to catheterise.

> "I think if you're worried then you certainly are going to want them to have a catheter just because it's hopefully the most reliable way of getting the information that you need." **SS SENIOR HOUSE OFFICER AMU**

These desires appeared to outweigh the potential harms caused by IUC, as it appeared clinicians viewed it as less risky to make the decision to place an unnecessary IUC than to not place an IUC which might have been beneficial.

> "I think it's just based on clinical judgements like if someone's unwell you're instantly going to think, okay, well it's a lot more practical to just have a catheter in where we can monitor it a lot more effectively and we'd really know how much they're passing whereas like obviously with pans or going out to the toilet or whatever or a pad, it's a lot harder to measure due to like a pad like it might have gone on the sheets or someone might have walked out to the toilet and forgotten." **SS AMU ADVANCED NURSE PRACTITIONER**

In reality, although catheters do appear to improve documentation, fluid balance charts when a catheter is in place are still not always completed correctly outside of critical care/HDU. Despite this, clinicians appeared to view catheters with attached urometers as guardians of accuracy.

> "If it is a patient that is confused, a patient that is agitated, a patient that is incontinent, I will probably have a conversation with the nurse in charge and say, 'Do you know what, it is going to be very tricky to monitor on this patient. I can do it, but it won't be accurate, so it might be beneficial to pop a catheter in, because that way we can do it hourly, two hourly, whatever the doctors need, and it will be accurate'." **SS MOP STAFF NURSE 6**

Interestingly, the term 'pop a catheter in' was frequently used by nurses. The language used to describe catheterisation will be explored further in the discussion chapter in relation to risk perception.

Protocolised Medicine

The need for accurate fluid balance monitoring is advocated by the Acutely Ill Competencies produced from NICE Clinical Guideline 50 (NICE 2019) and Acute Kidney Injury: prevention, detection and management (NICE CG169, 2013). Both nurses and doctors referenced national guidelines as providing information to which patient would be identified as requiring urine output monitoring. Sepsis, AKI and the acutely unwell patient were the most frequently cited conditions that required urine output monitoring. Contrary to this, clinicians also expressed how catheterising a patient for urine output monitoring can part of a tick-box exercise and acknowledged in interviews this shouldn't be preferred practice.

> "I think there has to be a really good reason to put the catheter in, with a plan, because there's no point putting a catheter in when you're actually not going to monitor anything and you're just ticking the boxes, right? An unwell patient came in, catheter in, it shouldn't be like this. You know, there should be a good reason, you know, if they have got significant renal failure and we're expecting problems then, yeah, you know, it should be a really considered decision." **SS MOP REGISTRAR**

However, in practice, there was a sense that catheterising patients for output monitoring was following the "correct" procedure. There appeared to be a perceived threat that not inserting a catheter could be seen as negligent or not implementing the appropriate care

plan. Nurses reported examples of junior doctors displaying elements of defensive medicine, to which catheter orders in part were made for the purpose of protecting a doctor from criticism rather than them being an absolute necessity to patient care. Reflex decisions to insert a catheter despite successful use of non-invasive collection methods are described in the quote below.

> "I think there's a lot of reflex, though, asking for catheters - 'they've got an AKI, they need a catheter, they're septic, they need a catheter, they have got heart failure, there's lots of reasons why they must have to have a catheter' but actually they tend to be some of our junior doctors and not our more experienced senior clinicians…. I have seen two patients in the last two days and both of them have been passing good volumes of urine, both of them have got accurately filled-in fluid balance charts and both of them, the medical teams have said 'catheterise', the junior doctors have said 'catheterise' and I challenged one in surgery on Friday - in fact I didn't challenge him, I said 'no, no, you're not catheterising him' and they said 'but he's got an AKI' and I said 'but he's peeing and clearly beautifully filled-in fluid balance charts. He's able to take a bottle and give it to the nurses and the nurses are filling in the chart, why do you need to?' 'Because he's got an AKI' and I said 'It's not NICE guidance'. One of the other patients today, I said to them 'you shouldn't need to catheterise her' - 'yes we do because she's got an AKI' - 'I'm the AKI nurse, you don't need to catheterise her' and they were like 'we're going to do it anyway'. I was like 'okay, it's just an unnecessary indwelling device'." **SS AKI NURSE PRACTITIONER**

There appeared to be a spectrum of views amongst clinicians as to when an IUC was required for urine output monitoring. Perhaps surprisingly, the AKI lead nurse appeared to have strong views regarding avoiding catheterisation when possible.

> "So, I think they were worried the patient had an AKI and therefore 'they must have a catheter so we can strictly monitor their urine output' and that I would get cross if they didn't have one, and I was like 'no, I love no catheters, it's my favourite thing, as long as the patient is peeing!' so when I came and went 'no, you don't need one' they were like 'oh okay, good, that's fine'." **SS AKI NURSE PRACTITIONER**

The above view describes how clinicians worry that not inserting a catheter would be seen as controversial by colleagues and appears to tie in to the theory of defensive medicine. This view was shared by a ward sister who highlights how concerns regarding litigation and the requirement to ensure care is documented could be driving the increase in strict fluid balance monitoring, not necessarily the acuity of the patient.

> "Because there's so much emphasis, quite rightly, in their training about litigation and making sure they've documented everything and actually if it's not documented, then you haven't done it. I think we're almost coming out at the other extreme of, well, we'll over-estimate and say, "Everybody needs it, because everybody's unwell because they're in hospital." **SS SENIOR SISTER MOP**

The recent drive to improve the management of sepsis has promoted achieving a urine output of > 0.5ml per kg/hr as a therapeutic goal of treatment. The Sepsis Six care bundle was frequently reported as essential guidance that helped clinicians formulate a care plan. The need to monitor urine output in patients with sepsis was unequivocal and embedded in practice. The concept of recognising and responding to reduced urine output was viewed as a priority by all staff groups however there was a lack of consensus as to what methods of monitoring were required and most beneficial to patient outcomes. Physicians expressed a high degree of certainty that patients with sepsis required catheterisation and hourly urine output monitoring. However, the decision to insert a catheter appeared to be a default action directed by Sepsis Six rather than a considered decision on the importance of needing hourly measurements.

> "So, on admission, any sepsis markers, the clinical staff would indicate that actually they need a catheter and part of the sepsis six automatically will involve catheter, venous blood gas and all the rest, so they'd get a catheter." **SS MOP CONSULTANT**

> "It is a medical decision to insert a catheter but if a patient has sepsis, it is part of the Sepsis Six pathway so that decision is made for you. The Sepsis Six pathway has a requirement for accurate hourly urine output measurements and the gold standard for that is catheterisation". **IC AMU DOCTOR**

A commonly held view amongst nursing staff was that there is medical expectation that particular groups of patients would be catheterised for urine output monitoring.

> "Yeah, from my perspective, I think a lot of the doctors go immediately straight for the catheter, and that's like in their medical plan, it's like, urine output needed, straight to catheter… I don't think having a catheter makes things necessarily easier. I think maybe some nurses would see it that way, because they're not having patients constantly asking to go to the toilet, because it's just kind of going in. But from my perspective, I think doctors are more the ones pushing for the catheter" **SS AMU STAFF NURSE**

> "I think it's kind of expected that they should have one because it's just an easier way of monitoring the output more accurately so the doctors and like outreach would usually want you to put a catheter in if they are poorly with sepsis." **SS AMU STAFF NURSE**

Convenience of Care

Although convenience of care is not a widely accepted indication for catheterisation, many clinicians reported how inserting IUC can help manage workload. Some clinicians expressed views that is was unreasonable to expect nursing staff to monitor urine output using non-invasive methods, illustrated by the comment below.

> "It's obviously very much more difficult if patients aren't catheterised. And I guess my view, my thought process is that asking for urine output monitoring in a female who is not catheterised is very challenging on the nursing staff, and is probably a bit unfair. But for men who are continent, it's easier because they can pee into bottles." **SS MOP REGISTRAR**

Another physician expressed how short staffing can lead to prolonged catheterisation as nursing staff are resistant to catheter removal requests.

> "The nurses don't always want it out as it is easier to monitor urine using a catheter as otherwise, they have to escort a patient to the toilet and measure which is challenging if they are short staffed." **IC AMU DOCTOR**

It is notable that although there were differing views amongst nurses as to whether IUC were an easier option, many nursing staff did acknowledge the role their workload can play in IUC decisions.

> "Catheters are easier as its just on the edge of the bed so you can look at it whereas otherwise you have to roll the patient to check their pad which is more time consuming." **IC MOP STAFF NURSE**

Monitoring urine output using non-invasive monitoring was described as more time consuming compared to using a catheter. Ease of nursing care appeared to influence decisions to insert an IUC, particular in fast paced environments such as AMU.

> "I was going to say is it easier, like sometimes I think it almost feels like it's easier having a catheter to get the data of, yeah, they've passed as much urine whereas actually we should be promoting collecting in other methods…. once a catheter's in it's really easy to see how much they're passing whereas I guess if you're under time pressures like it's a lot quicker just to open a urometer every hour thinking, okay, they've passed 50mls, great, I'll document that whereas like if someone says, 'Oh I'm going to the toilet', you know, you'll walk to the sluice you'll get a pan, you'll walk back, you'll walk the patient to the toilet and you sit them on it, you take them back to the bed, you'll collect the urine, you'll take it back, you'll measure it, like it's a lot more time consuming so I think if there's time pressures that might factor into the stress of like oh why have they not got a catheter? So, that's time saving." **SS AMU ADVANCED NURSE PRACTITIONER**

The impact of staff availability and workload was witnessed during observations of practice in AMU. Repeated requests by a patient to use the commode resulted in the nurse deciding to insert a catheter.

> "I'm going to put a catheter in now and you're going to be a lot more comfortable…we don't want to wear you out… it's going to be in quicker than it's going to take us to get a commode." **FIELD WORK AMU STAFF NURSE**

The nurse reported to the researcher that that the catheter was inserted as a comfort measure as the patient was short of breath and frequently needed the toilet. However, it was questionable whether patient comfort or convenience of care was the driving motivator. The ability to be able to monitor urine output was reported by the nurse to be a "nice bonus".

The justifications provided by clinicians to insert an IUC for urine output monitoring often included an explanation of how an IUC would make the patient's situation easier and more comfortable. Clinicians expressed the view that for patients on diuretics it was kinder to insert a catheter.

> "I mean although we like to see how much urine primarily in heart failure for me as a clinician, I put catheters in or discuss with a patient whether they'd like a catheter in heart failure, if they find it like difficult to get to the toilet because obviously it will make them pee buckets while they're in." **SS MOP CONSULTANT**

> "A catheter is nicer for the patient when they are having furosemide otherwise, they are on the commode or bedpan every half an hour." **IC AMU STAFF NURSE**

Informal conversations with patients recruited for medical document analysis revealed how catheters were also viewed as convenient by patients whilst in hospital across both care environments. The main driver for this appeared to be concern with 'bothering' the nurses.

> "It's easier to have a catheter whilst in hospital as you don't have to keep asking the nurses to help you go to the toilet." **IC MOP PATIENT**

> " I don't mind catheters. I've had urine output monitored before using bottles and a catheter. Catheters are no problem. It means I don't have to walk to the toilet and find it full or keep trying to pull curtains around when fluids are connected pulling. Plus, you don't have to keep bothering the nurses for more bottles." **IC AMU PATIENT**

Although there was a common view between clinicians that IUC provided comfort, there were differing views amongst patients. Some patient's commented on painful insertion but described the benefits of not having to worry about going to the toilet.

> "It's a horrible experience going in but I've had one once before 4 years ago. It's okay, when I want to go to the toilet, I just have to remember to take the bag with me. When you have fluids and a catheter you can feel tied to the bed but it saves the trouble of weeing. I was in and out of bed at night a hundred times**." IC AMU PATIENT**

> "I nearly died, I screamed my head off when it was going in and I was so ashamed. Oh, it was terrible…. But it saved me from going to the toilet and it was alright once it was in no trouble at all but you have to be a little bit careful when your moving." **IC MOP PATIENT**

Whereas, other patients reported ongoing discomfort from having an indwelling urinary catheter and expressed their preference would be to use non-invasive collection methods.

> "I can't remember it going in but it's sore and uncomfortable. I've had one before when I was in a coma. They said this time it was put in to monitor my urine but I'd prefer not to have one and use the commode or go to the toilet." **IC AMU PATIENT**

In the above case, the patient requested to have the catheter removed on day three of admission. Interestingly, no urine output measurements had been recorded by nursing staff on this day however it had been documented that the catheter was removed at the request of the patient. The entry appeared to be written to justify the action of removing the catheter, emphasing how nursing staff believe they are providing the "correct" care by catheterising patients for output monitoring.

The quote below highlights the lived experience of patients feeling 'locked to their bed'. This has implications for not only patient well-being in hospital but also possible complications to occur due to restricted mobility.

> " It's uncomfortable. It felt as though you were locked to your bed. You couldn't go any further." **IC MOP PATIENT**

These patient experiences emphasis the need to take into consideration patient's preferences regarding urine output monitoring and for healthcare professionals not to make assumptions about patients' views. Interestingly, risks of catheterisation such as

infection or trauma did not appear to be discussed with patients. However, if a patient objected to catheterisation, nursing staff reported having conversations about the risks of not having an IUC placed.

> "she was reluctant at first to have the catheter, but I think once it was explained that she was quite poorly and needed it, she was on board with having it done." **SS AMU STAFF NURSE**

This likely reflects the shared view amongst clinicians, that reduced urine output is more of a risk to patient safety than complications associated with catheters. It appears when a patient's preference is to not have a catheter inserted, efforts are made by healthcare professionals to influence patients into agreeing. It is questionable whether shared decision-making takes place and to what extent care is being 'done to the patient' rather than negotiated.

Urometers: a cue to monitor

Clinicians frequently described how one of the benefits of using a catheter with attached urine meter (urometer) is the visual aid they provide, which is used as an environmental cue by healthcare professionals to alert them to urine output monitoring requirements. These quotes provide examples of how urometers can influence care.

> "If somebody's got a Urometer on I think it's a Belisha beacon to, 'Oh right, okay, we have to monitor that'. If they've got a straightforward urine bag, people don't think about that in the same way." **SS CLINICAL PRACTICE EDUCATOR**

> "Well, I prefer the catheter just from a clinical perspective, not from the patient's because it's uncomfortable and I understand that, but it's easier and it's more accurate, and everyone can see the urometer on the side of the bed. They know that it needs to be monitored." **SS AMU STAFF NURSE**

> "Urometers are really good because they're a good visual aid…I'm quite a visual person so if I see someone with a urometer I'm like, okay, they should be having hourly urine outputs." **SS AMU ADVANCED NURSE PRACTITIONER**

Healthcare assistants frequently reported one of the reasons using non-invasive collection methods are unsuccessful is because staff do not always know if that particular patient using a pulp bottle/bedpan/commode requires monitoring. This implies than an issue to do with communication between healthcare staff places the patient at increased risk of avoidable harm. Organisational change from paper fluid balance charts to electronic monitoring has also contributed to the problem. Clinicians reported that green paper fluid balance charts hung on a clipboard at the end of bed previously alerted staff to this requirement. Without an environmental cue, healthcare assistants found it difficult to differentiate which patients who were using non-invasive collection methods needed monitoring.

"One advantage is that people can physically see that that needs to be measured, whereas the pads sometimes maybe the HCA hasn't been told, whereas if you see a catheter you know that that has to be measured and jotted down." **SS AMU HEALTHCARE ASSISTANT**

It appears that in acute medical environments within the study hospital, a culture has developed where clinicians now associate a catheter and a urometer with fluid balance monitoring requirements. This potentially could have a detrimental impact of attempts to implement non-invasive monitoring, as culturally clinicians no longer recognise them as viable collection methods.

"It's more obvious when someone's got a catheter in to the nursing staff that we might want to be monitoring their urine output as well." **SS AMU SENIOR HOUSE OFFICER**

"The other area was like 'yeah, the night nurses probably won't do the urine output unless they've got a catheter, so we will catheterise them'." **SS AKI NURSE PRACTITIONER**

A semi-structured interview with a senior healthcare assistant in AMU revealed they were unaware of the concept of weighing incontinence pads to monitor urine output.

"Oh my goodness because I suppose what you could do is you could measure a pad that isn't wet to a pad that is wet then work out the difference between the pad that's dry to the pad that's wet and that can give an indication to the amount

of urine on that wet pad, I didn't think about that… It's not something that I have ever seen." **SS AMU SENIOR HEALTHCARE ASSISTANT**

Similarly, a discussion with a consultant physician revealed they were unaware of measuring techniques to monitor urine output and viewed catheterisation with attached urometer as the only accurate option.

" I think catheters and urometers are the main sort of more accurate ways. The sort of commode or other means are just to ensure that they are passing urine, you know, plain and simple. I don't think we can sort of infer much from that…I think commode and bottles are just for that really; are they passing urine? It's for convenience. You know, you lift them up, "Oh, there's a bit of urine there, that's good, that's satisfying." But I think if you want to get any kind of assessment of urine output, then a urometer is essential**." SS MOP CONSULTANT**

Distrust

Field work and interviews revealed distrust in urine output monitoring was common amongst healthcare professionals. Drivers of distrust included clinicians not trusting their colleagues to do the work and non-invasive methods themselves.

Distrust in People

Although many clinicians displayed faith in catheters to provide accuracy, other healthcare professionals showed scepticism in this viewpoint. Physicians in AMU expressed how both invasive and non-invasive methods are only as accurate as the person implementing the monitoring.

"I think all the methods, you know, anything we use unless it's as good as, you know, the people who do it really." **SS AMU SENIOR HOUSE OFFICER**

"I think the most important thing is the accuracy with which they're all used. Even if someone's got a catheter in, if the numbers aren't being recorded accurately, you still don't necessarily know what their fluid balance is, so you can put a catheter in but unless it's being regularly reviewed and the output is being

documented then it's no more helpful than using a bottle or any other method." **SS AMU CONSULTANT**

Similarly, a registrar in MOP highlighted how if a nurse is committed to monitoring, they will be able to be accurate whichever approach they take.

> "Well, they are not accurate. They won't be as accurate as the catheter. However, I think it depends really on the, you know, whatever the nurse is like. So, if the nurse is really devoted to it and she will be able to monitor it even without the catheter, whereas if they're not, you know, if we're not insisting or the nurses are busy or whatever, then they won't be even monitoring well with the catheter." **SS MOP REGISTRAR**

Interestingly, a nurse practitioner expressed how decisions to catheterise a patient for urine output monitoring can be influenced by doctors not trusting nurses to monitor appropriately using other methods. The view that there is not necessarily a problem with the non-invasive methodology but a distrust of colleagues is a striking observation.

> "The other area was like 'yeah, the night nurses probably won't do the urine output unless they've got a catheter, so we will catheterise them' so it is a distrust in the non-invasive … it's not necessarily the non-invasive methods, it's the people that are doing the work….I think there is a lot of trust that would need to be gained for doctors to feel confident that the fluid balance charts were completely accurate." **SS AKI NURSE PRACTITIONER**

High levels of distrust may undermine efforts to implement non-invasive monitoring and consequences of inadequate recording not only impacts on patient safety but also on clinicians' distrust which has implications for IUC use.

> "I've been and seen patients where they've said 'we're not going to catheterise them because they are elderly and frail and they don't want one' and I've gone 'that's fine' and I've gone back the next day and there's nothing on their fluid balance chart and in a 24-hour period it doesn't look like they've peed at all and on a bladder scan they've got nothing in their bladder and they are like 'we don't know whether they peed or not' and actually we are going to have to catheterise

them and that's really bad and I don't really want that to be the case." **SS AKI NURSE PRACTITIONER**

Distrust in Non-invasive Collection Methods

Distrust was found to be mediating factor that may drive down the willingness of clinicians to use non-invasive collection methods. Clinicians appeared most concerned regarding the accuracy of incontinence pad weighing and bed pans compared to other collection methods.

> "I would say probably weighing the pads is probably not accurate, because you've got the pad and you don't actually know how much the pad actually weighs, then there's that with the urine on top. I don't know if it's actually accurate…" **SS MOP HEALTHCARE ASSISTANT**

Nursing staff in both clinical areas described difficulties in using bed pans to accurately monitor urine output due to leakage of urine. An example of a nurse's experience is shown below.

> "Well, if they use a commode it is okay because we can take that and just weigh it on the scales that we have got. But I think bed pans, because they are quite flat, and if we pop under the patient, the patients don't like it to start with because it feels uncomfortable and is just strange, but if for a reason that patient cannot get out of bed, we need to use them, and then because they are like paper, once the patient rolls on his back it just destroys them completely, and they will just leak everywhere." **SS MOP STAFF NURSE**

Distrust in non-invasive collection methods was widespread within MOP which both staff nurses and the area matron reporting not to trust alternatives to catheters.

> "I think any method that doesn't involve a catheter is always going to be tricky if you're looking for amounts because of the fact that people are so different and you never really have that 100% assurance that someone hasn't missed a bottle or missed a pad or something has gone wrong." **SS MOP MATRON**

> "Some patients need urine output strict monitoring, but then they won't have a catheter. And it's, like, it's very difficult. You have to weigh the pads and things, or if the bed's wet, how is that accurate, so I think… If they need a strict urine output, they need to have a catheter really." **SS MOP STAFF NURSE**

8.16 Section Summary

This section has presented the findings of factors that influence a clinician's decision to insert a catheter for urine output monitoring. It would seem that clinical reasoning when making the decision to place an IUC for urine output monitoring varied widely. There were both clinical and non-clinical rationales for inserting a catheter to monitor urine output. Clinical rationales included being able to take hourly urine output measurements; this made it easier for staff to adhere to 0.5ml/kg/hr output target that is commonly used as a therapeutic goal. For patients who were very sick, catheters were seen as practical but also proactive allowing staff to make timely assessments. Accuracy was seen as being important to clinicians, however, alongside these clinical rationales there were also non-clinical rationales.

Catheters were used to mitigate the risk of inaccurate charting. Clinicians reported feeling reassured by hourly measurements but questioned whether they were actually used for frequent decision-making. It was reported that catheter insertion was often a reflex decision when a patient had sepsis, which was driven by protocols such as sepsis six rather than a considered decision as to if hourly measurements were actually required. Urometers were viewed as valuable tools to prompt staff to monitor urine output and were described as important visual aids that increased the chance that urine would be measurement reliably. Clinicians appeared to distrust non-invasive collection methods and staff using them.

These findings address significant gaps in the current literature and provide insight into the phenomenon of urine output monitoring. The next section will discuss findings that contribute to inaccurate urine output monitoring, providing evidence of the wider context.

