Examining Intensive Care Nurses' Clinical Decision-Making Associated with Acute Kidney Injury and Continuous Renal Replacement Therapy in Saudi Arabia

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Submitted in fulfilment of the requirements for the degree of
Doctor of Philosophy

School of Nursing, Faculty of Health
and Institute of Health and Biomedical Innovation
Queensland University of Technology

2018

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Keywords

Acute kidney injury, An abductive approach, Clinical decision-making, Conceptual analysis, Continuous renal replacement therapy, Deductive conceptual content analysis, Intensive care nurses, Intensive care units, Intensive care nursing practice, Nurses' clinical decision-making, O'Neill et al.'s Clinical Decision-Making Model, and Saudi Arabia.

Abstract

This research sought to understand how and why intensive care nurses make clinical decisions that inform their nursing actions when managing patients with acute kidney injury (AKI) and continuous renal replacement therapy (CRRT). The increasing numbers of patients with AKI on CRRT in intensive care unit (ICU) settings in Saudi Arabia and the constantly changing management techniques has brought greater attention nursing clinical knowledge and understanding in the area in order to ensure appropriate and safe nursing care.

The research explored the dimensions of the intensive care decision-making processes of nurses in the Saudi Arabian ICU setting through a lens informed by a decision-making theoretical perspective (O'Neill et al. clinical decision-making model). Data were generated through participant observation and individual interviews. Over a six-month period, 29 nurses working in ICUs were observed while caring for patients who were receiving CRRT. Observations were followed by individual semi-structured interviews. Data were analysed through the lens of two different approaches; a deductive content analysis and a conceptual analysis.

The key outcomes of the content analysis were three levels of decision-making generated from the key concepts of O'Neill et al. CDM model: *independent decision-makers, gaining independence as decision-makers and dependent decision-makers.* Variations in decision-making levels were largely the result of contextual factors including workforce characteristics, management practices, socialisation and organisational constraints. The conceptual analysis produced three key concepts that explained the processes underpinning intensive care nurse clinical decision-making in CRRT practice; *negotiating CRRT practices, normalising CRRT practices*, and *centrality of technology.* The three concepts constitute an explanation of the ways in which the interplay of social, organisational and technological boundaries constructed the process of nursing clinical decision-making and performance with

advanced technology in the Saudi Arabian ICU setting. Using two different approaches to data analysis allowed for the development of a broader understanding of intensive care nurses' clinical decision-making in ICU and CRRT practices.

The findings point to an urgent need for organisational and social change in the Saudi Arabian context care to improve intensive care nursing practice with advanced technologies and to ensure adequate autonomy for nurses as decision-makers. Technology-centred, rather than patient centred, care in this research was associated with the marginalisation of nurses in the decision-making process and with the limited understanding of the challenges of CRRT practice.

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List of Abbreviations

- AKI Acute Kidney Injury
- AKIN Acute Kidney Injury Network
- CDM Clinical Decision-making
- CRRT Continuous Renal Replacement Therapy
- CVVH Continuous Veno-Venous Haemofiltration