8.17 Factors contributing to inaccurate urine output monitoring in two acute medical environments

The previous section provided insight into factors influencing clinicians to insert an IUC for urine output monitoring. Non-invasive alternatives such as pad weighing for incontinent patients or measuring urine from a bottle or bed pan, were not considered to be accurate or timely enough for most clinicians. However, qualitative findings in the first phase of this study revealed that even when an IUC is placed to monitor the hourly output of urine, measurements are often not recorded. It is evident that both invasive and non-invasive urine output monitoring methods require improvement. In order to reduce clinicians' reliance on IUC for output monitoring and improve the quality of fluid balance charts, it is important to understand factors which contribute to inaccurate urine measurements. These findings illustrate the complexity of urine output monitoring and highlight the multiple influences that contribute to inaccurate charting in the study site hospital.

Main themes	Sub-themes
Distributed Responsibility	• Role differentiation • The problem of many hands
Ineffective Communication	• Missed opportunities • Uncertainty • Ambiguous abbreviations
Organisational Factors	• Workload pressures • Organisational change

Practicalities	• Individual patient factors • Incontinence pad efficacy
Delays in Catheter Removal	• Lack of stop criteria for urine output monitoring • Change of indication • Lack of nurse empowerment

8.18 Distributed Responsibility

Role Differentiation

Findings from this study revealed a contributing factor to inaccurate urine output monitoring was distributed responsibility. Although nurses as a staff group acknowledged a sense of responsibility for ensuring accurate documentation of urine output, in practice the responsibility was distributed between the nurses and healthcare assistants and individuals appeared to not take full ownership in ensuring the job was completed.

> "I'd say it's my responsibility, yeah, I mean you would maybe work with the healthcare assistant, they'd help you and they'd let you know how much… they might have got rid of the bottle and you ask them to measure it but I'd always kind of be the one putting it in the iPad and making sure it's been filled in." **SS AMU STAFF NURSE1**

> " I think healthcare assistants should take equal responsibility, well, not equal responsibility, but they should be doing it alongside. But I don't think a lot of HCA here do, maybe because they don't have the knowledge on what they should be doing." **SS AMU STAFF NURSE3**

Interchangeable roles can be beneficial to help ease workload as long as there is accountability for task completion. Although registered nurses were accountable for their decisions to delegate tasks, it appeared in regards to urine output monitoring, role

boundaries were often blurred and duties delegated to other people were not always completed.

> "We are horrendous at filling them in, 90% of them I would say are not filled in, often the HCA and that will leave it to the trained nurses to do." **SS MOP SISTER**

> "Some are really good and will ask you who needs to be monitored and who needs to be measured etc., but a lot of them don't. Yeah, I think that's something we need to be improving on, because a lot of the time it's the healthcare assistants that will go and put that patient onto the commode or be emptying the catheter." **SS AMU STAFF NURSE3**

> " I think sometimes we rely on the nurses too much to do it and vice versa, they think we are doing it so it gets missed." **IC AMU HEALTHCARE ASSISTANT**

Healthcare assistants in particular were uncertain of their job role with regards to urine output monitoring with some having a sense of responsibility for this and others not.

> "So, it's during handover if we get told. But for me, I haven't really been doing it as much. If I'm told specifically by a nurse or if I've handed over then, okay, I'll try my best and I'll do it whenever I go, but if I'm not told then we won't do it. I think that's one thing I'm struggling with is we sometimes do miss patients when they're supposed to be on fluid balances because we find it hard to differentiate, well I do anyway, I don't know whether it's my role if I'm supposed to be doing it or if the nurses are supposed to be doing it. I know it's both our roles but because why I haven't been doing it, I just assume that the nurses are." **SS AMU HEALTHCARE ASSISTANT**

> "Well, I would say it is our role as well. Nurses do it too, but it's part of our role because we're the ones that are more frequently having to change the patients, but the nurses I would say too because they're the ones that usually come, and they sometimes come to us and say, 'Can you go and measure please and let us know how much it is?'." **SS AMU HEALTHCARE ASSISTANT**

In day to day practice this led to staff often assuming that others were responsible for taking action, or had already done so. When charts were incorrectly completed there appeared to be a lack of accountability for this. Fieldwork revealed healthcare assistants

often felt overwhelmed by 'trying to do everything' and many expressed uncertainties around the limits of their responsibilities.

> "We had another patient today who is actually hourly monitored, but I think because it's an hourly thing I think the nurse is doing that herself." **SS AMU HEALTHCARE ASSISTANT3**

> "I found that it's not my responsibility to do that, but if a nurse comes up and says, 'We're monitoring urine output', oh, you can also weigh pads and stuff." **SS AMU HEALTHCARE ASSISTANT**

Disparity regarding responsibility for review and escalation was also viewed amongst the medical team with one consultant acknowledging patients unwell enough to require hourly urine output monitoring should be under regular medical review, whereas another consultant identified nursing staff as being responsible for escalation.

> "somebody goes back four hours later and actually there's no urine output recorded then that's the time to have a conversation with the nurse about, well, does this mean that they haven't peed or have you just not managed to measure it? Whereas if that process happens over 12 to 16 hours you probably weren't that bothered to have the hourly urine output in the first place because I think anybody who is having hourly urine outputs should be pretty unwell and they should be seen regularly by somebody on the medical team." **SS AMU CONSULTANT**

> "We're effectively relying on the nursing staff to tell us and flag this up to us if they became oliguric. So, it's kind of based on if we're seeing the patient or if the nursing staff are flagging it up to us but we don't routinely go around and ask everyone if they're sort of passing urine so you have to work closely with others." **SS AMU CONSULTANT**

The Problem of Many Hands

The proverb 'many hands make light work' can be used to describe a difficult task which becomes easier if enough people help complete it. However, findings from this study revealed problems from many hands that can arise from multiple staff attempting to complete the same task.

> "…also, with catheters, you don't know who's opened the port, do you know what I mean, so it's just like… People do try and help, which is great, but I think if one person just sticks to that task, it's much easier." **SS MOP STAFF NURSE7**

Nursing staff reported incidences where multiple colleagues monitoring a patient's urine output can lead to inaccuracies. Role blurring of this nature can often lead to confusion if communication between members of the team are ineffective. Examples of the problems caused by the help of many hands are given below.

> "It can be hard to get to the patient every hour to monitor hourly output when you are busy this is difficult to achieve…in one way it is good if people help you but then you are not sure if someone has emptied the chamber and just not recorded it and then you don't know if that is the actual output." **IC AMU STAFF NURSE**

> "If the patient's using a bottle or a commode and all of us can be very busy and one person may take the commode to the patient but that might not be the same person that gets them off." **SS AMU STAFF NURSE2**

> "Physios are actually quite good at doing it as well because they mobilise the patient quite a lot and if they've got a catheter in it's a lot easier just to empty it before they start mobilisation but I guess often they take them up to the toilet and it's often us sort of like running after them saying oh, you know, urine output can you do it rather than them coming to us and checking before they do it." **SS AMU ADVANCED NURSE PRACTITIONER**

8.19 Ineffective Communication

Ineffective communication was highlighted by clinicians as a reason urine output monitoring was often missed. Healthcare assistants reported they were frequently unaware that a patient required monitoring and therefore the opportunities to record urine output were often missed, reducing accuracy and trust in using non-invasive collection methods.

Missed Opportunities

Missed opportunities to monitor urine output were frequent across both clinical environments. Communication failures occurred from missed information during clinical handovers but also due to the changing and unpredictable nature of urine output monitoring requirements. Urine output monitoring is not static, a requirement to monitor a patient's urine output may fluctuate within a shift and this information was not always communicated to all the relevant individuals within the team.

> "there's been times where I've worked and I've changed someone's pad, chucked it away, and then the nurse has said to me, 'What was the?' and I've said, 'Oh, no one's told me to measure it, no one's told me that their pad needs to be measured'…That's happened many times where we don't know it's supposed to be measured." **SS AMU HEALTHCARE ASSISTANT**

> "If people don't have a catheter, staff aren't always aware the patient is on fluid balance monitoring and the bedpan or bottle can be taken away without being measured. Handovers should include if patient is on a fluid balance chart but this can sometimes be missed." **IC AMU STAFF NURSE**

Nursing colleagues reported a high cognitive workload whilst working within a highly pressured environment, this appeared to affect clinicians' cognitive capacity to undertake their work and often the requirement to monitor a patient's urine output was forgotten.

> "like if you're doing it with a commode, sometimes you forget that you need to weigh it and you chuck it out, cos I've done that before... Sometimes you don't always remember, you just take it, put it in and that's it." **SS AMU HEALTHCARE ASSISTANT**

In AMU, effective communication was particularly challenging due to a number of interrelated dynamics. Nursing staff involved in providing care for patients were often dispersed across the large unit, creating spatial gaps and limited opportunities for regular interactions and sharing of information. Nursing staff acknowledged this communication failure and described work arounds such as writing "measure" on the pulp urine bottles to inform colleagues of monitoring requirements.

> "If a doctor requests a catheter, I will always try use a bottle first. I always write measure on the bottle so if an HCA collects it, they hopefully will measure it. HCA's don't always measure it sometimes they just chuck it away as they don't know." **IC AMU STAFF NURSE**

Medical staff also acknowledged there were multiple points for insufficient communication to occur. Medical document analysis identified repeated written medical requests for a patient to receive urine output monitoring in MOP however this was not implemented by nursing staff. It was unclear why this failure occurred; however, it is likely to be due to a combination of factors described in this chapter.

> "So, there's a number of kind of points of failure in that process so I can think to myself it would be good to have this urine output monitored, I don't mention it to anybody, it doesn't happen. I could think to myself it would be good to have urine output measured and I'll say to the nurse, 'Can you measure the urine output?' and they won't know how often I want it measured. I can say to them, 'Can you measure their urine output hourly?' but I haven't told them what to do if it's low, so there's lots of different steps in that kind of process and that's probably why it doesn't always work terribly well." **SS AMU CONSULTANT**

> "I mean generally speaking it's done by the nursing staff so the nursing staff need to be aware that you actually want the urine output monitoring first instance, also the patient needs to know particularly if a patient's up and about and can go to the toilet if they don't know that they're having their urine output monitored they have a tendency to just go and wee and then you never know." **SS MOP CONSULTANT**

Uncertainty

Nursing staff reported a lack of differentiation between pulp urine bottles/ commode liners for patients requiring urine output monitoring and those using them for convenience increased confusion. In environments were verbal communication was limited, nursing staff relied upon visual cues to direct their work.

> "Yeah, with the catheters, they all know that they must write it down, but if it's just a male using a bottle, it's a grey area, "Do I need to document? Do I not do it?" And it's not always weighed; they just throw it away, because a lot of patients do use bottles that don't need monitoring." **SS AMU STAFF NURSE**

> "if a patient has urinated in a bottle and they've just got it and emptied it without realising it needs to be…because we don't measure everyone's." **SS AMU STAFF NURSE**

Inadequate documentation on fluid balance charts also caused uncertainty. Clinicians often reported they could not decipher whether a patient had not passed urine or whether it had not been documented. The trust AKI lead nurse highlighted how communication could be improved by recording zeros on fluid balance charts for hours when urine is not passed.

> "A blank fluid balance chart, a blank urine output over 24 hours, means 'I didn't do it or the patient didn't pee' but you don't know which, whereas a zero clearly means they didn't pee." **SS AKI NURSE PRACTITIONER**

> "And it'll go back to you don't know what you don't know. You may never know that it's been missed; you might think, "Oh, only two bottles today; that's a bit strange because I normally have three". So, unless you're lucky enough that the patient says, "No, I've given three bottles", and you know there are only two then you've found one was missed but you still don't know whether it was a 100 mill pee or a 500 mill pee so then that day is essentially wiped because you're then doing best-guess; if you're going to do best-guess you might as well just use the hydration chart and say they went to the toilet three times." **SS MOP MATRON**

Ambiguous Abbreviations

Point prevalence survey results from Phase One of this research project revealed only 39% of patients with an intention to employ non-invasive monitoring of urine had numerical urine output measurements recorded. Use of abbreviations such as “wet” and “OTT” (out to toilet) were found to be recorded in place of an estimated volume. Clinicians during the qualitative phase of this study acknowledged these abbreviations are often used and expressed how they can be ambiguous and decrease accuracy.

> “Yeah, so say wet pads might just go down as wet and that’s really difficult to distinguish…When it’s not done and people have put wet or passed urine you don’t know how much that is so you’re guessing” **SS CRITICAL CARE OUTREACH ADVANCE NURSE PRACTITIONER**

> “We don’t sort of estimate how much it is but I remember on the fluid balance chart sometimes so I would put… wet bed or wet pads plus plus (++) and then they’d put plus signs at the end so some of them would put plus plus plus (+++) which indicate very wet pads, not so much wet sheet but just mainly wet pad.” **SS AMU HEALTHCARE ASSISTANT**

During field work a physician discussed their reasoning for inserting a catheter and reported one of the benefits would be you avoid seeing wet bed on fluid balance charts. This highlights how ambiguous recording is possibly increasing IUC reliance.

> “Catheterising the patient will also avoid seeing wet bed plus (+) or plus plus (++) on the fluid balance chart… I don’t know the difference between one plus (+) and two plus (++).” **IC AMU DOCTOR**

Additionally, using abbreviations can also pose a risk to patient care when they have more than one meaning or when they can be misread or interpreted differently. An interview with a consultant revealed their understanding of ‘OTT’ was to mean ‘over the top’ implying a patient has passed large quantities of urine. Nursing staff however record ‘OTT’ when a patient has gone ‘out to the toilet’ and urine quantity is unknown.

> “OTT, over the top, you know, okay, so they’ve peed something probably quite a lot unless we’ve got a very small liner but, you know, so you’ll see that written on fluid charts certainly I’ve seen that, OTT, over the top.” **SS AMU CONSULTANT**

Introduction of hydration charts and electronic fluid balance recording was hoped to eliminate ambiguity.

> "they've brought in a hydration chart so that they can monitor frequency without actually worrying about the exact amount; so I think that was brought in to combat the fact that on the fluid charts there was a lot of, "Wet plus plus; out to toilet; wet plus plus", which doesn't really tell you anything." **SS MOP MATRON**

8.20 Organisational factors

Workload Pressures

Both observations and interviews provided evidence that nursing staff prioritise some tasks more so than others. The overarching routine that appeared to take priority over most nursing work in AMU was the admission and discharge of patients. It was evident in the data that patient flow was one of the main concerns for the hospital and one that was scrutinised regularly. The tasks that dominated nursing staff in both areas included the repositioning of patients, documentation, medication and the recording of vital signs.

> "I think if you're busy and don't have many staff around that's really hard and challenging to… you know, if you've got four unwell patients and they all need urine outputs but two of them have a catheter in two of them are going out to the toilet that's quite a lot of… like it's quite time consuming." **SS AMU ADVANCED NURSE PRACTITIONER**

There was overall agreement between nurses that they are often too busy to provide the level of care for patients that they would like. Nurses expressed that nursing capacity was not always optimally matched to the needs of patients and workload related to urine output monitoring was sometimes unmanageable.

> "I just think you just need to be on the ball. I know it's so difficult in this sort of environment when you have, like, 12 patients to look after and everything to do for them, it's very difficult, but you just need to make it one of your priorities. I think it's hard to put it in every hour but I think usually what I do, I write it on a bit of paper and then when I get a chance, I'll put it all in." **SS MOP STAFF NURSE**

Nurses appeared to organise their work in response to these pressures by focusing on nursing routines such as doing the medication or observation round. When competing priorities would interrupt this routine, nurses would respond to the most urgent task at hand. Task orientated working was viewed as the most efficient to get the job finished however it is unclear whether this way of working affects nurses' ability to provide person centred care.

Organisational Change

It is clear that advances in technology can benefit healthcare providers by supporting clinicians with their daily work, however developments should seek to fit in with working practice rather than hinder it. Unlike NEWS2, there is no national standard for fluid management and fluid balance. Urine output monitoring practice therefore varies amongst organisations, with some hospitals using paper fluid balance charts and others opting for electronic recording.

In between Phase One and Phase Two of this research project, the study site hospital introduced electronic fluid balance recording. The change aimed to increase accuracy of balance at all times of the day (the computer would auto calculate) and improve visibility of charts. It was also hoped that electronic recording would improve ease of recording or at least would be no harder that using paper. However, staff frequently reported difficulties with using the electronic recording system. One limitation highlighted was the time required to input or amend entries. Although, ideally measurements should be recorded in real time, clinicians would regularly need to input a recording hours after, which was time consuming using the current system.

> "I think one of the barriers to recording urine output is classically - especially if patients aren't catheterised - they … people take a bottle away from a patient, say, and then write on their handover sheet and they go to add it to the electronic system and you have to scroll back five hours and it takes something like 24 clicks to get to put the urine output in and therefore you lose the will to live when you have to do that for five patients or six patients." **SS AKI NURSE PRACTITIONER**

A further issue, not anticipated prior to the electronic roll out was the visual aid paper fluid balance charts provided to clinicians. As discussed in the previous chapter, staff reported that the green paper fluid balance charts hung on a clipboard at the end of bed previously alerted staff to fluid balance requirement. Without an environmental cue staff found it difficult to differentiate which patients who were using non-invasive collection methods needed monitoring.

> "I prefer the paper charts because you can see, it's in the folder, I look through in the mornings just to check my patients. I can see it's green, it's easy to tell, I know that they're on it, so then I will take a mental note, write it down, and try and tell the healthcare assistants as well." **SS AMU STAFF NURSE**

> "Because we no longer have that visual fluid chart that is in front of you that's a paper piece and a lot of the time people don't have an iPad with them, it's charging, and it just doesn't get done, I think we're horrendous at doing it." **SS MOP SISTER**

Both medical and nursing staff encountered technical difficulties when trying to use electronic fluid balance recording. Various problems such as device availability, login/access issues, connectivity faults and the device taking too much time to load information impacted on staff's ability to accurately record output. Manging this process resulted in time taken away from other clinical tasks and increased staff frustration.

> "I think it was easier when it was paper charts and the nursing staff could just look at the catheter for example or when the patient passed urine, just write it down straight away. I think it's a bit more difficult when you've got to then find an iPad or to log in to record it" **SS SENIOR HOUSE OFFICER AMU**

> "Monitoring is inaccurate because staff don't have time to log in every time every patient passes urine, you are always interrupted and called away and then it is forgotten**." IC AMU STAFF NURSE**

> "It is so much easier to just write outputs down on paper instead of having to find an iPad that is charged and log into it every hour" **IC STAFF NURSE AMU**

8.21 Practicalities

A variety of practical problems appeared to contribute to clinicians' ability to accurately record urine output. Individual patient factors such as co-operation, incontinence and confusion were reported to impact on the success of implementing non-invasive collection methods. Other practicalities such as urine often being mixed with stool and incontinence pad efficacy were reported to reduce accuracy. Often these practicalities were out of a nurse's control, therefore inaccuracy was sometimes unavoidable.

Individual Patient Factors:

Cooperation

Using non-invasive collection methods to monitor urine output often requires cooperation from the patient. Both nursing and medical staff reported independent patients often forget that their urine output needs monitoring, impacting on accuracy.

> "I think ambulant patients peeing into bottles is just fraught with, 'Oh I forgot to pee into the bottle, I've peed into the toilet, shall we just say it was 300mls', you know, that kind of thing." **SS AMU CONSULTANT**

> "It's harder to monitor urine output without a catheter as patients forget and just go to the toilet even though you ask them to monitor." **IC AMU STAFF NURSE**

> "If a patient doesn't use commodes or bottles and they are independent and they go to the toilet, that's when you can always miss as well, because we do give them pans to put in the toilet to urinate in, but patients don't always do that so they may go to the toilet and you haven't seen that they've gone to the toilet, they've come back, you don't know they've been and they've urinated and you don't have a clue how much it has been." **SS AMU STAFF NURSE**

Confusion

Patients with dementia or cognitive impairment are often at the highest risk of dehydration therefore making these patients most vulnerable. However, clinicians

frequently reported difficulty in accurately recording urine output for confused patients using non-invasive methods.

> "Monitoring urine output is harder when a patient is confused or incontinent as it makes it more difficult to be accurate." **IC AMU STAFF NURSE**

> "Patients who are peeing into bottles obviously it depends on the co-operation of the patients, it's easier for them, easier for the patient if they're young, co-operative, they can pee into bottles, if it's an elderly confused patient then obviously it might be difficult in which case we will have to adopt another method." **SS AMU CONSULTANT**

Incontinence

Incontinence was also highlighted as a barrier to urine output monitoring accuracy by nursing staff.

> "They may be incontinent and then they'll pull the pads out because they're uncomfortable but they won't call the nurse and then you'll find them and the pads come out and then they've been wet on the bed, you know? You get those that are trying to use the commode but often with the ladies they're weeing before they get there so then it's on the floor and down their legs so you're not fully getting the measurements." **SS MOP SISTER**

> "I mean if men are cognitively good and have the dexterity to be able to use a bottle, I would say that is acceptable in a lot of situations, to be able to weigh that to monitor their urine output…It's harder for ladies. If they're up, if they're mobile and they can pee into a collection pot in the toilet, that's okay. But our patients, as their continence isn't as good sometimes as some of the younger patients, it's quite challenging." **SS MOP CONSULTANT**

Incontinence Pad Efficacy

Concerns regarding incontinence pad efficacy were also raised. The effectiveness of pads to manage urinary incontinence and contain urine appeared to influence whether some clinicians believed that a patient needed an IUC for urine output monitoring.

> "You can weigh an incontinence pad but urine often leaks onto the sheets which you can then estimate but that's not accurate." **IC AMU STAFF NURSE**

> "You weigh the pad but of course often patients will particularly at night may overflow the pad so you can't weigh the sheets so then you have to do a rough estimate, everybody's estimation of things like that would be wildly different, you might look at it and say oh they've passed 200mls, I might look at it and think oh they've only passed 50 and actually over a period of time that difference in measurements is very inaccurate." **SS MOP SISTER**

> "They always leak through the sheets, so if they are on urine output and we have to measure it, how much is lost? How much is still there?" **SS MOP HEALTHCARE ASSISTANT**

Pad availability was consistent between clinical areas, with a range of absorbent insert pads and net fixation pants accessible. However, nursing staff reported that net fixation pants were often not used as they marked patient's skin and were viewed as uncomfortable.

> "Non-invasive collection methods are fine as long as when you are using incontinent pads it doesn't go on the sheets. Using pad and pants helps stop that but the net pants can cut in so sometimes you might not put pants on if the patient is in bed. Pull up incontinence pads are lovely and much easier and better than using pads and pants that cut in." **IC MOP STAFF NURSE**

Pull up incontinence pads were voiced by nursing staff as favourable due to increased absorbency and leakage security. However, it was noted these had recently been withdrawn from stock due to cost implications. It is unclear whether pad efficacy relates to the product or how the pads pants are used by staff. Nevertheless, it evident that current practice is in adequate leading to increased nurse workload and discomfort for patients. Without suitable products, it would seem likely that more patients would receive IUC for urine output monitoring.

Urine mixed with stool

All healthcare professionals' in both areas identified urine mixed with stool as problem for utilising non-invasive collection methods for monitoring of urine output. This particular practicality is difficult to overcome, however the recording of mixed urine and stool output appears to be a pragmatic solution.

> "It's a bit more difficult with women and I mean they do sit on the commode but often they'd open their bowel as well and it would cause… it was a palaver." **SS MOP CONSULTANT**

> "They can use a commode where it's collected in a pan, but that's how we usually do it; it's either the bottle or pan, and then we weigh how much urine is passed, but that can always be a bit difficult because if someone's passed faeces as well, weighing it's then not accurate, so it can be a bit difficult that way." **SS AMU STAFF NURSE**

> "And often weighing pads is difficult cos often it's mixed in with faeces, so I guess in my head pads are not an accurate way of measuring urine output." **SS MOP CONSULTANT**

8.22 Delays in Catheter Removal

Lack of Stop Criteria for Urine Output Monitoring

Medical document analysis of recruited patients and field work identified hourly urine output measurements appeared to aid decision-making during the first 24 hours of admission for patients who were cardiovascularly unstable with sepsis and were receiving fluid resuscitation. A lack of criteria or guidance as to when to stop hourly urine output monitoring lead to prolonged catheterisation and less frequent monitoring which appeared to no longer aid therapeutic decisions apart from providing reassurance to the clinicians that urine output was adequate and meeting the minimum target. During observations and informal conversations, nursing staff often reported that they had made no therapeutic decisions from monitoring the urine output however they continued to

monitor due to a medical request or guidelines stating patients with certain conditions require monitoring.

An AKI nurse practitioner highlights how NICE recommendations advise to monitor urine output for patients with an AKI, however the guidance makes no recommendations on when accurate monitoring can cease if a patient appears to be improving.

> "NICE guidance is that if you have an AKI you get a fluid balance chart so NICE doesn't differentiate, unfortunately, so I can't really say that when they're getting better they don't need one; however, there needs to be a bit of clinical judgement because we have patients who go home with AKI stage 2 because they are better than the stage 3 and they are improving so we send them home." **SS AKI NURSE PRACTITIONER**

> "Medical teams will often ask for fluid balance charts, but won't often say that they want them stopped, that they're not required. So, I think that comes into it as well, "Oh, if the consultant's asked for a fluid balance chart then we must do it… I think if there was more guidance for more junior staff to go…to feel like they can be empowered to make those decisions, that would go a long way to improving the quality of our fluid balance charts."" **SS MOP SENIOR SISTER**

Interestingly, consultants in MOP described examples where patients had been catheterised for urine output monitoring and even when urine output was good, the catheter remained in place and the monitoring intervals instead extended.

> "I was on call over the weekend we had a patient with a very low sodium and we needed to know how much they were producing and stuff so he was catheterised to keep any eye on his urine output which was okay, in fact there was another patient in the bed next to him with a similar scenario but he had an acute kidney injury and a pneumonia and he's got a catheter that we were just monitoring his urine output. But actually, over the weekend that I looked after him his urine output was very good and his kidney renal function got better so we extended the time that they didn't have to do it every hour." **SS MOP CONSULTANT**

> "A lot of them, when they come onto the ward and say, "Well, they don't really need a urometer, they're getting better," they'll change them to just a bag until such time we can take it out." **SS MOP CONSULTANT**

In many cases the choice to insert an IUC appeared more straightforward than the decision to remove the catheter which appeared less clear-cut. This illustrates risk aversion and can offer an explanation as to why catheters are left in place longer than clinically necessary.

> "One of the things is that it is easy to catheterise someone and then it's a hard decision to take that catheter out, when do you take it out?" **SS AKI NURSE PRACTIONER**

Change of Indication

It is not uncommon for catheter indications to change from appropriate placement to inappropriate use during an older patient's hospital stay. An understanding of the dynamic change in the appropriateness of urinary catheter use is crucial for further intervention. Findings from this study revealed that IUC inserted initially for urine output monitoring often remain in place due to changes in indication. Indication changes include concerns regarding mobility, avoiding moisture damage and avoiding possible acute urinary retention.

Mobility

Medical teams reported older patients as having poor mobility which would lead to a catheter remaining in place for longer. Interestingly, reduced mobility in itself was not voiced as an appropriate indication to insert a catheter but appeared to be justified as a reason to remain in place. The medical perspective that catheters should remain in place whilst patients' mobility improves is in direct contrast with patient's views, who themselves identified the impact having a catheter has on reducing mobility.

> "So, once the patient is stable from the reason that they were catheterised, then as long as they're mobile then we'll try and get them out quickly so it's probably a few days. It depends if the patient is quite unwell and is - from a mobility point of view

has deteriorated as well then sometimes catheters stay in a little bit longer just because from a practicality point of view." **SS AMU SENIOR HOUSE OFFICER**

"Some who've got severe illnesses, we leave them in for longer while they're recovering from their illness, until such times that their cognition and their mobility is such that we can safely remove the TWOC and they know, cognitively, they have the urge to pass urine, they can us the commode or indeed walk out to the toilet." **SS MOP CONSULTANT**

Avoiding Moisture Damage

Another potential adverse event that some clinicians cited as influencing their decision to keep an IUC in place was to prevent deterioration in skin condition, even when there was no existing damage.

"We do know that there are patients who may actually, for the benefit of their skin if nothing else, benefit for a longer period of time with a catheter rather than having it removed and be at risk of excoriation of their skin because they're not maintaining their urine function adequately." **SS CLINICAL PRACTICE EDUCATOR**

"As soon as possible so when you are confident the infection is under control or the antibiotics have finished, oh and when the patient can comply with going to the toilet independently so to avoid moisture damage." **IC AMU DOCTOR**

This again highlights how clinicians appeared to view urinary catheters as low risk option compared to other threats such as moisture damage or acute kidney injury. Protecting patients from such risks were seen as legitimate indications for a catheter to remain in place.

Avoiding Acute Urinary Retention

Clinicians in MOP anticipated that acute urinary retention (AUR) was likely to occur in many of their patients due to constipation, this appeared to prolong catheterisation. Often a decision was made to leave an IUC in place until a patient has their bowels opened, even when AUR was not the initial indication for IUC.

"It's that remembering that when the patient's better to say to the doctors, right, they need a trial without catheter and then normally what we've got to then do is wait for them to make sure they've had their bowels opened properly so that we don't end up with them going to retention because they're constipated because they're elderly and they're sapped with constipation." **SS MOP SISTER**

"Patients are usually transferred to the wards with the catheter and then you see TWOC when bowels open even if they didn't go in for retention." **IC AMU STAFF NURSE**

Lack of Nurse Empowerment

Nurses appeared to have little autonomy with regards to catheter removal, often nursing work seemed to be governed by others. During the observations and the interviews, it was clear that nurses were often ruled by those in a position of higher authority such as the medical team. Despite the nurses appearing to know what was best for the individual patient, a lack of nurse empowerment to make autonomous decisions was evident. Nursing staff were not often able to make decisions regarding stopping fluid balance monitoring or catheter removal and were normally following orders from others.

"My experience it tends to be more medical, yeah, just in terms of… unless the ward leaders, ward nurses did it themselves based on a very good reason to do it, then they would want to maybe just check with the medical team, "Are you happy that we take it out?" **SS MOP CONSULTANT**

"If you have a switched-on nurse to prompt the doctors, do we still need the catheter and to discuss this with doctors but I wouldn't expect a nurse to remove it without discussing it first." **IC AMU STAFF NURSE**

"I think a lot of nurses probably would just follow it because it's in the plan, but I do question it, just because the doctors have said it in the plan doesn't mean it's necessarily the right thing for that patient at that time." **SS AMU STAFF NURSE**

Senior nursing and medical staff discussed how projects were ongoing to empower nurses to make decisions regarding catheter removal.

"As part of the project I was saying about catheters, we're trying to move to more of a nurse led TWOC protocol so the nursing staff are now leading TWOC so that's our aim so they should be sort of realising or discussing with us and we've said the acute period is over so they can then think about getting that catheter out." **SS MOP CONSULTANT**

However, there was disagreement between senior nursing and medical staff as to who should be responsible for discontinuation of urine output monitoring.

"I would expect the nursing staff to make more of a decision about it if it was a pressure sore, that it would be resolved and they weren't sore, so they were thinking about getting that out and if they were in retention because they were constipated and their bowels had opened, I'd expect them to make that decision. I probably wouldn't expect them to make the decision of when we've decided the acute phase of a kidney injury or heart failure is over, I would make sure I handed that over in person because actually, it's not just one aspect of it, it's how they are clinically unwell, what their bloods are doing and things and that's quite complicated and I think nursing staff would want that reassurance from the clinician involved that they were able to take that catheter out and stop that hourly or twice daily or whatever monitoring**." SS MOP CONSULTANT**

"It should be a nurse's decision because actually it's a nursing piece of documentation and we don't let doctors tell us about any other nursing pieces of documentation, do we?" **SS AKI NURSE PRACTITIONER**

"Certainly, our Band 5, our registered nurse workforce is quite junior, so they might err on the side of caution in keeping the patient on a fluid balance chart…But I think staff always worry about making that decision to stop a fluid balance chart, because they think they'll be doing something wrong and detrimental to the patient, rather than looking at the patient as a whole and holistically." **SS MOP SENIOR SISTER**

8.23 Section Summary

This section has identified a variety of factors that contribute to inaccurate charting in two acute medical environments. The themes described in this section highlight how inaccurate urine output monitoring is multifaceted and achieving accuracy is not always straightforward. The interrelated nature of the factors identified and the findings presented in previous chapters demonstrate the complexity of this phenomenon. These findings reveal that due to a lack of evidence, clinicians are guided by their own beliefs about whether a catheter should be inserted for output monitoring. Often there are combined indications which include both clinical and non-clinical rationales. Projects aiming to improve the quality of urine output monitoring need to be aware of these issues in order to implement mitigating strategies that improve accuracy without increasing reliance on IUC.

8.25 Chapter Summary

This chapter has presented the findings from the analysis of the focused ethnographic phase of this study. The findings described in this chapter highlight the complex nature of urine output monitoring and offer insight into the factors impacting on a clinicians' decisions to insert a catheter to record urine output measurements. It was unequivocal between clinicians that patients with sepsis, AKI and those at high risk of deterioration should have their urine output monitored, however, the method of monitoring and the duration of requirement was less certain and was likely to be influenced by individual preference. This study has revealed how clinicians have multiple perceptions of risk, which can affect care decision-making. This understanding can help generate greater insight into tackling inappropriate catheter use. These findings in combination with the previous quantitative results chapter offer insight into the urine output monitoring phenomenon. The next chapter integrates these findings to develop a conceptual model for urine output monitoring practice in acute medical settings.

Chapter 9 Synthesis of Findings

9.1 Introduction

This mixed methods research study has examined urine output monitoring practices across acute medical environments in one NHS hospital and has explored the key factors that influence how clinicians undertake this element of their work. The study is underpinned by a pragmatic philosophical perspective and follows a sequential explanatory design. This chapter provides a synthesis of the findings from the previous two chapters towards meeting the research aim to explore how and why urine output is monitored and the factors that influence use of IUC for output monitoring. The development of a descriptive conceptual model for urine output monitoring practices was constructed from the findings to offer insight on the aspects of care, which have previously received little attention in the literature. In addition, a prescriptive conceptual framework identifying a possible guide for urine output monitoring processes has been developed.

9.2 The Urine Output Monitoring Continuum

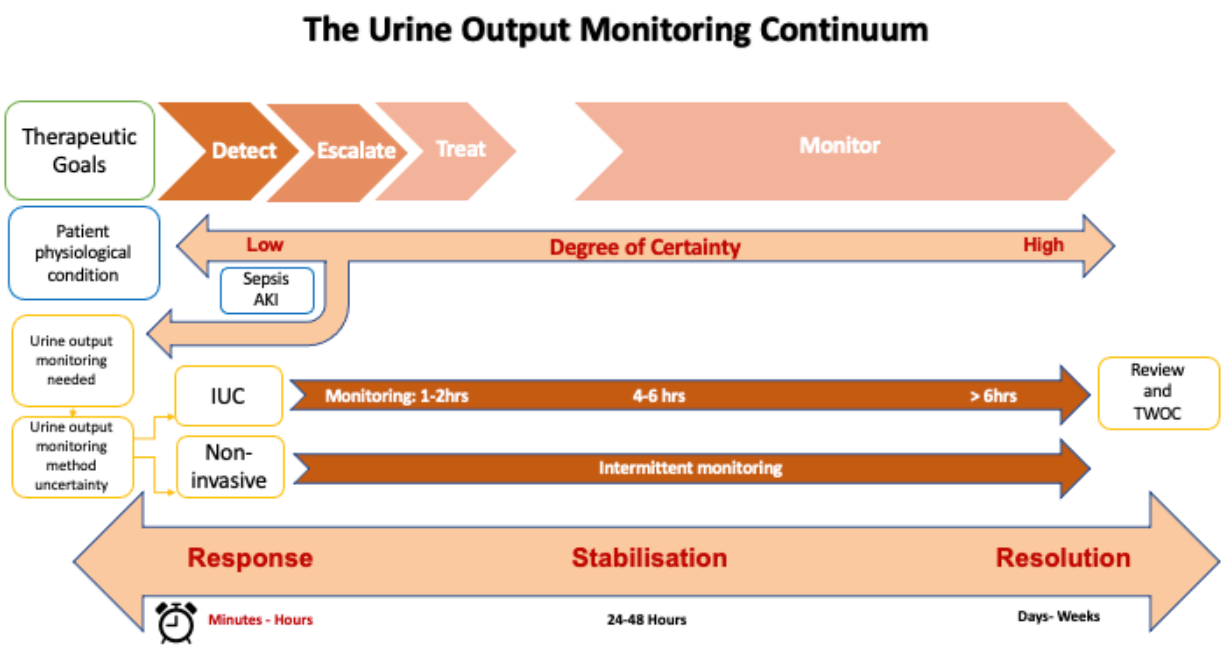
Urine output monitoring practices and the necessity for an IUC in acute medical environments has been poorly explicated both in the literature and in clinical practice. Although guidelines agree on the appropriateness of placing an IUC to monitor hourly urine output in critically ill patients (Loveday et al. 2014, Gould et al. 2009, RCN 2021), major gaps in knowledge exist around how hourly urine output measurements guide therapeutic decisions compared to less regular measurements and for what duration monitoring is required in acute medicine. Knowing when to insert an IUC to monitor urine output compared to using non-invasive methods of monitoring therefore remains a clinical conundrum. Urine output monitoring can play a fundamental role in the management of acutely unwell patients. However, prolonged and inappropriate hourly monitoring requirements can lead to delays in catheter removal, increasing the risk of CAUTI and other complications.

The descriptive conceptual model and prescriptive framework have been developed based on the findings of this study and are intended to contribute to building theory on

urine output monitoring practices in acute medical environments given that this has been lacking to date. These frameworks recognise urine output monitoring practices as a continuum with three distinct phases: Response, Stabilisation and Resolution. Logically, this process occurs over a time course in correlation to a patient's improving clinical condition. However, this is not necessarily linear. Urine output monitoring is dynamic with requirements fluctuating in response to evolving clinical circumstances and the patient's clinical condition, thereby moving back and forth along the continuum. As a patient's clinical condition changes, therapeutic goals may also change, creating uncertainties which require re-assessment. A patient may experience a temporary deterioration necessitating switching from a resolution strategy back to a stabilisation or response phase. The descriptive conceptual model for urine output monitoring practices in acute medical environments is presented visually in Figure 22. In the account which follows, the dimensions of the descriptive model and prescriptive conceptual framework are discussed in relation to the findings of this study.

9.3. A Descriptive Conceptual Model

Figure 22: A descriptive conceptual model of the urine output monitoring continuum



Response Phase

The Response phase represents the point in time when a patient presents with a clinical condition that requires urine output monitoring. Typically, most patients diagnosed with sepsis, AKI, identified as acutely unwell or at risk of imminent deterioration enter at the Response phase. Titration and adjustment to treatments can occur at any point along the urine output monitoring continuum; however the ethnographic findings of this study identified it is most likely to occur during the Response phase.

Degree of Certainty

This study has identified there are degrees of certainty relating to the patient's physiological condition that influence urine output monitoring practices in acute medical environments. The extent of certainty varies depending upon how much knowledge can be established regarding the clinical diagnosis and the patient's physiological condition. When a patient first presents as acutely unwell, there is often a low degree of certainty regarding the stability of their physiological condition and whether they will respond to treatment and improve or continue to deteriorate. There was consensus amongst healthcare professionals that particular clinical circumstances/ conditions require a patient's urine output to be monitored in order to assess the stability of their condition over time. For example, clinicians widely agreed that acutely unwell or deteriorating patients required urine output monitoring with sepsis and AKI being the most frequently cited conditions.

Quantitative findings revealed the most common diagnosis of patients with a medical request for urine output monitoring was acute kidney injury 38/76 (50%) and sepsis 21/76 (27.6%). These indications reflect the most common rationales for output monitoring discussed in the literature and reported by clinicians during the ethnographic phase of this study**.** Despite confidence that some conditions required urine output monitoring, there was less confidence as to which method of monitoring was required. It appeared clinical reasoning when making a decision to insert a IUC for urine output monitoring could vary. Some physicians believed hourly monitoring was required as best

practice whereas others expressed that IUC insertion could be seen at times as a tick box exercise.

> "I think there has to be a really good reason to put the catheter in, with a plan, because there's no point putting a catheter in when you're actually not going to monitor anything and you're just ticking the boxes, right?" **MOP PHYSICIAN**

Nonetheless, this study revealed for patients admitted to AMU with sepsis and haemodynamic instability, the requirement to insert an IUC to monitor urine output and guide therapeutic decisions was indisputable amongst most clinicians. Time was considered to be an influencing factor as watchful waiting for a patient to pass urine was not considered as timely enough. The immediacy of action required in the 'response' phase is identified in the framework by the clock infographic. Nurses and physicians wanted to be able to promptly review the patient's physiological response to treatment, particularly when a patient was considered unstable.

> "So, generally catheters are for patients who we're very worried about, who are very unwell, particularly from a sepsis point of view, especially if they're maybe not responding initially to treatment then we'd want to catheterise them to get an accurate understanding of their fluid balance." **SS AMU CONSULTANT**

During observations of care on AMU, deteriorating patients were often reviewed by critical care outreach nurses. In these cases, a catheter was usually inserted to monitor the patient's response to treatment to determine if they were deteriorating further. The extract below describes a clinical situation where a patient with oliguria despite fluid resuscitation would be transferred to intensive care. In these circumstances there was a sound clinical rationale for IUC insertion.

> "patients with sepsis who's had 7 litres in and they're still not fluid responsive the blood pressure's… they're still hypotensive with oliguria then you might need to think about intensive care for vasopressors, blood pressure up to be able to perfuse the kidneys." **SS CRITICAL CARE OUTREACH NURSE**

Outside of critical care, 82% (n=28/34) of patients with an IUC inserted solely for urine output monitoring had a diagnosis of sepsis or AKI. 36% (n=10/28) had been diagnosed

with both conditions. The remaining 6 patients could be categorised under either having heart failure or being acutely unwell and at risk of deterioration. However, for 35% (n=22/62) of patients with a diagnosis of AKI there was the intention to monitor urine output using non-invasive collection methods indicated by a documented medical request for output monitoring. In contrast, for 11% (n=7/62) of patients diagnosed with AKI there was no documented intention to monitor urine output, highlighting inconsistencies in patient care.

One explanation for these inconsistencies in care for patients with AKI could possibly relate to the different stages of AKI severity requiring different management and methods of monitoring.

> "For very sick patients, so patients that may have an acute kidney injury stage 3 or patients who are profoundly septic we may ask for hourly urine output so hourly observations and hourly monitoring of the patient's urine output." **AMU CONSULTANT**

Although NICE guideline 148 (2019) recommends urine output monitoring for patients with or at risk of AKI, the literature does not differentiate between monitoring requirements for a patient with AKI stage one compared to stage three. This lack of clarity has created grey areas for decision-makers, amplified by a broad spectrum of beliefs amongst clinicians as to which method of monitoring is required for patients with AKI.

> "In the context of somebody with an acute kidney injury when would I put a urinary catheter in? If they've got a normal blood pressure I'd be much less likely to put a catheter in, if I know that they're peeing I might be relatively relaxed about the amount that they're peeing if I know it's happening, I think the times when… you know, so often it will be, yes, they've got a bit of an acute kidney injury, their blood pressure's okay, I'm not too worried about this so let's just measure their urine output but if they haven't peed in the next six hours then we'll put a catheter in because actually if they haven't peed in six hours are they producing urine at all?" **AMU CONSULTANT**

The uncertainty surrounding urine output monitoring practices appears to have led to risk aversion among clinicians. This manifested as increased IUC use to mitigate the risk of

missing physiological deterioration in patients. However, this was at the expense of increasing the risk of infection. Findings from Phase One revealed that of the 80 patients with no catheter, but an intention to employ non-invasive monitoring of urine output, only 31/80 (39%) had numerical urine output measurements recorded. A lack of confidence in the accuracy of urine output measurements when using non-invasive collection methods has likely influenced decision makers towards a more cautious approach. Both nurses and physicians reported that inaccurate recordings can delay treatment decisions. Although the direct impact of this on care is unknown, it is well documented that delays in detecting and responding to deterioration can lead to poorer patient outcomes.

> "So, it's frustrating and it certainly does delay some treatment decisions. Often you just have to go with the information that you've got." **SS AMU SHO**

> "When you've got someone with quite a serious AKI stage 3 and it's getting worse and things haven't been filled in, that can just impede your clinical decision-making." **SS CRITICAL CARE OUTREACH NURSE**

The gap between patients being unwell enough to require hourly urine output monitoring and those patients requiring accurate urine output measurements to monitor possible deterioration is wide. To mitigate the realities of practice, it appears IUC are left in place longer than hourly measurements are required, as a safety net to increase the accuracy of monitoring.

Therapeutic Goals

Therapeutic goals identified by the ethnographic phase of this study included detecting oliguria, escalating deterioration to the medical team for review and administration of treatment, usually in the form of intravenous fluid therapy. These clinical priorities occur within the 'Response' phase of the urine output continuum framework and are related to the acuity of the patient.

Medical document review of fluid balance charts during Phase Two revealed patients with an IUC inserted for urine output monitoring were monitored 1-2 hourly during the first 24 hours of admission before the frequency of monitoring decreased, usually as the acuity of the patient's condition improved. Patients admitted to AMU with sepsis condition usually

stabilised within 24 hours of treatment. However, patients whose condition did not improve were often transferred from AMU to the intensive care unit. Qualitative findings echoed the view that the majority of patients in acute care environments are expected to improve within 24 hours and therefore move into the 'Stabilisation' phase of the framework.

> "Well, they should get better quite quickly, like you are hoping that people aren't going to be acutely unwell for more than 24 hours, there will be some patients but they should be in critical care areas and that's a whole different ball game." **AKI NURSE PRACTITIONER**

Stabilisation Phase

The Stabilisation phase reflects the point at which urine output measurements (particularly hourly) were no longer influencing regular therapeutic decisions as the patient's physiological condition improves. In this study, some patients were still receiving intravenous fluid infusions for ongoing maintenance. However, this phase was distinguishable from the Response phase as the patient was no longer at imminent risk of circulatory shock. The therapeutic aims of monitoring when the patient enters the Stabilisation phase was to prevent AKI and subsequent organ dysfunction from hypoperfusion and therefore continuation of urine output monitoring was required.

However, during ethnographic conversations, nursing staff on AMU frequently reported that no therapeutic decisions had been made from monitoring the urine output of patients who were viewed as clinically stable. Nurses acknowledged that patients in this phase were usually passing good amounts of urine so therefore they were not of concern. In such cases, the urinary catheter remained in place but frequency of monitoring usually decreased. The clinical goal in these circumstances was simply to continue to monitor output to ensure patients were meeting the minimum urine target of 0.5ml/kg/hr and therefore aim prevent the development of an AKI. Interestingly, it appears when a patient's condition is stable, the goal becomes focused on clinicians (to ensure nobody misses reduced urine output) rather than assessing changes in the patient's condition per se. During this Stabilisation phase patients were often transferred from AMU to a medical ward. Physicians and nurses in MOP reported patients are often transferred from AMU with an IUC inserted for urine output monitoring and on a fluid balance chart.

Clinicians reported the requirement for this was not always reviewed promptly, leading to prolonged monitoring and increased IUC dwell time.

> "the majority of patients that come up to the ward from the acute medical unit will be on a fluid balance chart, it's not until somebody senior reviews that that's necessarily stopped." **SS MOP WARD MANGER**

> "I'd say 90% of people it's a kind of it happened acutely when they came in and then they're getting better and we're looking to get the catheter out and stop monitoring the urine output." **SS MOP CONSULTANT**

During the Stabilisation phase, physicians reported decision-making based on physical examination and blood chemistry. Medical staff appeared to rely on nursing colleagues to escalate concerns regarding a reduction in urine output but appeared less concerned at the requirement for strict hourly measurements. Less frequent measurements at this point were clinically acceptable, and generally at this point physicians were interested in the overall 24 hour fluid balance.

> "It's quite rare that we say that someone needs hourly urine output monitoring in elderly care but when it does happen it does tend to happen reasonably well, more often you get the charts that kind of have six hours of 0000 and then 400mls when it's been recorded which is fine because we can extrapolate over a day how much urine someone's making." **SS MOP CONSULTANT**

Notably, for patients in the Stabilisation phase, an IUC inserted for urine output monitoring did not necessarily correlate with a continued requirement for hourly measurements but appeared to be used as a tool to maintain accuracy of monitoring. The window of opportunity for prompt review and removal of the IUC once a patient's physiological condition stabilised did not appear to be recognised or acted upon by clinicians in this study. The implication of this meant IUC were often left in place longer than clinically necessary exposing patients to an increased risk of developing CAUTI and other complications.

Uncertainty regarding when to stop urine output monitoring in patients with AKI and sepsis was evident amongst nursing staff. This suggests that the decision to place an IUC appears to be clearer cut than the decision to remove a catheter. Both quantitative and

qualitative findings revealed IUC inserted for urine output monitoring for patients diagnosed with sepsis or AKI were left in place longer than clinically necessary and were not promptly removed despite sepsis or AKI symptoms resolving. In these cases, urine output measurements recorded on a patient's fluid balance chart would become less frequent or in some cases stop being monitored. However, this did not appear to instigate the removal of the catheter. When weighing up the decision to remove an IUC placed for urine output monitoring, the clinician's assessment of risk plays a part but this also appears to be influenced by the likeliness that nursing staff will monitor urine output effectively using other methods. It appears that there would be more tolerance among clinicians for non-invasive collection methods to be used if they were reliably completed. In addition, the convenience afforded by an IUC on managing nursing workload may also influence clinicians decisions on when to remove a catheter.

Resolution Phase

The Resolution phase can be described as the stage a patient transitions from the acute period of illness to the resolution of symptoms and probable clinical recovery. Unlike the previous two phases where patients were likely to transition through within 48 hours, the resolution phase is patient specific and duration varies, for some patients lasting weeks.

The quantitative phase of this study revealed that for patients in acute care with a short-term IUC inserted solely for urine output monitoring, 38 % (n=13/34) were having 4-6 hourly urine measurements recorded during the day. For 12% (n= 4/34) of patients measurements were recorded at over 6 hourly intervals or no entries recorded at all during the daytime. Overnight, this increased to 38% (n= 13/38) of patients, highlighting a reduction in the frequency of urine output monitoring during nightshifts. Medical and MOP wards have lower staffing ratios at night, therefore managing the workload when there is rising acuity of patients and more therapeutic activity taking place can be challenging. These findings highlight that either vital care is being missed, particularly during the night, or that IUC are left in place for longer than clinically necessary when hourly urine output measurements are no longer required.

Although there was a consensus amongst nurses and physicians that it is a medical decision to stop urine output monitoring for a patient for whom it was instigated due to

clinical concern, there was no documented evidence of medical teams requesting urine output monitoring to cease in patients' medical notes. However, frequently 'TWOC (trial without catheter) when bowels opened' was noted.

> "Medical teams will often ask for fluid balance charts, but won't often say that they want them stopped, that they're not required." **SS MOP WARD MANAGER**

Physicians reported that stopping monitoring is variable and guided by the patient's condition and clinical judgement.

> "It's a bit variable really, I think it depends on how the patient's doing, obviously a lot of our patients are frail or unwell and it might become apparent that they're dying and not going to get over this in which case we stop, you know, monitoring so closely it's just a case of emptying a bag every now and again. So, it really depends on their recovery and how well they were before and things like that as to how long we do it for, yeah." **SS MOP CONSULTANT**

It is a well-known principle that short term catheters should be used for the shortest time possible. However, quantitative findings in this study revealed 75.5% (n=37/49) patients with an IUC inserted for urine output monitoring had been in for longer than 48 hours and 24.4% (n=12/49) had been in place for over 12 days. Interestingly, ethnographic work revealed once patients moved into the Resolution phase, IUC inserted initially for hourly monitoring remained in place to continue monitoring less frequently, instead of removing the catheter and instigating non-invasive methods of monitoring. The point prevalence survey identified 50% (n=6/12) of IUC indicated for urine output monitoring, which had been in place for over 12 days, were having urine measurements recorded 4-6 hourly with a further two patients having less than 6 hourly measurements.

Medical document analysis for patients participating in the ethnographic phase of this research also confirmed hourly measurements are usually recorded for the first 24 hours of a patient's admission before frequency of measurements reduce. Findings suggest that IUC removal appears to be prioritised once a patient is being prepared for discharge, rather than when the insertion indication ceases. Implications of this can include

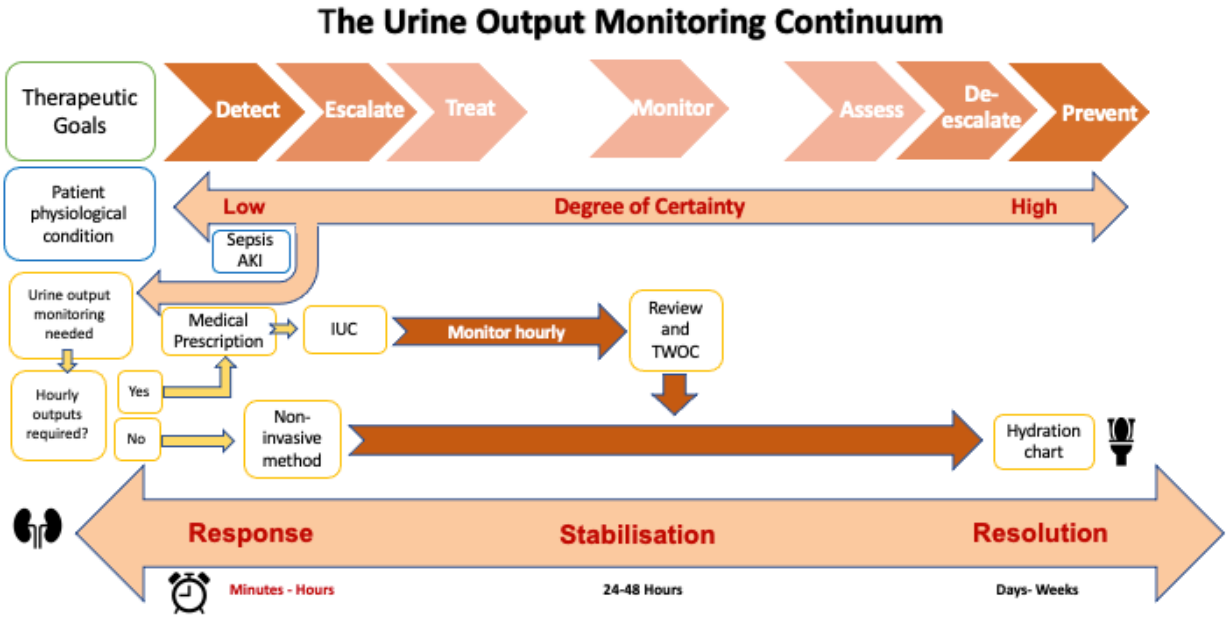
increased hospital stay as well as exposing patients unnecessarily to risk of infection and other catheter-related complications.

9.4 A Prescriptive Conceptual Framework

Judicious use of IUC needs to be prioritised by clinicians to reduce the risk of CAUTI and other complications that arise from prolonged catheterisation. In order to achieve this, catheter stewardship, a novel concept which follows the principles of antibiotic stewardship to measure and improve how catheters are used by clinicians, may be required. Catheter stewardship recommendations will be explored further in Chapter 10.

A preliminary prescriptive conceptual framework has been developed from the findings of this study to help guide clinicians' decision-making when determining urine output monitoring requirements (Figure 23). It is important to note that this is a tentative framework offering guidance to address some of the issues identified by the study, in particular prolonged catheterisation. However, the framework has not yet been tested and therefore it remains unknown whether it will have beneficial outcomes on care.

Figure 23: A prescriptive conceptual framework for urine output monitoring practices



Response Phase

In the Response phase, the prescriptive conceptual framework differs from the descriptive framework as it promotes the need to assess whether hourly urine output measurements are clinically required. If hourly measurements are needed to guide therapeutic decision-making, it is recommended that a medical prescription should be obtained for the insertion of a urinary catheter. Once inserted, hourly measurements should be recorded until the patient enters the Stabilisation phase where the IUC should be reviewed and removed. For patients not requiring hourly urine measurement to guide treatment decisions, non-invasive collection methods should be utilised until the patient enters the Resolution phase.

Stabilisation Phase

Similarly, to the descriptive framework, the prescriptive framework recognises that patients in acute care environments usually enter the Stabilisation phase by 24 hours. Within this phase, urine output measurements are usually being used by clinical staff to monitor perfusion rather than guide specific therapeutic decisions. Therefore, at this point the IUC inserted for hourly urine output monitoring should be reviewed and removed. However, patients should continue to have their urine output monitored using non-invasive collection methods until they progress in to the Resolution phase.

Resolution Phase

In this phase as a patient's physiological condition improves, the prescriptive framework recommends urine output monitoring requirements to be re-assessed and de-escalated if appropriate. This would usually require discontinuation of a fluid balance chart and for some patients who are identified as being at risk of dehydration to be transferred to a hydration chart for less stringent monitoring, the aim being to reduce the number of unnecessary fluid balance charts whilst also preventing dehydration and AKI for patients at risk.

9.5 Chapter Summary

This thesis has demonstrated the utility of using a mixed methods study to understand a previously under-researched clinical problem. Using a pragmatic two-phase approach, various influences on urine output monitoring practices have been identified. Both quantitative and qualitative findings formed the basis of the descriptive and prescriptive conceptual frameworks. These findings have made a key contribution to knowledge: firstly, by providing further understanding of situations that lead healthcare professionals to insert IUC for urine output monitoring and secondly, by identifying that urine output monitoring occurs along a continuum with three phases, each with different clinical goals that can influence the care a patient receives.

Although inserting a catheter to monitor urine output on the face of it appears to be a relatively simple clinical decision, it was evident that uncertainty and risk aversion play an important role. The decision to remove a catheter once inserted is even less straight forward. The challenge to accurately monitor a patient's urine output using non-invasive collection methods in an acute care environment is highly complex. The difficulties reported by participants during this study have provided possible explanations for this. Guidance to assist the development of effective strategies to minimise unnecessary IUC placement and ongoing use for output monitoring need to consider these complex influences. In order to change the catheter culture in acute medicine, to which urine meters and catheters are left in place for prolonged monitoring when the clinical requirement for hourly measurements has stopped, catheter stewardship is required and improvements to alternative methods of monitoring are needed.

In the next chapter the concept of catheter stewardship, alongside other findings from this study, will be discussed and a range of potential theoretical explanations will be explored. The implications of the study findings in relation to clinical practice and future research will also be considered.

Chapter 10 Discussion

10.1 Introduction

Urine output monitoring is dynamic, constantly changing in response to evolving circumstances. As a patient's clinical condition changes, therapeutic goals will also change creating uncertainties which require re-assessment. It is crucially important to improve understanding of such clinical decisions if we are to develop an appropriate solution to inaccurate urine output monitoring and the overuse of IUC in acute care environments. Although indications for catheterisation for urine output monitoring appear in some areas to be routine practice, the decision-making process behind these behaviours has to date remained unclear. It has long been recognised that urine output monitoring in clinical practice can be inaccurate but the use of IUC as a solution to this problem requires a major re-think.

The findings of this research project suggest the current approach for monitoring urine output in acute medical environments is unreliable and potentially unsafe, both in relation to infection risk and the failure to detect physiological deterioration. This is a multifaceted problem and is independent of whether non-invasive or invasive methods are used. Although the accuracy of monitoring increases when hourly monitoring is instigated via an IUC, the requirement for this intense level of monitoring appears to be only clinically justifiable for a short duration of time. Hesitation from healthcare staff to monitor urine output using non-invasive collection methods has led to prolonged catheterisation, which can expose patients to avoidable catheter-related complications.

In this chapter, key findings will be summarised and possible theoretical and practical explanations will be explored. Throughout the chapter findings will be examined within the context of the existing relevant research literature. The discussion will centre around understanding decision-making and changing behaviours to reduce unnecessary and prolonged catheterisation in medical environments.

10.2 Complexity of the problem

The findings of this study reveal the complexity of how and why urine output is monitored in acute care. The intricacy of this phenomenon could provide an explanation as to why there is limited empirical research to investigate the topic. The integrative review described in Chapter 3 demonstrated that there is little evidence to support which method of urine output monitoring is most beneficial to patient care. To date, clinical guidelines agree on the appropriateness of placing an IUC to monitor hourly urine output in critically ill patients (Loveday et al. 2014, Gould et al. 2009, RCN 2021). However, it remains unclear as to when the benefits of using an IUC to monitor urine output outweigh the risks in acute medicine. Indwelling urinary catheters increase the risk of urinary tract infection and other complications, whilst undetected persistent oliguria also poses a significant risk to patient safety. Understanding how healthcare professionals make decisions and perceive risk in relation to urine output monitoring is a crucial step toward solving this complex issue.

10.2.1 Decision-making in uncertain situations

Good decision-making is crucial to delivering safe and effective healthcare. In many instances, decisions are made in uncertain and challenging clinical environments where information and time is limited. These individual choices can impact on patient safety and the quality of care received. When trying to understand a particular healthcare process such as urine output monitoring, it is important to consider the context of clinical decision-making. Findings from this study revealed the decision to insert and remove an IUC is not straightforward as clinicians believe the risks associated with IUC are outweighed by the risks of potential physiological deterioration. By understanding clinical decision-making and behaviours in relation to this aspect of care, inroads can be made in addressing the problem of unnecessary and prolonged catheterisations for patients on acute medical wards.

The field of decision-making features a variety of theories on how decisions are made, from traditional models promoting rationality (Huczynski and Buchanan 2001), to models that incorporate how contextual factors can influence decision outcomes (Klein et al. (1986, 2010) and Nibblelink and Reed (2019). Decisions made in acute care are

complex, as available information is often ambiguous and uncertain (Currey and Botti 2003). Findings from this study identified an initial dilemma in assessing a patient who may require urine output monitoring in relation to identifying whether a patient is passing a normal amount of urine. Such information is often difficult to observe or obtain the first time a patient is evaluated, particularly if non-invasive collection methods are being used. Patients' care needs are dynamic and decision outcomes are usually iterative requiring further consultation or evaluation.

In an acute care ward, the ability to make timely and effective clinical decisions is crucial to ensure effective patient care and management. Currey and Botti (2003) describe the multifaceted nature of decision-making in clinical practice, which are depicted in Table 24. The influence of these factors on clinical decision-making related to urine output monitoring is not well understood, leading to gaps in understanding on how to best support clinicians. However, literature describing decision-making in uncertain situations has been explored.

Table 24. Characteristics of clinical decision-making

- Decisions are complex
- Information is ambiguous and uncertain
- The quantity of information to consider if large
- Problems are poorly structured
- Goals are shifting, poorly defined or competing
- Decision outcomes are iterative and require further evaluation
- Decisions have high stakes and consequences ensue for the decision maker and patient
- Decisions can be made individually or in consultation with others
- Organisational goals and norms must be considered
- Decisions take place within a dynamic environment
- Time constraints exist

(Currey and Botti 2003)

Heuristics and Biases

Tversky and Kahneman (1974) prominent paper 'Judgement Under Uncertainty: Heuristics and Biases' discovered humans tend to take mental shortcuts and make assumptions when we are forced to deal with uncertainty, complexity or have to make

challenging decisions. Heuristics can be both useful and necessary but can also introduce a series of biases when making decisions under certain conditions (Albar and Jetter 2009). The heuristics and biases paradigm (Tversky and Kahneman 1974) demonstrated that humans do not generate probability estimates for different courses of action, instead mental shortcuts allow people to solve problems and make judgements quickly and efficiently. Indeed, this theory was derived from laboratory based studies, it is therefore difficult to conclude that this positivist view of decision-making reflects the dynamic world which exists in a clinical environments (Currey and Botti 2003).

Research investigating the influence of heuristics on catheterisation decisions in acute care is limited. However, Cowey et al. (2011) prospective study on decisions to insert indwelling urinary catheters in acute stroke patients identified some components of decision-making, which were influenced by heuristics. It was discovered that in clinical practice, there is a set of unwritten, often unspoken rules of behaviour relating to catheterisation. An example of this relating to gender and profession was the decision to catheterise a male patient being a medical one, whereas nurses could make the decision to catheterise female patients. Evidence based healthcare promotes the idea that clinical decisions should be determined by rational analysis, after careful evaluation of the available information (Hancock and Durham 2007). According to this approach, decision-making appears simple and lineal, however, research suggests clinicians often make decisions based on 'rules of thumb' (Cowey et al. 2011).

Unlike Cowey et al. (2011), this study did not discover similar heuristics to the example described above. However, findings did reveal that catheters inserted for output monitoring were sometimes placed based on 'rules of thumb' such as the patient having sepsis or AKI rather than a careful clinical evaluation. Tick box approaches to catheter insertion are likely to increase use and it remains questionable whether monitoring patients' urine with a catheter improves patient outcomes. Similarly, findings from this study identified an unwritten rule and widespread belief that non-invasive methods of monitoring were inaccurate and therefore using these approaches would often be regarded as futile.

The use of habits and cues in challenging environments

Theories of decision-making used to understand clinicians' behaviours in healthcare environments often focus on the conscious processes that drive decisions. However, less is known about the role that automatic processes such as habit have on healthcare professionals' behaviour (Potthoof et al. 2019). Dowies and Elstien (1988) suggest cues fall into one of three categories; technical cues (such as patient physiological parameters), interactive cues, and information from the environment (the presence or absence of equipment and perceptual cues). However, the use of cues in acute care and their relevance to urine output monitoring practices is yet to be fully explained and requires further investigation.

Habit can be defined as a behaviour which has been repeated until it is enacted without purposeful thinking, largely without any sense of awareness (Neilson et al. 2012). The process of forming habits occurs through a gradual shift in cognitive control from intentional to automatic processes which are triggered by internal and external (situational or contextual) cues (Potthoof et al. 2019, Lally et al. 2010). The use of cues are thought to be key in the way nurses make decisions (Hancock and Durham 2007). Findings from this present study revealed catheters and urometer bags were frequently used as a visual cues in acute medical environments. It appears a culture has developed where clinicians associate a catheter and a urometer with fluid balance monitoring requirements. This potentially could have a detrimental impact of attempts to implement non-invasive monitoring as culturally, clinicians no longer recognise them as viable collection methods.

Potthoof et al. (2019) systematic review suggests habit plays a significant role in healthcare professional behaviours to which many activities in clinical practice can be assumed to be habitual. Habit allows clinicians to use their skills and training efficiently, minimising the cognitive load of active weighing of pros and cons in every clinical situation (Potthoof et al. 2019). Although there is minimal research that explores catheterisation as a habitual behaviour, Meddings and Saint (2011) highlight how for healthcare professionals "kicking the catheter habit is difficult" and refer to Knoll et al. (2011) 5 year quality improvement project to reduce inappropriate catheterisation as similar in its successes and challenges to aspects of other habit-changing programmes.

Gabbay and le May's (2004) ethnographic study showed clinicians' rarely accessed research findings or clinical guidelines directly. Rather, clinical decisions were made by collectively reinforced, internalised tacit guidelines, which were informed by brief reading but mostly by their interactions with colleagues and patients. Gabbay and le May (2004) referred to this process as using mindlines and emphasised how clinicians were often influenced by prior experiences and relied on their peers to acquire knowledge. Findings from this doctoral study revealed physicians would frequently cite the sepsis six guideline as justification for IUC insertion for hourly monitoring however these decisions were sometimes viewed as a tick box exercise and influenced by wanting to be seen to be ordering the "correct "standard of care for patients by colleagues. Notably, the benefit to patient outcomes when utilising an IUC to monitor urine output remain unclear with the updated Sepsis 6 care bundle now advising a IUC *may* be required to monitor urine output rather than a more prescriptive order.

Klein's (1993) recognition-primed decision (RPD) model, a psychological theory derived from the NDM framework, suggests when needing to make a decision individuals can quickly match the situation to the patterns they have experienced in the past and therefore make a rapid decision. However, this often means individuals choose the first option that works, not necessarily the best option. It remains unclear how well the RDP model reflects clinical decisions made in healthcare settings. However, in regards to catheter related decision-making within fast-paced environments such as AMU, the choice of a catheter to measure urine output is often the most familiar and easiest option for clinicians to choose as opposed to alternative methods of monitoring that are perceived as less accurate and more time consuming.

Nibblelink and Reed (2019) used theory derivation to formulate a new nursing model relevant to a practice context of acute care nursing incorporating important elements identified in Naturalistic Decision-Making, a Recognition Primed Decision Model and an integrative review of nurse decision-making literature. The RPD model was congruent with the contexts in which acute care nurses had to make decisions, which involved ill-

structured problems in patient care within limited time frames and uncertain and serious conditions (Nibblelink and Reed 2019).

Nibblelink and Reed's (2019) Practice-Primed Decision Model (PPDM) describes the clinical decision-making process as, understanding of patient status, recognising the patient situation as similar to previous nursing practice or fitting a protocol, the nurse mentally simulates a patients response to a considered intervention, the intervention is either implemented or no intervention takes place and then the patient response is evaluated. The PPDM also included seven variables (experience, nursing unit culture, education, autonomy, colleague collaboration, and Registered Nurse bias and understanding of patient status/situation awareness) that were considered important in understanding factors that facilitate acute care nurse decision-making. This model resonates with the findings of this doctoral study and can help offer understanding regarding decision-making in relation to urine output monitoring.

Decision-making in acute care environments is multifaceted. Nurses often seek information from multiple sources to make decisions such as seeking advice from colleagues, observing vital signs and are guided by their own knowledge and experience. The PPDM helps illuminate different aspects of this clinical reasoning process which align with the findings of this doctoral study.

The PPDM highlights how following a clinical intervention, nurses would reassess the patient condition to determine if their clinical condition had improved or if further decisions and interventions are required. The reassessment triggers the decision-making cycle to restart with understanding patient status. Throughout this process, nurses would use previous experiences to guide their decision-making for a current patient care situation (Nibblelink and Reed 2019). Findings from this doctoral study identified urine output monitoring as dynamic with requirements fluctuating in response to evolving clinical circumstances and the patient's clinical condition, thereby moving back and forth along the continuum. As a patient's clinical condition changes, therapeutic goals may also change, creating uncertainties which require re-assessment. Nibblelink and Reed's (2019) PPDM helps to better understand the complex nature of nurse decision-making in relation to urine output monitoring.

Nibblelink and Reed (2019) emphasise how understanding *patient status* includes effective assessment of the patient's condition, accurate understanding of the significance of the assessment findings and an ability to consider possible patient outcomes that may occur as a result of the patient's current condition. Findings from this study revealed how certain conditions such as sepsis and AKI would trigger urine output monitoring protocols to be instigated and nursing staff frequently reported the need to ensure patients were passing 0.5ml/kg/hr to ensure renal perfusion and early detection of oliguria. In practice however, hourly monitoring was rarely utilised outside of intensive care despite catheters frequently inserted for this purpose.

NPSA (2007a) raised concerns that acutely unwell patients on general wards may receive sub-optimal care due to clinical deterioration not being recognised, appreciated or acted upon sufficiently quickly. However, it is unknown whether the reduced frequency of urine output monitoring identified in this study impacted on patient outcomes. This study identified that the frequency of urine output measurements often decreased when a patient's condition improved and urine output production was considered by nurses as adequate. Therefore, the reduced frequency of urine measurements for patients with catheters is possibly in relation to goals shifting following nurses clinical assessment of the *patient status*.

Nibblelink and Reed (2019) highlight how levels of experience and autonomy will likely vary among nurses which is likely to influence decisions. This study identified nursing experience and autonomy did influence decision-making. Nurses appeared to have little autonomy with regards to catheter related decision-making and often appeared to be governed by others, which stifled their autonomy. Interviews and observations of practice revealed a perception that nurses were often ruled by those in perceived positions of higher authority such as the medical team. Despite nurses often deciding on the frequency of urine monitoring in a catheterised patient, a lack of nurse empowerment resulted in decisions to stop fluid balance monitoring or catheter removal normally being made by physicians. However, senior nurses with more experience appeared to work more autonomously and were more confident in making these clinical decisions without authorisation from the medical team.

Nibblelink and Reed (2019) also refer to RN bias as an unconscious use of heuristics to guide decision-making. As previously discussed, findings from this study identified an unwritten rule and widespread belief that non-invasive methods of monitoring were inaccurate and therefore using these approaches would often be regarded as futile. This bias amongst nursing and medical teams likely increased the use of catheters for urine output monitoring and helped create a catheter culture within the unit, in which IUC were inserted for urine output monitoring even when precise hourly measurements were not necessarily a clinical requirement.

Despite Nibblelink and Reed's (2019) PPDM offering insight into nurse decision-making, which aligns with findings from this study, a limitation of the model is that risk perception and its involvement in clinicians' subsequent care decisions is not explored. Behaviours in relation to risk were identified by this study as key to understanding catheter related decision-making. Therefore, the next section will review literature in relation to risk.

10.2.2 Understanding risk and changing behaviours to reduce unnecessary catheterisation

The insertion of an IUC to monitor urine output is commonplace in hospitals and in this study, output monitoring was the most frequent indication for IUC placement in acute medical wards. Findings revealed both nurses and physicians viewed the consequences of inserting an IUC as low. Although, urinary tract infections were reported by clinicians as a risk of catheterisation, it was apparent CAUTI were not viewed as serious complications and had little impact on IUC use.

These findings are consistent with those of Atkins et al. (2020) whose secondary analysis of published literature identified six barriers and facilitators that influenced healthcare professionals' behaviour related to CAUTI. Atkins et al. (2020) identified 'Beliefs about Consequences' as a key domain in CAUTI related behaviours. Within this domain, the theme 'perceived severity of CAUTI' was identified, which reported clinicians viewed catheters as a potential source of risk for patients. However, CAUTI were perceived to be common and benign and a lack of perceived benefits of interventions targeting CAUTI were identified as barriers to appropriate catheter use.

Dixon-Woods et al. (2009) is situated in the wider risk perception literature on risk related reasoning. Horlick-Jones (2005) reports when individuals engage with the practicalities of risk issues, in their specific contexts, a diversity of informal reasoning may be seen to inform their actions, identified as 'informal logic of risk'. Dixon-Wood et al. (2009) reports risk related reasoning were not the property of one individual, rather they drew upon shared negotiated understandings amongst staff. This doctoral study identified justifications for catheter insertion for urine output monitoring were influenced by both clinical and non-clinical rationales which were views shared across the majority of clinicians which aligns with both the work of Horlick-Jones (2005) and Dixon-Wood et al. (2009).

Dixon-Woods et al. (2009) "four ways staff orient to risk" framework provides insight into how healthcare professionals assess risk and the effect this might have on their subsequent care decisions. The framework identifies four ways that staff orient to risk:

- Normative work in managing risks- staff deal with competing priorities about matters that are inherently contestable;

- Cutting corners- staff acknowledge that they do not always do things perfectly but produce a range of justifications for their behaviour;

- Tightly coupled errors- negative outcome and the error are clearly linked;

- Process weaknesses- risks arise because of fallible and precarious organisational processes.

Harrod et al. (2013)

Harrod et al. (2013) study highlights catheter related behaviour can also be influenced by healthcare professionals' perceptions of risk. The study identified multiple perceptions of risks, some non-evidence based, are used by healthcare providers to determine if using a IUC is necessary. Harrod et al. (2013) mapped their findings to the "four ways staff orient to risk" framework to gain greater understanding on how risk and use of invasive devices are related. The following section will explore how findings from this study align with the Dixon-Woods et al. (2009) framework.

Normative work in manging risks

Findings from this study are in agreement with Dixon-Woods et al. (2009) and Harrod et al. (2013) who identified healthcare professionals dealing with competing priorities often have to decide which values to promote in the context of limited resource. The catheter paradox, in which catheters on the one hand can offer early detection of deterioration, however at the same time can expose patients to harm can cause presents a challenging patient safety dilemma for clinicians. As described by Dixon-Woods et al. (2009), healthcare professionals often have to prioritise competing patient safety initiatives. In the case or urine output monitoring, two patient safety messages are juxtaposed: the need to accurately monitor hourly urine output whilst also reducing the use of IUC.

Findings from this study revealed clinicians appear to prioritise inserting an IUC to improve urine output monitoring accuracy in acute medical environments over using non-invasive collection alternatives due to a distrust in accurate recording and a fear of missing reduced urine output. Dionne et al. (2018) emphases how the perception of risk can be subjective, high risks can be underestimated, low risks overestimated and the rationality with which individuals make decisions can be influenced by perceptual biases. Participants in this study placed greater importance on the need to accurately monitor urine output over risks associated with catheterisation. However, as a single centre study it is not known what extent these findings are representative of other healthcare settings.

The language used by nurses to describe catheterisation is also worthy of note. During semi-structured interviews and observations of practice the term “pop a catheter in” was frequently used by nurses. The word "pop" suggests clinicians see this as a quick procedure and minimalises the potential risks associated with insertion. It remains unclear whether nursing staff use this language in attempt to reassure patients undergoing the procedure. However, observations of practice revealed when this approach is taken, patients are not always informed of the risks associated with catheterisation at time of insertion. Safdar et al. (2016) identified 70% of patients were unaware of the risk of infections associated with IUC and 75% of patients perceived they had not received adequate education on IUC risks. It is possible that nurses view catheterisation as a low risk procedure that does not require informed consent form patients. However, it is questionable whether if “ pop a catheter in” was replaced by

'aseptically insert' that clinicians and patients would think differently about the risks of catheterisation.

Arfanis et al. (2011) indicate that the vast majority of healthcare professionals understand risk as something intrinsic to healthcare. Risk was defined as 'professional' risk or 'environmental' risk. Professional risks involved actions of healthcare professionals and focused upon competence and adherence to safe practice. Environmental risks rose from lack of resources. Staffing levels and time pressures were consistently described as major factors preventing staff from adhering to safe practice. There was a shared view that a risk-free environment in healthcare settings was unattainable. They reported how healthcare professionals tend to approach this issue of which risks are acceptable or unacceptable based on an ad-hoc calculation of perceived benefits involved in taking a particular risk against the perceived benefit of not taking that risk. However, findings from this study suggest for some diagnoses, placement of a IUC is a passive, almost compulsory choice rather than a considered risk versus benefit decision. Further research on healthcare workers' perception of risk in relation to urine output monitoring may shed further light on the issue. Notwithstanding, there is clearly a need to establish whether prolonged hourly urine output measurements offer any advantage to patient outcomes over a non-invasive collection approach, since without a definitive answer to this question, patient care is likely to vary and be guided by clinicians' personal belief systems.

In addition to prioritising competing patient safety initiatives, healthcare professionals also have to juggle their clinical workload caring for multiple patients (Harrod et al. 2013). In the present study, workload pressures were identified as a subtheme that contributed to inaccurate urine output charting. Both observations and interviews provided evidence that nursing staff prioritise some tasks (such as drug administration) more so than others as a way of managing their workload. As illustrated in the findings, urine output monitoring using non-invasive methods was described as more time consuming and was viewed as less accurate. Although convenience of care is not a widely accepted indication for catheterisation, many clinicians reported how inserting IUC can help manage workload.

The European Joint Report (2020) identified nursing staff work overload as a significant barrier to adherence to CAUTI prevention recommendations. Similarly, Atkins et al.

(2020) reported convenience and ease of monitoring as the most frequently identified theme across studies relating to beliefs about consequences, including inserting catheters for convenience purposes such as for measuring patients' urine output or avoiding transfers to a bedpan or commode. However, as highlighted by Harrod et al. (2013), the perception that catheters are inserted or left in place longer than clinically necessary for 'convenience' does not consider the wider organisational issues contributing to these decisions such as lack of staffing. In this present study, a lack of stop criteria / guidance for when catheters inserted for urine output monitoring should be removed appeared to be the greatest influence on prolonged catheterisation rather than convenience. Clinical staff believed they were doing the "right thing" in terms of patient safety by monitoring the patients' urine output using a catheter. With this in mind, it is important to consider the way in which risks associated with catheterisation are presented and good practice promoted in acute care settings. More specifically, there is a need to determine whether some form of insertion and removal mandate is required in order to reduce unnecessary prolonged catheterisation.

Cutting corners

Dixon et al. (2009) describes "cutting corners" as staff not following standardised procedures and then justifying the reasons for the behaviour. Cutting corners can occur when the outcome can only be loosely linked to a behaviour and responsibility can be widely diffused and blame easily spread (Dixon et al. 2009).

In the present study, distributed responsibility amongst nursing staff was identified as a contributing factor to inaccurate urine output charting. Findings suggested when care was missed, for instance when urine output was not monitored, consequences of this would be diffused amongst all clinical staff working multiple shifts and was therefore not easily traced to any one individual. In addition, findings highlight the confusion in role differentiation and role clarity resonating between health care support workers and nurses. Role boundaries appeared to be blurred with members of the nursing teams confused about whose responsibility it was to monitor and record urine output. Healthcare assistants in particular expressed uncertainty about the limits of their responsibilities.

This is in direct contrast to physicians, who appeared to believe there was a risk to their professional identify if a catheter order was not made and oliguria was missed. O'Dowd (2015) highlights how doctors are becoming more cautious and practicing "defensive" medicine to prevent litigation after treating patients. Interestingly, physicians viewed requesting a medical order for catheterisation and urine output monitoring as an important part of the patient's clinical management however the same value was not placed on providing a catheter removal order or requesting urine output monitoring ceased. It appeared physicians viewed it has a nursing responsibility to ensure urine output was monitored and concerns escalated. Although the medical teams documented requesting output monitoring in the notes, they did not appear to ensure this was regularly completed.

The concept of diffusion of responsibility has been described in the literature, however its relevance to nursing teams and patient safety is limited. Hinrichs et al. (2012) and Christensen (2018) describe the diffusion of responsibility as a lack of accountability, when an individual feels less responsible for their own actions because others share in the responsibility. Christensen (2018) highlights nurses can unintentionally ascribe accountability for personal action to others which can lead to a diffusion of responsibility. Findings from this study illustrated a diffusion of responsibility particularly amongst nursing staff where role confusion meant individuals were often unsure which member of the team was responsible for completing the task. McNulty and Williams (2014) reports clinical settings can provide the perfect environment for the diffusion of responsibility when several people are all vaguely responsible for patient care. The factors that influence the occurrence of diffusion of responsibility are complex and multifactorial and therefore are not always easy to resolve (Mcintosh 2018).

Tightly coupled errors

Tightly coupled errors can be described as the link between the error and negative outcomes (Harrod et al. 2013). Dixon et al. (2009) define this as "significant lapse in patient safety that [can] be directly attributed to someone doing something incorrectly". Harrod et al. (2013) re-defined this element of the framework as 'loosely coupled errors', due to participants acknowledging urinary catheters could cause CAUTI but the outcome of this risk was not thought to be life threatening and therefore not very compelling.

There is considerable resonance between these explanations and the findings of the present study, as the perceived risk associated with IUC and the specific outcome of CAUTI was relatively low among participants in this study.

However, unlike Harrod et al. (2013) study, this present study also identifies a link related to tightly coupled errors. Findings revealed that in practice, there was a sense that catheterising patients for output monitoring was following the "correct" procedure. There appeared to be a perceived threat that not inserting a catheter could be seen as negligent or not implementing the appropriate care plan. Paradoxically physicians seemed to "err on the side of caution" when deciding catheterisation was necessary as clinicians appeared to view missing oliguria as a significant lapse in patient safety, which could be directly attributable to their actions.

Uncertainty plays a major role in how people perceive risk, particularly around ambiguous, complex or unpredictable situations (Brashers 2001). In this study, one advanced nurse practitioner described how when a patient has a history of renal failure, clinicians often remain anxious regarding the patient's urine output and catheters are used to monitor output to provide reassurance to the clinician. Previous work by Eiser (2004) reports it is not unusual for an individual's previous experiences to be drawn upon when making decisions even when the situation no longer resembles the risk in question. These previous experiences trigger associated memories and emotional reasons, which then help individuals to make sense of an uncertain risk and guide their decision-making.

This concurs with findings of wider risk perception literature whereby a common response to risk is to worry about it. MacGregor (1991) found that worry was higher for risks when respondents had more knowledge of consequences. Worry thus appears to be an adaptive mechanism learned from experience and used to manage uncertainty. This also aligns to one of the elements within Psychometric Paradigm in Chapter Two in that when experts judge risk, they are able to solve a particular problem, but are more likely to frame a problem within a narrow perspective. Therefore, if a clinician views a consequence of a health-related risk will be severe, then they will be more likely to take preventative precautions (Janz and Becker 1984).

In the present study, exploring clinicians' perspectives of urine output monitoring methods has revealed important influences that may have a bearing on efforts to

improve practice. However, in order to reduce the reliance on IUC for urine output monitoring, the issue of distrust of non-invasive collection methods needs to be addressed.

Process weaknesses

Process weaknesses are defined by Dixon-Woods et al. (2009) as organisational processes that healthcare professionals believe could pose more of a risk when used. Staff participants in Dixon-Woods et al. (2009) study revealed processes can be unreliable, particularly if collaborative work is required and coordination across professional teams, shifts or time boundaries is needed. In the present study, healthcare professionals viewed using non-invasive collection methods to monitor urine output as unreliable and distrusted the process due to lack of accuracy. As reported in Chapter 7, there are multiple influences that are likely to have impacted on the inaccurate charting of urine output in the study site hospital. Practical issues such as pad efficacy and organisational change related to electronic record keeping have contributed to a suboptimal process currently in place. Certainly, the findings of the present study reveal beliefs surrounding the inaccuracy of non-invasive approaches were prevalent amongst nurses, health care assistant and physicians. Shifting clinicians' beliefs on this may be difficult to overcome without considerable investment into education and improvement to non-invasive collection approaches.

As highlighted by Dixon-Woods et al. (2009), weaknesses in process were problematic for healthcare professionals as they were unclear how to change a problem, instead staff were left trying to rescue situations where processes have failed. In this present study, the removal of paper fluid balance charts as an environmental cue has made it more difficult for staff to differentiate which patients need their urine output monitored. Distrust in the ability to accurately record urine output using non-invasive methods has likely led to prolonged catheterisation.

10.2.3 Promoting catheter stewardship in acute medical environments

Despite the ubiquitous use of urinary catheters in acute care, IUC are not risk free. Prolonged catheterisation increases the risk of infection therefore removing an IUC as soon as possible is the foundation of good CAUTI prevention. A seminal study from

Garibaldi et al. (1974) reported that catheter dwell-time (the number of days spent catheterised) was a significant risk factor for CAUTI, with a 7.4% risk of infection in the 24hours following insertion, and a steady 8.1% risk increase each subsequent day for the first 7days. More recently, Letica-Kriegel et al. (2019) large retrospective cohort study of catheterised patients found CAUTI rates increased non-linearly for each additional day of catheterisation. CAUTI-free rate was 97.3% at 10 days, 88.2% at 30 days and 71.8% at 60 days. This translated to an instantaneous higher risk of infection 49%–1.65% in the 10–60 day time range. The duration of IUC was identified as a contributing factor for 16.5% of the CAUTI cases, however, for almost 25% of the cases reviewed, the clinical teams and infection preventionists stated that the catheters could have been removed earlier.

Findings from this present study revealed 8.1% of short term catheters inserted for urine output monitoring had a dwell time of over 30 days emphasing that once IUC are inserted, they can remain in place for longer than clinically necessary. As described in Chapter 8, urine output monitoring practices progress across a continuum, where initial insertion of a catheter to manage a critically ill patients could be clinically justifiable. However, once a patient's conditions has stabilised, prompt IUC removal should be prioritised. Findings from this study, identified nursing staff on AMU believed catheters inserted for urine output monitoring during the acute response phase would be removed once the patient was transferred downstream to a ward. However, quantitative findings revealed IUC are not removed quickly enough and catheters often remain in place long after the indication for hourly urine output monitoring as ceased.

Meddings and Saint (2011) conceptual model illustrates the 'lifecycle of the urinary catheter' and highlights the four stages of the IUC lifecycle which can be targeted to decrease catheter use and subsequent CAUTI. The 'lifecycle' of the catheter (1) begins with its initial placement, (2) continues when it remains in place, day after day, (3) ceases when it is removed and (4) may start over if another catheter is inserted after removal of the first one. Meddings et al. (2013) highlight that avoiding unnecessary initial placement of IUC and prompt removal are the most important strategies in prevention of CAUTI. Findings from this study revealed there is the opportunity to reduce the amount of catheters initially inserted for urine output monitoring by improving non-invasive collection method practices and ensuring IUC are only inserted when hourly urine output measurements are required to guide therapeutic decision-making. Additionally, there is

scope to interrupt the lifecycle of a catheter by ensuring IUC inserted for hourly urine output monitoring are promptly removed when a patient's condition moves into the stabilisation phase.

Quinn et al. (2019) identified that catheter removal was not seen as a high priority for clinicians. However, judicious use of IUC needs to be prioritised by clinicians to reduce the risk of CAUTI and other complications that arise from prolonged catheterisation. Catheter stewardship is a novel concept which follows the principles of antibiotic stewardship to measure and improve how catheters are used by clinicians. Conceptually, the goals of catheter stewardship can be categorised into: preventing overuse in hospital settings, minimising the development of catheter associated infections/complications; and optimising urine output monitoring practices to improve care for patients.

Improving antibiotic prescribing has been critical in protecting patients from harm caused by unnecessary antibiotic use (PHE 2015). Antimicrobial stewardship incorporates a wide range of interventions that are designed to ensure that antibiotics are used in the most effective manner (Dellit et al. 2007). This thesis proposes the same principles could be applied to IUC in order to combat unnecessary catheterisation and prolonged use.

The following catheter stewardship principles have been adapted from the 'Start Smart – The Focus' antimicrobial stewardship toolkit for English hospitals (PHE 2015).

Proposed principles of catheter stewardship:

- Non-invasive collection methods to monitor urine output should be the preferred approach.

- A urinary catheter should only be inserted for urine output monitoring when hourly measurements are required to guide therapeutic decision-making. A physician prescription is required if a catheter is to be inserted.

- The following should be documented in the patient's medical notes: clinical indication for catheter, duration or review date, urine output target parameters and process for escalation.

- The clinical diagnosis and the continuing need for a catheter should be reviewed before 48 hours from initial insertion. A clear plan of action regarding catheter removal and switching to non-invasive collection methods if continued urine output monitoring is required.

- The review and subsequent decision should be clearly documented in the patient's medical notes.

In the UK, almost all antibiotics for medicine require a prescription from a physician (PHE, 2015). The introduction of physician prescriptions for indwelling urinary catheters is an intervention that should be explored. Protocols that restrict catheter placement can serve as a reminder about the appropriate use of catheters but also generate accountability for placement of each individual urinary catheter (European Joint Report 2020). In addition, it is best practice for intravenous antibiotics to be switched to oral after 48 hours if a patient is able to tolerate oral therapy (Shrayteh et al. 2014). The sample principle could be introduced to ensure catheters are removed promptly and any IUC used for output monitoring should be reviewed and stepped down to non-invasive collection methods once clinical stability is established.

The European Joint Report (2020) suggest 'stop orders' which prompt the clinician (either nurse of physician) to remove the catheter by default after a certain period of time has elapsed (such as 24-48hr after insertion) could help reduce unnecessary prolonged catheterisation. Meddings et al. (2010) found the rate of CAUTI reduced by 52% with the use of a reminder or stop order and the mean duration of catheterisation reduced by 37%, highlighting how stop orders can enhance the safety of patients in hospitals.

This present study highlighted a lack of nurse empowerment as a barrier to prompt catheter removal. Quinn et al. (2019) also identified that nurses often waited for physician approval before removing indwelling urinary catheters. In addition, Quinn et al. (2019) reports physicians were found to place "Do Not Remove' orders which superseded nurse-empowered removal policies and added to confusion. Stop orders directed at nurses can help empower them to seek a removal request from a physician or autonomously remove the catheter on the basis of an appropriate indication list (European Join Report 2020). The European Joint Report (2020) recommends that nurse leaders equip nursing staff with evidence-based protocols to help guide decision-making.

Recent studies (Landerfelt et al. 2020, Russel et al. 2018, Sherley et al. 2018) have identified strong nursing leadership and nurse-initiated catheter discontinuation orders can decrease CAUTI rates. Landerfelt et al. (2020) highlights how nursing leadership can facilitate reducing CAUTI through nurse-physician teamwork and allowing nurses the autonomy to make important patient care decisions.

10.3 Study contribution to knowledge

This mixed methods research study has made a unique contribution to knowledge, being the first study to date to provide in-depth insight into urine output monitoring practices in acute medical environments. Chapter 2 and 3 of this thesis highlight how knowledge regarding urine output monitoring in acute care is limited. Although the challenge surrounding accurate urine output monitoring in an acute care environments was well documented, this study has shed light on the complexities contributing to these difficulties, including the facilitators and barriers to urine output monitoring using both urinary catheters and alternative non-invasive collection measure. This study has revealed inserting a catheter for the purpose of urine output monitoring was often a relatively simple clinical decision whereas the decision to remove a catheter once inserted was less straight forward. This work has important clinical relevance as prior to this study, there was a lack of understanding on the factors that influenced the use of urinary catheters and other strategies to monitor urine output in acute care.

In addition, this doctoral study is the first to recognise urine output monitoring practices as a continuum, where the requirement for precise monitoring may reduce over time. This process has been illustrated in the conceptual model, which has been developed and displayed in Chapter 9. The findings of this doctoral study acknowledge there are certain clinical situations to which catheterisation for hourly output monitoring may be appropriate. However, it is clear there is also an overreliance on IUC for output monitoring, leading to unnecessary prolonged catheterisation.

10.4 Strengths and limitations of the research approach

This mixed methods study has provided clinically relevant findings that answer the research questions and meet the study objectives. Strengths of the study design have been discussed in Chapter 4. By using a pragmatic approach, quantitative and qualitative methodology were able to be combined to answer both the how and why research questions, helping to offer insight into this real world clinical problem. Incorporating both quantitative and qualitative approaches to data collection has allowed for added richness and increased the scope and comprehensiveness of findings.

Despite these strengths, this study also has limitations and weaknesses. Due to the constraints of doctoral research, data were collected from one single NHS hospital site. Therefore, findings are not generalisable to other clinical areas. However, the contextual descriptions facilitate the transferability of the findings to other settings with similar contexts (Creswell et al. 2009). Nevertheless, this study could have been improved by conducting data collection on multiple NHS hospital sites over a longer period of time to add weight to the findings made. Further research of this kind is therefore necessary to establish both the validity and generalisability of these findings.

Additionally, although some interview and observational data was collected out of hours, qualitative data was predominantly collected Monday to Friday, which could have impacted on the findings. However, quantitative survey data captured a 24 hour period of care and therefore offered insight into aspects of care received during the night.

10.5 Directions for future research

After review of the current evidence base and following the completion of this mixed methods study, further areas of research have been identified that need to be addressed in the future. This study has provided a starting point for improving urine output monitoring in acute care environments and has shed light on the need to reduce prolonged and clinically unnecessary catheterisation.

As previously highlighted, there is clear need for further research to identify health care workers' perceptions of risk in relation to urine output monitoring and how different methods of monitoring, particularly using an IUC for hourly measurements impact on patient outcomes. Further studies investigating specific therapeutic decisions influenced by urine output would also assist in the development of knowledge and understanding. This in turn may inform the development of evidence-based criteria that can be used by healthcare professionals to guide decisions on how and when to monitor urine output, in order to promote a more judicious approach to monitoring and prevent inappropriate catheterisations. Investigations into whether bladder scanners are valid and suitable alternatives to IUC to assess hourly urine production would also be beneficial.

The findings of this study have provided in-depth insight into the facilitators and barriers to monitoring urine output in acute care environment. Exploring ways in which these challenges can be overcome will not only assist in the advancement of knowledge but it will also change practice and improve patient care. It is likely that attempts to reduce IUC use in acute care will continue to be limited until clinicians can trust non-invasive urine output monitoring approaches. The difficulties experienced by participants when trying to implement non-invasive methods in this present study has highlighted some possible explanations for inaccuracies when using these approaches. In view of this, there is a clear need to investigate non-invasive methods of monitoring more closely to establish how this important element of care can be improved. In particular the use and efficacy of different incontinence pads for monitoring urine output in acute care should be explored in order to assess whether this could be better managed.

Further studies exploring patients' views and experiences regarding the use of IUC compared to non-invasive collection approaches would also be valuable in order to gain additional knowledge of the patient experience. In addition, studies investigating whether catheter stewardship programmes can impact on reducing catheter dwell time and CAUTI rates would also be advantageous.

As a final point, this study has shown that a mixed methods approach which incorporates both survey and ethnographic methodology can successfully investigate clinical issues in practice. How and why type research questions can be effectively answered and knowledge of the wider factors influencing care can be explored. It is, therefore,

encouraged that future clinical research considers using mixed methods techniques when undertaking comparable studies in clinical settings.

10.6 Implications for clinical practice

Despite the knowledge gaps discussed in the above section, there remains areas of current clinical practice that could be improved to address the over-reliance on urinary catheters and improve urine output monitoring in acute medical environments. Findings from this mixed methods study illustrate that the need to monitor urine output accurately drives up the use of urinary catheters, particularly when non-invasive methods of urine measurement are less successfully employed. Improvement in the use of non-invasive methods, together with accurate charting, is needed to avoid over-reliance on urinary catheters and urine meters for urine output monitoring.

Urine meters were found to be over-used in medical wards, yet hourly urine output measurements were rarely undertaken outside of critical care. Urine meters are costly and bulky items that can restrict mobility and potentially prolong catheter dwell time. Guidance is needed to help clinicians distinguish between indications for hourly urine output monitoring and accurate, but not hourly, monitoring. This will support decision-making about judicious use of catheters and urine meters or alternative urine collection methods.

Hydration charts offer a viable alternative to fluid balance charts for those patients who require less precise monitoring. Despite being straightforward to complete, only one quarter of charts assessed were completed in full and so this requires improvement. It may be possible to involve some patients in completing their hydration chart. It is important to ensure patients are involved in decision-making about their care regarding urine output monitoring to ensure they are informed and to gain their co-operation. This includes informing them about the risks associated with indwelling urinary catheters.

Recommendations for practice

Improving the use of non-invasive methods of urine output monitoring

- Training is needed to ensure all staff are aware of how urine output can be monitored non-invasively including the weighing of incontinence pads.
- All sluice rooms need an information poster including dry weights for urinals, commode liners, bedpans and incontinence pads to improve the use of digital weighing scales for urine measurement.
- Wrap-around incontinence pads were identified by nurses in this study to reduce leakage (compared to insert pads), potentially improving the accuracy of fluid balance charting for patients with incontinence on fluid balance charts.
- Urethral sheaths are under-utilised as an alternative to indwelling catheters for male patients who require urine output monitoring. Training is needed to ensure nurses and healthcare assistants are competent in the use of urethral sheaths.
- Ensuring good communication systems are in place to alert healthcare staff to the requirement to monitor a patient's urine output.

Reducing unnecessary use of catheters and urine meters

- Catheters inserted for urine output monitoring should be reviewed daily review by the medical and nursing team. Patients no longer requiring hourly monitoring should be considered for trial without catheter (TWOC). Non-invasive collection methods should be utilised if urine output monitoring is still required.
- Whenever possible, patients transferring from a critical care/HDU area to a ward who no longer require hourly urine output monitoring should be considered for TWOC before transfer to avoid unnecessarily prolonged catheter dwell time.

Improving the use of hydration charts

- To reduce the number of unnecessary fluid balance charts in use, patients with resolved AKI and resolved sepsis should have this clearly documented in order to avoid on going identification as risk factors in the hydration assessment.
- Whenever possible, patients should be encouraged to participate in completing their own hydration chart.

Encouraging patient involvement

- Whenever possible, patients should be involved in decision-making about their care regarding urine output monitoring, including the use of urinary catheters and alternative methods.
- Patients should be informed about the risks associated with urinary catheters and encouraged to use alternatives when possible.

10.7 Conclusion

In conclusion, this pragmatic mixed methods study has advanced knowledge of urine output monitoring practices in acute medical environments. The catheter paradox in which catheters on the one hand can offer early detection of deterioration, however at the same time can expose patients to harm remains an important clinical issue. Further work is required to raise the profile of infection prevention (and other catheter related harms) amongst clinicians, so that similar priority is given to risks posed by catheters as to other patient safety issues.

Two decades on and the recommendation made by Maki and Tambyah (2001) that urine output should be monitored hourly only when clearly indicated by the patient's condition has yet to be resolved in clinical practice. Conflicting goals, risk aversion and limited resources have likely increased clinicians' reliance on indwelling urinary catheters to monitor urine output.

The work in this thesis has highlighted the need to address the unnecessary and prolonged use of catheters in acute care to monitor urine output. The redundancy of most urine meters outside of critical care reveals considerable potential for reduction in urinary catheters and thereby in catheter-associated infections. Catheter stewardship should be explored further as problems highlighted by this study could be addressed by applying these principles. In addition, barriers associated with non-invasive collection methods need to be resolved to increase clinicians' trust in these approaches and to ensure patients receive safe and responsive care without overreliance on urinary catheters. For every additional day a IUC remains in place, the risk of infection increases. Therefore, wherever possible, non-invasive urine output monitoring methods need to be viewed and implemented as a viable alternative and made the option of choice when hourly measurements are not indicated.

Appendices

Appendix 1: AKI classification, risk factors and management.

AKI Classification:

Pre-renal AKI

Kidney function is dependent upon adequate blood pressure when a patient has a prolonged drop in their blood pressure they are at risk of developing AKI. This is usually reversible on correction of underlying cause. Causes of pre-renal AKI in patients include:

- Sepsis, due to a drop in blood pressure as a result of vasodilatation
- Increased losses leading to volume depletion, for example vomiting and diarrhoea, severe bleeding
- Dehydration when patients are unable to maintain good hydration without help from others
- Reduced cardiac output or heart failure that leads to hypotension

(Think Kidneys 2018)

Intrinsic AKI

Intrinsic causes of AKI relate to direct damage to the kidneys, causes include:

- Prolonged pre-renal AKI, whereby a sustained drop in blood pressure results in tubular cell damage
- Medications that may exacerbate hypovolaemia and hypotension such as Loop diuretics, Angiotensin Converting Enzyme inhibitors and Angiotensin Receptor Blockers
- Medications that can be potentially harmful to the kidneys in the setting of acute illness such as Non-Steroidal Anti-inflammatory drugs
- Toxins such as Iodinated contrast or Myoglobin which is released following muscle injury secondary to trauma, infections or medication resulting in rhabdomyolysis
- Diseases of the kidney such as glomerulonephritis or tubulointerstitial nephritis

(Think Kidneys 2018)

Post-Renal AKI

Post-renal AKI may develop when there is an obstruction to urinary flow within the renal tract. Relief of obstruction usually leads to recovery of function. Examples of this include:

- Males with enlarged prostate which can lead to urinary retention
- Kidney or renal tract stones
- Pelvic/abdominal masses

(Think Kidneys 2018)

AKI Detection

AKI can be detected, in line with the RIFLE (Risk, Injury, Failure, Loss, End stage renal disease), AKIN (Acute Kidney Injury Network) or KDIGO (Kidney Disease: Improving Global Outcomes) definitions, by using any of the following criteria:

- a rise in serum creatinine of 26 micromol/litre or greater within 48 hours
- a 50% or greater rise in serum creatinine known or presumed to have occurred within the past 7 days
- a fall in urine output to less than 0.5 ml/kg/hour for more than 6 hours in adults and more than 8 hours in children and young people

(NICE NG148 2019)

AKI Risk Factors

For patients admitted to hospital, NICE NG148 (2019) recommends clinicians investigate for acute kidney injury by measuring serum creatinine and comparing with baseline in adults with acute illness if any of the following are likely or present:

- chronic kidney disease
- heart failure
- liver disease
- diabetes
- history of acute kidney injury
- oliguria (urine output less than 0.5 ml/kg/hour)
- neurological or cognitive impairment or disability, which may mean limited access to fluids because of reliance on a carer
- hypovolaemia
- use of drugs that can cause or exacerbate kidney injury
- use of iodine-based contrast media within the past week
- symptoms or history of urological obstruction, or conditions that may lead to obstruction
- sepsis
- deteriorating early warning scores
- age 65 years or over

AKI Management

Renal perfusion can be restored in patients with AKI by assessing and treating volume status. Volume status can be categorised into three states; hypovolaemic, euvolaemic or hypervolaemic (Harty 2014).

- Hypovolaemic patients may have clinical signs of dehydration and are likely to be oliguric, this should be promptly corrected with repeated fluid boluses.

- Euvolaemia is characterised by haemodynamic stability with an absence of clinical signs of dehydration or volume overload. Oliguria in this context often reflects established acute tubular necrosis and will not respond to increasing fluid challenges, which put the patient at risk of fluid overload. In these cases, it is recommended that fluid intake should be restricted to match daily output.

- Hypervolaemic patients may have signs of peripheral and pulmonary oedema. Calculation of total fluid balance should alert clinicians to the potential of fluid overload. For hypervolaemic patients with AKI it is recommended that fluid intake should be restricted. In patients with pulmonary oedema, a short course of loop diuretics may be trialled however failure to respond would be an indication for haemofiltration.

(Harty 2014)

Appendix 2: Summary of studies: Oliguria

Reference	Study design	Total sample size	Setting	Results	Strengths	Limitations
Harrison et al. (2006)	Retrospective cross sectional survey	3046	Multicentre 5 hospitals.	Decrease in urine output a prevalent predictor for mortality.	Multicentre with large sample size therefore results are genralisable.	Retrospective nature introduces potential bias and confounders.
					Bias reduced by analysing date from admission rather than total number of recordings.	Data may only represent minimum prevalence of signs and not truly reflect actual deterioration.
Avila et al. (2009)	Retrospective cohort study	879	Single centre	Reduced urine volume was identified as an independent strong predictor of mortality for critically ill AKI patients.	Logistic regression used to find correlation between urine volume and risk of death.	Single centre therefore limited generalisabilty.
						Small sample size.
						Retrospective nature introduces potential bias and confounders.
						Patient's disease severity scores not recorded,

						which could create bias.
Macedo et al. (2011a)	Prospective observational study	317	ICU in single centre	Oliguric patients without a change in serum creatinine had a mortality rate of 8.8% significantly higher that patients without AKI (1.3%) and similar to patients with an increase in creatinine (10.4%). Oliguria of more than 12 h and oliguria of 3 or more episodes were associated with an increased mortality rate. Thus, urine output is a sensitive and early marker for AKI and is associated with adverse outcomes in intensive care unit patients.	Data collected prospectively. Population was heterogeneous. Urine output assessed hourly.	Single centre therefore limited generalisabilty. Small sample size. Patient disease severity scores unavailable. Baseline sCr prior to hospitalisation was not known in all patients. Not known whether volume status in these patients was optimised first, prior to applying definitions of oliguria to diagnose AKI.

Macedo et al. (2011b)	Prospective observational study	75	ICU in single centre	Fifty-five percent of patients had an episode of oliguria during the ICU stay.	Data collected prospectively.	Single centre therefore limited generalisabilty.
					Urine output assessed hourly.	Small sample size.
				There was no significant difference assessing urine output every hour or the total urine volume in a 6-h period for the detection of episodes of oliguria.		Patient disease severity scores unavailable.
						Baseline sCr prior to hospitalisation was not known in all patients.
				Urine output appears to be a valid criterion with prognostic value in patients with AKI.		Not known whether volume status in these patients was optimised first, prior to applying definitions of oliguria to diagnose AKI.

Mandelbaum et al. (2011)	Retrospective cohort study	14,526	Single centre	When urine output was less than 0.5ml/kg/hr mortality rate increased rapidly as urine output decreased. Urine output slightly out-performed creatinine in mortality prediction. Urine output features several advantages over creatinine such as an earlier indication of deterioration.	Large sample size. Strong statistical power.	Single centre therefore limited generalisabilty. Retrospective nature introduces potential bias and confounders. Data collected over 7 years during which changed of management if critically ill patients could change outcomes.
Wlodzimirow et al. (2012)	Prospective observational cohort study	260	ICU in single centre	6% had persistent oliguria and died without a rise in creatinine. Discarding the urine criteria significantly underscores the incidence and grade of AKI and significantly delays diagnosis, with associated higher mortality.	Data collected prospectively. Urine output measured hourly. Results were statistically significant.	Single centre therefore limited generalisabilty. Small sample size. SCr was measured daily, more frequent SCr measure-ments may result in earlier detection of AKI.

Zhang et al. (2014)	Retrospective cohort study	21,207	Various ICUs in single centre	Urine output on day 1 admission to ICU was significantly lower in non-survivors than in survivors.	Large sample size. Various types of ICU, therefore results applicable to heterogeneous ICU patients.	Single centre ICUs therefore limited generalisabilty to other wards. Retrospective nature introduces potential bias and confounders. Urine output was recorded for 24 h and then divided by 24 to obtain hourly urine output. Therefore excluding the 6hr analysis interval. Mortality rate was relatively low therefore less generalizable to other ICUs.
Harris et al. (2015)	Retrospective cohort study	155,624	226 ICUs from 212 hospitals	Large numbers of patients with mild oliguria have a significantly elevated ICU mortality.	Multicentre with large sample size therefore results are genralisable.	Baseline Cr unknown. 24hr urine collection, hourly urine output measurements not known.

Kellum et al. (2015)	Retrospective cohort study	32,045	8 ICUs in single centre	Stage 2 and 3 AKI by urine output criteria are associated with decreased 1-year survival.	Large sample size. Various types of ICU, therefore results applicable to heterogeneous ICU patients. Overall event rates and outcomes agree well with recent epidemiologic studies of AKI.	Single center ICUs therefore limited generalisabilty to other wards. Retrospective nature introduces potential bias and confounders. Study was observational and therefore cannot establish causality.
Vaara et al. (2016)	Prospective cohort study	2160	Multicentre-16 ICUs	Consecutive oliguria independently associated with an increased risk for 90-day mortality were 6–12 h of oliguria from 0.3 to 0.5 ml/kg/h, over 6 h of oliguria from 0.1 to 0.3 ml/kg/h, and severe oliguria lasting over 3 h.	Prospective multicenter design. Adjusted for confounding variables.	ICUs only therefore limited generalisabilty to other wards. Not known whether volume status in these patients was optimised first, thus some patients could have be dehydrated.

Appendix 3: Summary of studies: AKI

Reference	Study design	Total sample size	Setting	Results	Strengths	Limitations
Liangos et al. (2005)	Retrospective cohort study	40	ICU in single centre	AKI was non-oliguric in 63.9% of cases. Among patients with acute renal failure requiring intermittent hemodialysis, increased urine output is associated with higher mortality.	Statistically significant.	Single center therefore limited generalisabilty . Small sample size. Retrospective nature introduces potential bias and confounders. Underpowered to identify additional risk factors.
Barrantes et al. (2008)	Retrospective cohort study	471	ICU in single centre	Oliguria criterion did predict AKI but did not affect odds of in hospital mortality as no patient with AKI who either died of required RRT has decreased urine volume without increase in serum creatinine. Sole criterion of serum creatinine for AKI has advantage of not requiring hourly urine output measurements.		Single center therefore limited generalisabilty . Small sample size. Retrospective nature introduces potential bias and confounders. Detailed fluid challenge information only available for 123 patients.
Kolhe et al. (2008)	Retrospective cohort study	17,326	Data collected from the UK Intensive Care National Audit and Research Centre	AKI was non-oliguric in 63.9% of cases. However oliguric AKI was associated with greater ICU mortality.	Large sample size.	Retrospective nature introduces potential bias and confounders.
Joannidis et al. (2009)	Retrospective cohort study	16,784	Multicentre-303 ICUs	Classification of AKI using worst creatinine resulted in clearly higher mortality rates at each stage compared to urine output or both criteria.	Multicentre with large sample size therefore results are genralisable.	Retrospective nature introduces potential bias and confounders. Urine output not tracked at 6-h intervals, but only at 24-h intervals, therefore cannot distin-

						guish between the AKIN stage 1 and 2 subgroups. This may have resulted in classifying patients with less severe AKI into the inter- mediate degree of AKI.
Prowle et al. (2011)	Prospective observational study	239	Multicentre- 7 ICUs from 6 countries	Only 30 of 487 individual episodes of oliguria preceded the new occurrence of AKI-Creatinine. Presence of 4hrs or more oliguria provided the best discrimination. Therefore, although oliguria is significantly associated with AKI- Creatinine most episodes of oliguria are not followed by biochemical renal injury. Oliguria alone is at best only a fair predictor of AKI-Creatinine.	Prospective design, and representativ e of a diverse population of critically ill patients from several countries and a variety of ICU settings.	Small sample size. A number of patients had their baseline sCr and/ or body weight estimated. True significance of individual variables is difficult to assess.
Han et al. (2012)	Retrospective cohort study	1625	ICU in single centre	Urine Output Criteria (UOCr) did not detect >40% of the AKI. The UOCr could detect only oliguric AKI but not non-oliguric AKI. Non-oliguric AKI comprises 50% of AKI. CrCr predicted mortality better than the UOCr. Although misclassification of AKI occurred when using the UOCr alone, the UOCr had a beneficial effect in defining and staging AKI compared to the CrCr alone.	Adjusted diuretic doses in the analyses.	Retrospective nature introduces potential bias and confounders. Single center therefore limited generalisabilty Fluid balance data not collected which could influence outcomes.
Ralib et al. (2013)	Prospective cohort study	725	Single centre	A 6-hour urine output threshold of **0.3 ml/kg/hour** best associated with mortality and dialysis, and was independently predictive of both hospital mortality and 1-year mortality. A	Factors which influence urine output were included in the analysis of prediction of hospital mortality and 1-year mortality.	Single center therefore limited generalisabilty . Small sample size. Bias may have occurred

	shorter duration of urine output assessment may provide earlier diagnosis; however, this may be more susceptible to extraneous factors. A longer period of assessment >9 hours is less sensitive and may miss acute changes.	due to illness severity. Body weight was determined indirectly from the most recent body weight documented in medical records, or as reported by a patient or relative. 6% were estimated from the patient demi span.

Appendix 4: Summary of studies: Sepsis

Reference	Study design	Total sample size	Setting	Results	Strengths	Limitations
Bagshaw et al. (2009)	Retrospective	4,532	Multicentre 22 ICU	64.4% of patients with septic shock developed early AKI. AKI was associated with significantly higher odds of death. Survival was considerably lower for septic shock associated with early AKI, with increasing severity of AKI.	Large sample size. Multicentre	Retrospective nature.
Suh et al. (2013)	Retrospective	992	Single centre	AKI developed in 57.7% of patients admitted with sepsis and septic shock. The development of septic AKI was associated with poor clinical outcomes. Furthermore, the severity of AKI was associated with increased mortality.	Large sample size.	Retrospective nature. Data was collected in a single university hospital. Therefore, the incidence and severity of diseases might be biased.

Appendix 5: Summary of studies: Fluid Balance

Reference	Study design	Total sample size	Setting	Results	Strengths	Limitations
Shum et al. (2011)	Retrospective	639	Single centre	Fluid balance on the second plus third ICU days, and total fluid balance during ICU stay were positively associated with hospital death. Significant positive fluid balance on first ICU day, in contrast, was negatively associated with hospital mortality.	Large sample size	Retrospective nature. Absence of a standardised protocol on fluid administration. Therefore cause-effect relationship between positive fluid balance on the second plus third ICU days and observed hospital mortality could not be ascertained.
Teixeira et al. (2013)	Secondary analysis of prospective cohort study	601	Multicentre	Both higher fluid balance and a lower urine volume were shown to be independent predictors of 28-day mortality.	Multicenter contributing to reduce practice bias	Due to the observational nature of the study, a causal relationship between fluid balance, urine volume and mortality cannot be established.

Appendix 6: Summary of other included studies

Reference	Study design	Total sample size	Setting	Results	Strengths	Limitations
Chung et al. (2002)	Retrospective quantitative study.	250 medical records	Single centre	32% of FBC were found to be incomplete or inaccurate. 45% of nurses and almost 80% of doctors said that data entries were not always accurate. Over 60% of doctors agreed that the calculations of total FB were always inaccurate, while only 9.9% of nurses agreed with this.	Project originated from a genuine concern about the futility of much fluid balance documentation therefore findings are relevant to clinical practice.	Retrospective nature introduces potential bias and confounders. Single centre therefore limited generalisabilty Small sample size. Potential for observer effect or researcher bias to influence the opinion survey.
Tang and Lee (2010)	Prospective study	25 surgical trainees interpreting 13 fluid balance charts	Single centre	There is a statistically significant difference from the original documented values to calculated values. Incorrect interpretation of these charts is not due to lack of clinical experience, but the fundamental problem lies within the lack of education and inconsistent and poor documentation of these charts.	Prospective design. Findings relevant to clinical practice	Single centre therefore limited generalisabilty Small sample size
Perren al. (2011)	Prospective descriptive study	147	Single centre ICU	Cumulative FBCs were inaccurate in 49 cases	Prospective design. Findings	Single centre therefore limited

				(33%) with errors ranging from -3606 mL to +2020 mL. Patient care and clinical decision-making should be based on more objective techniques.	relevant to clinical practice	generalisabilty Small sample size
Bonfield (2013) (Unpublished)	Qualitative study.	17	Single centre	Results identified barriers to FBC completion. 5 key themes were revealed: individual insight, making time to do it, knowledge and training, making it easier to be accurate and competing ward activities. 16 participants identified that FBC are currently inaccurate.	Findings relevant to clinical practice	Small sample size. Purposive convenience sample. Single centre therefore limited generalisabilty
Diacon and Bell (2014)	Retrospective audit	103	Single centre ICU	The majority of fluid balance records were incorrectly calculated. 79% deviated by more than 50 mL from the audited calculations.	Findings relevant to clinical practice	Single centre therefore limited generalisabilty Small sample size Retrospective nature introduces potential bias and confounders.

Vincent and Mahendiran (2015)	Quality improvement project	117	Single centre	Initial results revealed 67% of patients were on input/output monitoring. Of all patients on input/output monitoring, it was only clinically relevant in 53%. Average chart completion rate was 50%. Average chart accuracy was 41%. Post-intervention audit showed a 93% reduction in unnecessary monitoring, with corresponding increases in completion (40%) and accuracy (48%) of remaining charts.	Findings relevant to clinical practice	Single centre therefore limited generalisabilty Small sample size Quality improvement projects can lack rigour of scientific research.
Dutta et al. (2009)	Comparative study	5	Single centre	Urinary losses are less from sanitary napkins than ANPs.	Findings relevant to clinical practice	Single centre therefore limited generalisabilty Small sample size
Enright et al. (2015)	Prospective pilot study	45	Single centre	Serial bladder ultrasound scanning using a hand-held device is a convenient, non-invasive and objective adjunct in the management of suspected dehydration in the emergency department.	Findings relevant to clinical practice	Single centre therefore limited generalisabilty Small sample size One investigator and so no opportunity to assess interobserver reliability.
Schallom et al. (2020)	Prospective correlational descriptive study	73	Single centre	Bladder volume can be measured accurately with bladder scanning or US, but abdominal	Findings relevant to clinical practice	Single centre therefore limited generalisabilty

				fluid remains a confounding factor limiting accuracy of bladder scanning.		
Apisarnthanarak et al. 2007	Cross-sectional study	895	Single centre	One hundred thirty-one (15%) of 895 patients had initiation of IUC. UC were inappropriately used more commonly among female, no ambulatory, and medical ICU patients.	Large sample size	Single centre therefore limited generalisability
Fernandez-Ruizet al. 2013	Cross-sectional study	380	Single centre	46 (12.1%) had a urinary catheter in place. Twelve of them (26.1%) were inappropriately catheterised. The most common indication for inappropriate UC was urine output monitoring in a cooperative, non-critically ill patient.	Large sample size	Single centre therefore limited generalisability
Litchfield et al. 2018	Qualitative study	10	Single centre	Four key themes were: 1) Assessment of Hydration describing the influences of clinical characteristics of patients and the staff responsible; 2) The Maintenance of Hydration, describing the provision of fluids and the monitoring of hydration levels; 3) Facilitators of hydration, describing third party support and staff awareness; 4) The Barriers experienced in relation to patient charac-teristics, finite	Findings relevant to clinical practice	Single centre and ward therefore limited generalisability

				resources and unreliable fluid balance charts. Opinions on when an IUC was warranted varied considerably. Inconsistency in decision-making was caused by differing beliefs on when an IUC was appropriate for each clinical indication.		
Murphy et al. 2015	Qualitative study	30 RTA interviews 10 Semi-structured	Single Centre		Findings relevant to clinical practice Combined two different interview approaches	Single centre and ward therefore limited generalisabilty Potential social desirability bias
Mulcare et al. 2015	Qualitative study	38	Single Centre	Participants reported believing that IUCs are overutilised in ED settings, confirming that IUCs are infrequently removed once placed and often inserted for staff convenience.	Findings relevant to clinical practice	Single centre and ward therefore limited generalisabilty

Appendix 7: NHS Trust Approval Letter

03 April 2017

Dear Sir/Madam

I am writing to authorise approval for a service evaluation of urine output monitoring strategies in Division B.

This project forms part of a programme of work in the Trust, led by Jacqui Prieto, to reduce catheter-associated urinary tract infection. Data collection will be undertaken by Jacqui and Camilla, together with two 3rd year student nurses, who will also participate in report writing. This is part of a wider initiative between the Trust and the Faculty of Health Sciences to provide group-based data collection and analysis opportunities for BN and PG Dip Nursing students towards the end of their studies. The students will undertake a pre-set programme of training and will be supervised throughout to ensure they are clear about their role and well supported.

I also note and am happy with the process for data collection and handling.

Yours sincerely

Appendix 8: Point prevalence survey data collection tool

Ward data	
Ward / unit name	
Specialty	
Gender	
Survey date	

Facilities	
Number of patients on ward	
Number of beds	
Number of single rooms	
Number of single rooms with ensuite toilets	
Number of toilets on main ward	

Equipment available	**Yes/No**		**Yes/No**
Medical grade scale		Catheter valve (flip flo)	
Info poster of dry weights		Intermittent catheter	
Poster includes inco pads		Catheter securing device	
Bladder scanner		2 litre drainage bag	
Ultrasound gel for scanner		Leg bag	
Insert incontinence pad		Night bag	
Wrap around incontinence pad		Urometer	
Sheath catheter (conveen)			

0

Comments

Patient data		**Sticker**
Ward / unit name		
Specialty		
Gender		
Survey date		

Admission date & diagnosis					
Current diagnosis					
AKI alert/risk factors	DM	>75 yrs	Vascular disease	Sepsis	Toxins
	Current / recent AKI	Hypo-volaemia	CKD	Heart failure	Liver failure
Hydration chart factors	LT catheter	Dementia / delirium	Diarrhoea/ Vomiting	Wound drainage	Decreased appetite
	Unable to pour drink	IV/NG/ PEG/TPN	NBM>6hrs	Fluid restriction	Diuretics
Request for urine output monitoring in medical notes				Yes	No
Request for indwelling catheter in medical notes				Yes	No

Hydration assessment (previous 24hrs)	No	FBC	HC	none
Reasons recorded for use of chart				
Other relevant reasons (not recorded)				
Appropriate chart used?				
HC completed (previous 24hrs)	0/3	1/3	2/3	3/3
FBC completed (previous 24hrs)	Target U/O ml/hr		Balance	
	Input: oral		IV	other
	Output: complete		partial	inadequate
Frequency of UO measurement	Hourly		2-4 hourly	
	4-6 hourly		>6 hourly	

Urinary catheter	Yes / No	Indication:	Days in situ:
Drainage system:		Urometer justified?	Yes / No / NA

Other method	Incontinence pad	Commode	Bedpan
	Urinal	Conveen	Pan in toilet

Mobility	Fully dependent	Assistance needed	Independent

Appendix 9: Clinician Participant Information Sheet

Clinician Participant Information Sheet

Study Title: Urine output: how and why is it monitored in acute medical environments?

Researcher: Camilla Bennett

IRAS Number: 226223

ERGO: 41421

Date: 22/11/18 **Version: 1.1**

You are being invited to take part in the above research study. To help you decide whether you would like to take part or not, it is important that you understand why the research is being done and what it will involve. Please read the information below carefully and ask questions if anything is not clear or you would like more information before you decide to take part in this research. You may like to discuss it with others but it is up to you to decide whether or not to take part. If you are not happy to participate you will be asked to sign a opt- out form.

What is the research about?

I would like to invite you to take part in my PhD research study. Before you decide I would like you to understand why the research is being done and what it would involve for you.

There has been little research about when, how and why urine output is monitored for patients in acute medicine. This study will help to provide an understanding of what influences the use of catheters and other methods of urine output monitoring.

Why have I been asked to participate?

You have been invited to take part in this study because the care that you provide involves monitoring urine output or making therapeutic decisions influenced by urine output measurements.

What will happen to me if I take part?

If you decide to take part there are two sections to the study. Firstly, data collection periods will take place at set times in your department/ward. During those periods, I will be

observing urine output monitoring practices. I may ask you about clinical decisions that have been influenced by urine output measurements that day, asking you to briefly talk me through the decision and outcome. I may also ask about clinical goals for the patient and factors that affect how urine monitoring is undertaken. I will make brief written notes of these conversations, which will be anonymised.

Secondly, I may invite you to participate in a semi-structured interview, at a time convenience to you, to discuss your views and experiences of urine output monitoring in acute medicine. It is anticipated that this interview will last around half an hour. The interview will be digitally recorded and notes will be taken. Written consent will be required if you decide to take part in an interview.

Are there any benefits in my taking part?

You will not be offered any form of inducement or compensation for participating in this study. However, you may feel like you have benefited from engaging in the study, by contributing to knowledge and having an opportunity to reflect on practice. While this study is unlikely to offer direct benefit at the time of your involvement, information gained may be used to improve future care.

Are there any risks involved?

I do not anticipate that there will be any risks to you in taking part in the study. I will make all efforts to minimise any interruption to your working day and, even if you have agreed to participate in the study, you are under no obligation to meet me if it is inconvenient or for any other reason.

Will my participation be confidential?

Your participation and the information we collect about you during the course of the research will be kept strictly confidential.

Only members of the research team and responsible members of the University of Southampton may be given access to data about you for monitoring purposes and/or to carry out an audit of the study to ensure that the research is complying with applicable regulations. Individuals from regulatory authorities (people who check that we are carrying out the study correctly) may require access to your data. All of these people have a duty to keep your information, as a research participant, strictly confidential.

If you consent to take part your name will be taken and you will then be attributed a study number. All data collected will be coded under this number and anonymised. There is a chance that participants could be linked to the data, however the 'key' to this link will be stored securely with restricted access. Data will be transcribed by the researcher and will be stored in electronic form on a password protected university computer in a password protected data file. Any paper versions will be shredded and disposed of as confidential waste. A master file of signed informed consent forms will be maintained in accordance with University and Trust guidance.

Data Protection Privacy Notice

The University of Southampton conducts research to the highest standards of research integrity. As a publicly-funded organisation, the University has to ensure that it is in the public interest when we use personally-identifiable information about people who have agreed to take part in research. This means that when you agree to take part in a research study, we will use information about you in the ways needed, and for the purposes specified, to conduct and complete the research project. Under data protection law, 'Personal data' means any information that relates to and is capable of identifying a living individual. The University's data protection policy governing the use of personal data by the University can be found on its website (https://www.southampton.ac.uk/legalservices/what-we-do/data-protection-and-foi.page).

This Participant Information Sheet tells you what data will be collected for this project and whether this includes any personal data. Please ask the research team if you have any questions or are unclear what data is being collected about you.

Our privacy notice for research participants provides more information on how the University of Southampton collects and uses your personal data when you take part in one of our research projects and can be found at http://www.southampton.ac.uk/assets/sharepoint/intranet/ls/Public/Research%20and%20Integrity%20Privacy%20Notice/Privacy%20Notice%20for%20Research%20Participants.pdf

Any personal data we collect in this study will be used only for the purposes of carrying out our research and will be handled according to the University's policies in line with data

protection law. If any personal data is used from which you can be identified directly, it will not be disclosed to anyone else without your consent unless the University of Southampton is required by law to disclose it.

Data protection law requires us to have a valid legal reason ('lawful basis') to process and use your Personal data. The lawful basis for processing personal information in this research study is for the performance of a task carried out in the public interest. Personal data collected for research will not be used for any other purpose.

For the purposes of data protection law, the University of Southampton is the 'Data Controller' for this study, which means that we are responsible for looking after your information and using it properly. The University of Southampton will keep identifiable information about you for 10 years after the study has finished after which time any link between you and your information will be removed. No identifiable information will be held at University Hospital Southampton NHS Foundation Trust.

To safeguard your rights, we will use the minimum personal data necessary to achieve our research study objectives. Your data protection rights – such as to access, change, or transfer such information - may be limited, however, in order for the research output to be reliable and accurate. The University will not do anything with your personal data that you would not reasonably expect.

If you have any questions about how your personal data is used, or wish to exercise any of your rights, please consult the University's data protection webpage (https://www.southampton.ac.uk/legalservices/what-we-do/data-protection-and-foi.page) where you can make a request using our online form. If you need further assistance, please contact the University's Data Protection Officer (data.protection@soton.ac.uk).

Do I have to take part?

No, it is entirely up to you to decide whether or not to take part. If you do not wish to take part, you can complete an opt-out form. If you decide to take part you are still free to stop observations of practice at any time without having to provide a reason.

If you decide you want to take part in the semi-structured interviews, you will need to sign a consent form to show you have agreed to take part.

What happens if I change my mind?

You have the right to change your mind and withdraw at any time without giving a reason and without your participant rights being affected. To withdraw please contact the researcher on the email address provided below.

What will happen to the results of the research?

The results from this study will be used for my PhD and a written report will be provided to the hospital. The report will also be provided to any participant who requests a copy. Anonymised results from the study will also be disseminated via journal publications and conferences.

Research data will be stored for a minimum of 10 years as per University of Southampton policy.

Where can I get more information?

The researcher is based at the School of Heath Sciences, University of Southampton. Contact details: Camilla.Bennett Cb26g11@soton.ac.uk

What happens if something goes wrong?

If you have a concern about any aspect of this study, you should speak to the researchers who will do their best to answer your questions.

If you remain unhappy or have a complaint about any aspect of this study, please contact the University of Southampton Research Integrity and Governance Manager (023 8059 5058, rgoinfo@soton.ac.uk).

Thank you.

Thank you for taking the time to read this information sheet and considering taking part in the research.

Appendix 10: Clinician opt-out form

CLINICIAN OPT-OUT FORM FOR ETHNOGRAPHIC STUDY

Study title: **Urine output: how and why is it monitored in acute medical environments?**

Researcher name: Camilla Bennett

IRAS number: 226223 **ERGO**: 41421

Date: 22/11/18 **Version: 1.1**

Please initial the box(es) if you agree with the statement(s):

I have read and understood the information sheet *(22/11/18 / Version: 1.1 Clinician participant information sheet)* and have had the opportunity to ask questions about the study.	
I would not like to take part in this research project.	

Name of participant (print name)……

Signature of participant……

Date……..

Name of researcher (print name)……

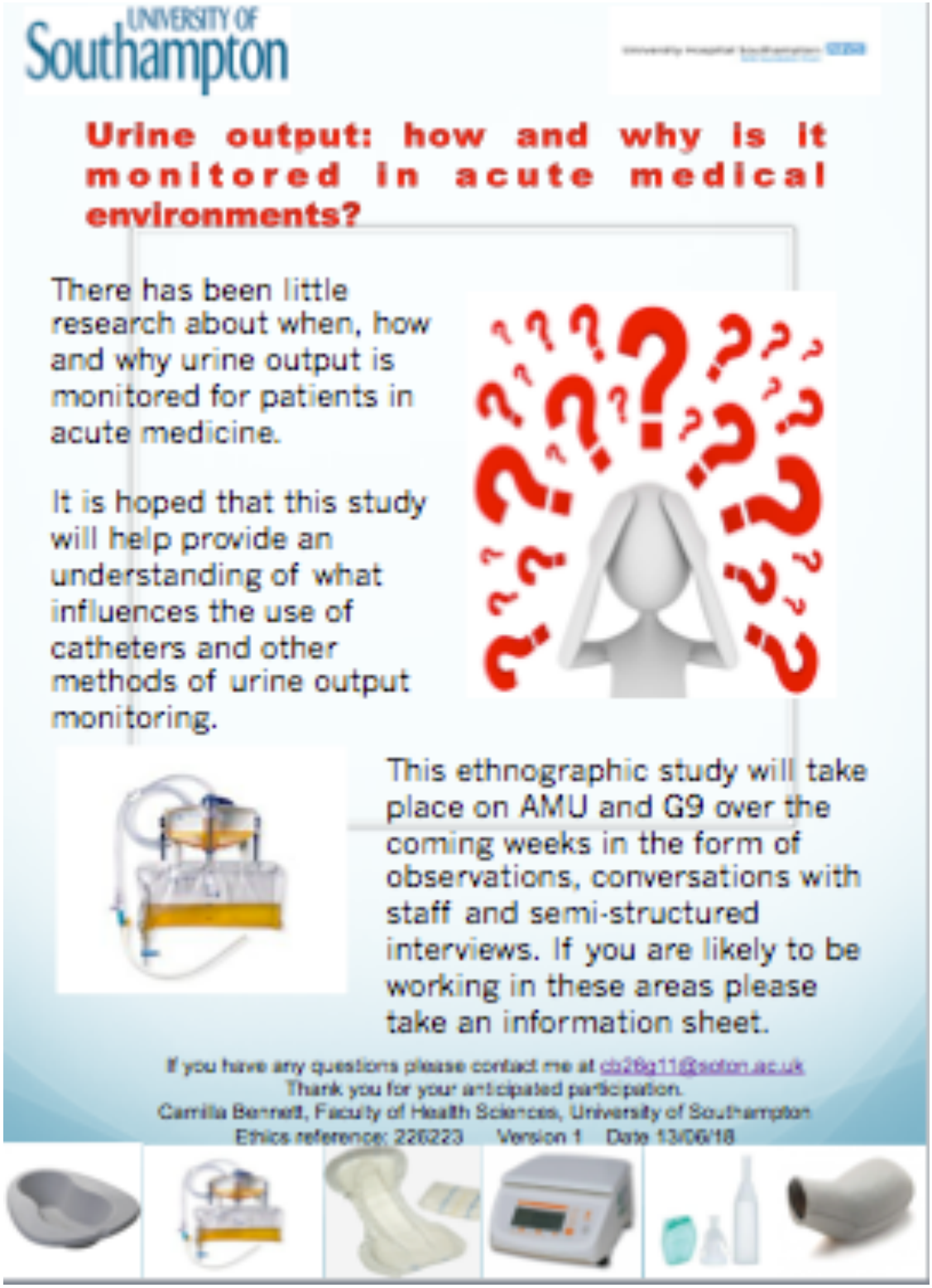
Signature of researcher

……

Date……

(copy for participant, copy for researcher)

Appendix 11: Research Information Poster



Appendix 12: Patient Participant Information Sheet

Patient Participant Information Sheet

Study Title: Urine output: how and why is it monitored in acute medical environments?

Researcher: Camilla Bennett

IRAS Number: 226223 **ERGO**: 41421

Date: 22/11/18 **Version: 1.1**

You are being invited to take part in the above research study. To help you decide whether you would like to take part or not, it is important that you understand why the research is being done and what it will involve. Please read the information below carefully and ask questions if anything is not clear or you would like more information before you decide to take part in this research. You may like to discuss it with others but it is up to you to decide whether or not to take part. If you are happy to participate you will be asked to sign a consent form.

What is the research about?

I would like to invite you to take part in my PhD research study sponsored by the University of Southampton. Before you decide, I would like you to understand why the research is being done and what it would involve for you.

Some patients in hospital need to have their urine measured. There are different ways of doing this and we would like to know more about which method is better in different situations. We hope that in the future this will help doctors and nurses choose the best method for each patient.

Why have I been asked to participate?

You have been invited to take part in this study because the care you receive involves measuring your urine.

What will happen to me if I take part?

If you decide to take part, your medical notes will be accessed and you may be asked about your understanding and involvement in your care. Data from your medical notes and anything you say that is of relevance to the study will be collected for the purpose of this study. The researcher may also observe the doctors during their medical ward round of your care. Data from their medical notes, observations of theses ward rounds, and anything else they say that is of relevance to the study will be collected for the purpose of this study. The researcher may access your medical notes for the duration of the study however there will be no long-term monitoring.

Are there any benefits in my taking part?

You will not be offered any form of inducement or compensation for participating in this study. However, you may feel like you have benefited from engaging in the study, by contributing to knowledge. While this study is unlikely to offer direct benefit at the time of your involvement, information gained may be used to improve future care.

Are there any risks involved?

I do not anticipate that there will be any risks to you in taking part in the study.

What data will be collected?

Data collected from your medical notes will include:

- Gender
- Age
- Diagnosis
- Relevant past medical history
- Blood test results
- Vital signs documented such as - blood pressure, heart rate, fluid balance.
- Medical and nursing plans and documentation

Will my participation be confidential?

Your participation and the information we collect about you during the course of the research will be kept strictly confidential.

Only members of the research team and responsible members of the University of Southampton may be given access to data about you for monitoring purposes and/or to carry out an audit of the study to ensure that the research is complying with applicable regulations. Individuals from regulatory authorities (people who check that we are carrying out the study correctly) may require access to your data. All of these people have a duty to keep your information, as a research participant, strictly confidential.

If you consent to take part your name will be taken and you will then be attributed a study number. All data collected will be coded under this number and anonymised. There is a chance that participants could be linked to the data, however the 'key' to this link will be stored securely with restricted access. Data will be transcribed by the researcher and will be stored in electronic form on a password protected university computer in a password protected data file. Any paper versions will be shredded and disposed of as confidential waste. A master file of signed informed consent forms will be maintained in accordance with University and Trust guidance.

Data Protection Privacy Notice

The University of Southampton conducts research to the highest standards of research integrity. As a publicly-funded organisation, the University has to ensure that it is in the public interest when we use personally-identifiable information about people who have agreed to take part in research. This means that when you agree to take part in a research study, we will use information about you in the ways needed, and for the purposes specified, to conduct and complete the research project. Under data protection law, 'Personal data' means any information that relates to and is capable of identifying a living individual. The University's data protection policy governing the use of personal data by the University can be found on its website (https://www.southampton.ac.uk/legalservices/what-we-do/data-protection-and-foi.page).

This Participant Information Sheet tells you what data will be collected for this project and whether this includes any personal data. Please ask the research team if you have any questions or are unclear what data is being collected about you.

Our privacy notice for research participants provides more information on how the University of Southampton collects and uses your personal data when you take part in one of our research projects and can be found at http://www.southampton.ac.uk/assets/sharepoint/intranet/ls/Public/Research%20and%20Integrity%20Privacy%20Notice/Privacy%20Notice%20for%20Research%20Participants.pdf

Any personal data we collect in this study will be used only for the purposes of carrying out our research and will be handled according to the University's policies in line with data protection law. If any personal data is used from which you can be identified directly, it will not be disclosed to anyone else without your consent unless the University of Southampton is required by law to disclose it.

Data protection law requires us to have a valid legal reason ('lawful basis') to process and use your Personal data. The lawful basis for processing personal information in this research study is for the performance of a task carried out in the public interest. Personal data collected for research will not be used for any other purpose.

For the purposes of data protection law, the University of Southampton is the 'Data Controller' for this study, which means that we are responsible for looking after your information and using it properly. The University of Southampton will keep identifiable information about you for 10 years after the study has finished after which time any link between you and your information will be removed. No identifiable information will be held at University Hospital Southampton NHS Foundation Trust.

To safeguard your rights, we will use the minimum personal data necessary to achieve our research study objectives. Your data protection rights – such as to access, change, or transfer such information - may be limited, however, in order for the research output to be reliable and accurate. The University will not do anything with your personal data that you would not reasonably expect.

If you have any questions about how your personal data is used, or wish to exercise any of your rights, please consult the University's data protection webpage

(https://www.southampton.ac.uk/legalservices/what-we-do/data-protection-and-foi.page) where you can make a request using our online form. If you need further assistance, please contact the University's Data Protection Officer (data.protection@soton.ac.uk).

Do I have to take part?

No, it is entirely up to you to decide whether or not to take part. If you decide you want to take part, you will need to sign a consent form to show you have agreed to take part. The researcher will then collect this from you.

What happens if I change my mind?

You have the right to change your mind and withdraw at any time without giving a reason and without your participant rights or routine care being affected. To withdraw please contact the researcher on the email address provided below.

What will happen to the results of the research?

Your personal details will remain strictly confidential. Research findings made available in any reports or publications will not include information that can directly identify you without your specific consent.

The results from this study will be used for my PhD and a written report will be provided to the hospital. The report will also be provided to any participant who requests a copy. Anonymised results from the study will also be disseminated via journal publications and conferences.

Where can I get more information?

The researcher is based at the School of Heath Sciences, University of Southampton. Contact details are:

Camilla Bennett- Cb26g11@soton.ac.uk

What happens if something goes wrong?

If you have a concern about any aspect of this study, you should speak to the researchers who will do their best to answer your questions.

If you remain unhappy or have a complaint about any aspect of this study, please contact the University of Southampton Research Integrity and Governance Manager (023 8059 5058, rgoinfo@soton.ac.uk).

Thank you.

Thank you for taking the time to read this information sheet and considering taking part in the research.

Appendix 13: Patient consent form

PATIENT CONSENT FORM

Study title: **Urine output: how and why is it monitored in acute medical environments?**

Researcher name: Camilla Bennett

IRAS number: 226223 **ERGO**: 41421

Date: 22/11/18 **Version: 1.2**

Please initial the box(es) if you agree with the statement(s):

I have read and understood the information sheet *(22/11/18 / Version: 1.1 Patient participant information sheet)* and have had the opportunity to ask questions about the study.	
I agree to take part in this research project and agree for my data to be used for the purpose of this study.	
I understand my participation is voluntary and I may withdraw (at any time) for any reason without my rights being affected.	
I agree to relevant sections of my medical notes to be accessed and data collected for the duration of this research project.	

I agree and understand that anonymised extracts from the data collected might be used in publications resulting from this study.	

Name of participant (print name)……

Signature of participant……

Date……..

……

Name of researcher (print name)……

Signature of researcher ……

Date……
…..

Optional - please only initial the box(es) you wish to agree to:

This should be used for any statements that are not mandatory for the participant to take part in the research.	
I agree to have a short informal conversation with the researcher who may ask about my understanding and involvement in my care.	
I agree for a researcher to be present during the medical ward rounds.	

(copy for participant, copy for researcher)

Appendix 14: Clinician consent form for semi-structured interviews

CLINICIAN CONSENT FORM FOR SEMI-STRUCTURED INTERVIEWS

Study title: **Urine output: how and why is it monitored in acute medical environments?**

Researcher name: Camilla Bennett

IRAS number: 226223 **ERGO**: 41421

Date: 22/11/18 **Version: 1.2**

Please initial the box(es) if you agree with the statement(s):

I have read and understood the information sheet *(22/11/18 / Version: 1.1 Clinician participant information sheet)* and have had the opportunity to ask questions about the study.	
I agree to take part in this research project and agree for my data to be used for the purpose of this study.	
I understand my participation is voluntary and I may withdraw (at any time) for any reason without my rights being affected.	
I agree to take part in a semi-structured interview for this research project.	

I agree to be digitally recorded during the semi-structured interview.	
I agree and understand that anonymised extracts from the data collected might be used in publications resulting from this study.	

Name of participant (print name)……

Signature of participant……

Date……

Name of researcher (print name)……

Signature of researcher ……

Date……

(copy for participant, copy for researcher)

Appendix 15: Consultee Information Sheet

Information for Consultee

Urine output: how and why is it monitored in acute medical environments?

IRAS number: 226223 **ERGO**: 41421

Date: 22/11/18 **Version: 1.1**

Introduction

We would like to invite you to help decide if your relative/friend should join this research study. We feel your relative/friend is unable to decide for himself/herself whether to participate in this research. Therefore we'd like to ask your opinion whether or not they would want to be involved. We'd ask you to consider what you know of their wishes and feelings, and to consider their interests. Please let us know of any advance decisions they may have made about taking part in research. These should take priority.

If you decide your relative/friend would agree to take part we will ask you to read and sign the consultee declaration on the last page of this information leaflet. We'll then give you a copy to keep. Please let us know if you have any concerns or you think your relative/friend should be withdrawn from the research at any time. Researcher contact details can be found at the bottom of the information sheet.

If you decide that your relative/friend would not wish to take part it will not affect the standard of care they receive in any way.

You relative/friend are being invited to take part in the above research study. To help you decide whether you think they would like to take part or not, it is important that you understand why the research is being done and what it will involve. Please read the information below carefully and ask questions if anything is not clear or you would like more information before you decide if your relative/friend will take part in this research. If you are happy for your relative/friend to participate you will be asked to sign a consultee declaration form.

What is the research about?

I would like to invite your relative/friend to take part in my PhD research study sponsored by the University of Southampton. Before you decide, I would like you to understand why the research is being done and what it would involve for your relative/friend.

Some patients in hospital need to have their urine measured. There are different ways of doing this and we would like to know more about which method is better in different situations. We hope that in the future this will help doctors and nurses choose the best method for each patient.

Why has my relative/friend been asked to participate?

Your relative/friend has been invited to take part in this study because the care you receive involves measuring their urine.

What will happen to my relative/friend if they take part?

If you decide your relative/friend would like to take part, their medical notes will be accessed and they may be asked about their understanding and involvement in their care. The researcher may observe the doctors during the medical ward round for your relative/friend care. Data from their medical notes, observations of the ward round, and anything else they say that is of relevance to the study will be collected for the purpose of this study. The researcher may access their medical notes for the duration of the study however there will be no long-term monitoring.

Are there any benefits in my taking part?

Your relative/friend will not be offered any form of inducement or compensation for participating in this study. However, you may feel like they have benefited from engaging in the study, by contributing to knowledge. While this study is unlikely to offer direct benefit at the time of your relative/friends' involvement, information gained may be used to improve future care.

Are there any risks involved?

I do not anticipate that there will be any risks to your relative/friend in taking part in the study.

What data will be collected?

Data collected from your relative/friends medical notes will include:

- Gender
- Age
- Diagnosis
- Relevant past medical history
- Blood test results
- Vital signs documented such as - blood pressure, heart rate, fluid balance.
- Medical and nursing plans and documentation

Will your relative/friends' participation be confidential?

Your relative/friends' participation and the information we collect about them during the course of the research will be kept strictly confidential.

Only members of the research team and responsible members of the University of Southampton may be given access to data about them for monitoring purposes and/or to carry out an audit of the study to ensure that the research is complying with applicable regulations. Individuals from regulatory authorities (people who check that we are carrying out the study correctly) may require access to their data. All of these people have a duty to keep your information, as a research participant, strictly confidential.

If you agree for your relative/friend to take part their name will be taken and they will then be attributed a study number. All data collected will be coded under this number and anonymised. There is a chance that participants could be linked to the data, however the 'key' to this link will be stored securely with restricted access. Data will be transcribed by the researcher and will be stored in electronic form on a password protected university computer in a password protected data file. Any paper versions will be shredded and disposed of as confidential waste. A master file of signed informed consent forms will be maintained in accordance with University and Trust guidance.

Data Protection Privacy Notice

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This Consultee Information Sheet tells you what data will be collected for this project and whether this includes any personal data. Please ask the research team if you have any questions or are unclear what data is being collected about your relative/friend.

Our privacy notice for research participants provides more information on how the University of Southampton collects and uses your personal data when you take part in one of our research projects and can be found at http://www.southampton.ac.uk/assets/sharepoint/intranet/ls/Public/Research%20and%20Integrity%20Privacy%20Notice/Privacy%20Notice%20for%20Research%20Participants.pdf

Any personal data we collect in this study will be used only for the purposes of carrying out our research and will be handled according to the University's policies in line with data protection law. If any personal data is used from which you can be identified directly, it will not be disclosed to anyone else without your consent unless the University of Southampton is required by law to disclose it.

Data protection law requires us to have a valid legal reason ('lawful basis') to process and use your Personal data. The lawful basis for processing personal information in this research study is for the performance of a task carried out in the public interest. Personal data collected for research will not be used for any other purpose.

For the purposes of data protection law, the University of Southampton is the 'Data Controller' for this study, which means that we are responsible for looking after your information and using it properly. The University of Southampton will keep identifiable information about you for 10 years after the study has finished after which time any link between you and your information will be removed. No identifiable information will be held at University Hospital Southampton NHS Foundation Trust.

To safeguard your rights, we will use the minimum personal data necessary to achieve our research study objectives. Your data protection rights – such as to access, change, or transfer such information - may be limited, however, in order for the research output to be reliable and accurate. The University will not do anything with your personal data that you would not reasonably expect.

If you have any questions about how your personal data is used, or wish to exercise any of your rights, please consult the University's data protection webpage (https://www.southampton.ac.uk/legalservices/what-we-do/data-protection-and-foi.page) where you can make a request using our online form. If you need further assistance, please contact the University's Data Protection Officer (data.protection@soton.ac.uk).

Does my relative/friend have to take part?

No your relative/friend does not have to take part. If you decide that your relative/friend would not wish to take part it will not affect the standard of care they receive in any way.

However if you decide your relative/friend would want to take part, you will need to sign a consultee declaration form to show you have agreed for them to take part. The researcher will then collect this from you.

What happens if I change my mind?

You have the right to change your mind and withdraw at any time without giving a reason and without your relative/friends' rights or routine care being affected. To withdraw please contact the researcher on the email address provided below.

What will happen to the results of the research?

Your relative/friends' personal details will remain strictly confidential. Research findings made available in any reports or publications will not include information that can directly identify your relative/friend without your specific consent.

The results from this study will be used for my PhD and a written report will be provided to the hospital. The report will also be provided to any participant who requests a copy. Anonymised results from the study will also be disseminated via journal publications and conferences.

Where can I get more information?

The researcher is based at the School of Heath Sciences, University of Southampton. Contact details are:

Camilla Bennett - Cb26g11@soton.ac.uk

What happens if something goes wrong?

If you have a concern about any aspect of this study, you should speak to the researchers who will do their best to answer your questions.

If you remain unhappy or have a complaint about any aspect of this study, please contact the University of Southampton Research Integrity and Governance Manager (023 8059 5058, rgoinfo@soton.ac.uk).

If you are unsure about taking the role of consultee you may seek independent advice.

We will understand if you do not want to take on this responsibility.

Thank you.

Thank you for taking the time to read this information sheet and considering taking part in the research.

Appendix 16: Consultee Consent Form

CONSULTEE DECLARATION FORM

Study title: **Urine output: how and why is it monitored in acute medical environments?**

Researcher name: Camilla Bennett

IRAS number: 226223 **ERGO**: 41421

Date: 22/11/18 **Version: 1.2**

Please initial the box(es) if you agree with the statement(s):

I have read and understood the consultee information sheet *(22/11/18 / Version: 1.1 Consultee information sheet)* and have had the opportunity to ask questions about the study.	
In my opinion he/she would have no objection to taking part in the above study.	
I understand that I can request he/she is withdrawn from the study at any time, without giving any reason and without his/her care or legal rights being affected.	
I agree to relevant sections of his/her medical notes to be accessed and data collected for the duration of this research project.	
I agree for a researcher to be present during the medical ward rounds of my relative/friend.	

I agree and understand that anonymised extracts from the data collected might be used in publications resulting from this study.	

Name of consultee (print name):

……

Name of participant:

……..

Relationship to participant:

……

Signature of consultee:

……

Date……..

Name of researcher (print name):

……

Signature of researcher:

……

Date……

(copy for participant, copy for researcher)

Appendix 17: Ethnographic informal conversation schedule

IRAS number: 226223 **ERGO**: 41421

Date: 13/06/18 **Version: 1**

- Provide information on the nature of the session and reconfirm participant's consent.
- Explain purpose of session – to collect data on therapeutic decision-making, clinical goals, environmental constraints, collaboration, work flow and barriers and facilitators relating to patients on urine output monitoring
- Confirming participant will be anonymous in written reports
- Explain written notes will be taken
- Ensuring the participant knows that he/she can stop the session at any point without need for explanation
- Ensure the participant fully understands and gives consent
- Thank participant

Explain process

- Ask the participant to verbalise their thought processes concerning care related to urine output measurements (e.g. therapeutic decisions influenced, clinical objectives, problems relating to monitoring a particular patient's output, justification for method used)
- Ask the participant to start at the beginning of the clinical episode that led directly to the decision being made to monitor urine output and then to go on to cover broader topics, providing step by step thought processes

Once the clinician has described their thought processes, use probe questions to elicit the following information if not provided

- The reason for urine output monitoring
- What therapeutic decisions have been made today that were influenced by urine output
- Why did they decide a catheter was required?
- Other participants in the process
- Non-invasive alterative considered
- What are their clinical objectives? – Aims to achieve negative fluid balance etc.
- Any problems- What makes monitoring urine output easier or harder?
- When do they anticipate the device being removed if urinary catheter in place?

Ending the session

- Offer the participant the chance to ask any questions
- Ask the participant's permission to contact them to arrange a semi- structured interview
- Thank the participant for their time

Appendix 18: Semi-structured interview schedule

IRAS number: 226223 **Date:** 13/06/18 **Version: 1 ERGO**: 41421

- Ensure the participant is comfortable and provide information on the nature of the interview and likely interview length.
- Briefly go through the PIS and answer questions. Complete consent form.
- Explain the interview will be digitally recorded and written notes might be taken.
- Explain I am looking for opinions and personal experiences, rather than right or wrong answers.
- Thank participant and switch on voice recorder.

Background questions

- What is your job title and responsibilities?
- How long have you worked in the department?
- What other clinical experience have you had?

Questions on topic areas

Topic 1: Urine output monitoring practices

- First, could you tell me about how urine output is monitored on your ward?
- Could you explain to me what your role is in that?
- In your opinion, what are the clinical reasons for monitoring urine output?

Topic 2: Decision-making

- Who decides which patients need their urine output monitored?
- How and why are these decisions made?
- Can you think of a recent example of one of these decisions?
- Does it always happen this way?
- How do healthcare professionals decide a urinary catheter is needed to monitor urine output compared to other collection methods?
- Which decisions are easy and which are more complex?
- In your experience, how is information provided by urine output monitoring used in practice?

Topic 3: Facilitators and barriers

- Could you tell me about your experience of caring for patients who need their urine output monitored in clinical practice?
- When does urine output monitoring in practice work well and when does it not?
- In your experience is there any advantages or disadvantages to different urine collection methods?

Ending the Interview

- Offer the interviewee the chance to add anything further or make comment.
- Offer to provide details of the conclusions of study.
- Thank the interviewee for their time.

Appendix 19: Phase Two Medical document data collection tool

Version 1 Date: 13.06.18 IRAS Number: 226223 ERGO: 41421

Patient research identity number:	
Ward / unit name	
Speciality	
Gender	
Admission date	

Admission diagnosis & Past medical history					
Current diagnosis					
AKI alert/risk factors	DM	>75 yrs	Vascular disease	Sepsis	Toxins
	Current / recent AKI	Hypo-volaemia	CKD	Heart failure	Liver failure
Hydration chart factors	LT catheter	Dementia / delirium	Diarrhoea/ Vomiting	Wound drainage	Decreased appetite
	Unable to pour drink	IV/NG/ PEG/TPN	NBM>6hrs	Fluid restriction	Diuretics
Request for urine output monitoring in medical notes				Yes	No
Request for indwelling catheter in medical notes				Yes	No

Documented rationale for UOM / IUC:		
Relevant blood results:		

Vital signs:		

Hydration assessment	No	FBC	HC	none
Reasons recorded for use of chart				
Other relevant reasons (not recorded)				
Appropriate chart used?				
HC completed	0/3	1/3	2/3	3/3
FBC completed	Target U/O ml/hr		Balance	
	Input:	oral	IV	other
	Output:	complete	partial	inadequate
Frequency of UO measurement	Hourly		2 hourly	3-4 hourly
	4-6 hourly		>6 hourly	

Urinary catheter	Yes / No	Indication:	Days in situ:

Drainage system:	Plan to TWOC: Yes/ No

Other method	Incontinence pad	Commode	Bedpan
	Urinal	Conveen	Pan in toilet

Mobility	Fully dependent	Assistance needed	Independent
Notes:			

Appendix 20: Hydration Assessment/Hydration Chart

Hospital Number:..... Date of Birth:.....	**Hydration Assessment** Ward:.....Chart ..... of .....

- All inpatients at UHS should be assessed for hydration status within 6 hours of admission.
- All patients should be reviewed at least once a day before 10 am or when condition changes to assess if a hydration chart, a fluid balance chart or no monitoring is required.
- Please **tick** appropriate factors. If patient has factors in **both** red and yellow sections, commence a fluid balance chart.

	Factors Influencing Hydration Any of the following:	Date	Date	Date	Date	Date	Date	Date
No action	None of the yellow or red risk factors.							
	Medical Fit patients awaiting discharge							
	Daily weights deemed appropriate for monitoring hydration							
	Monitoring not required after discussion with medical and/or nursing in charge							
	Patient on end of life care pathway							
Start Hydration chart	Dry mucous membranes, dry lips, skin turgor, sunken eyes							
	Difficulty handling cups/cutlery, unable to pour their own drinks?							
	Age over 75							
	Respiratory rate more than 25bpm							
	Oral diuretics							
	Febrile patients (Temp > 38 C)							
	Delirium and/or dementia							
	Constipation							
	Diabetes							
	Decreased appetite							
	Thickened fluids							
	Consuming clear or free fluids only							
	Long term catheter							
Start 24 hour fluid balance chart	Acute kidney injury and/or sudden decrease in urine output (<0.5mls/kg/hr)							
	Sepsis							
	IV fluids/NG/PEG feed or TPN							
	IV diuretics							
	Diarrhoea/High stoma output							
	Post Op < 48 hrs. (Excluding Day case)							
	Nil by Mouth > 6 hours							
	Fluid restriction (Exclude long term restrictions e.g. Dialysis)							
	IV Chemotherapy							
	High drainage wounds							
	Increased vomiting/High NG output							
	Short term catheter/Catheter removed < 24h							
	Request by Clinical team							
	MEWS > 3							

Name:.....

Hospital Number:.....

Date of Birth:.....

Hydration Chart

Chart ..... of .....

This chart is **not** to be used if strict input and output monitoring is required.

If minimum intake is not met at review time, or urine output is less than 4 times a day or any other hydration concerns, review the hydration needs with nurse in charge or medical team and consider a fluid balance chart.

Cross (**X**) off each drink if at least 80% of the drink is consumed. Half a cross (**/**) if half is consumed.
Cross (**X**) off each time patient passes urine or catheter bag emptied. (more than 250ml)

= **200ml** *(minimum of 8)*

Average portion jelly = 1 glass
Average yogurt = ½ glass
Average custard = 1 glass
Average soup = 1 glass
Fortisip compact = 1 glass

= *(minimum of 4)*

Wet pad = 1 toilet
Catheter bag = 250ml = 1 toilet

Increased frequency could indicate infection/incontinence issue.

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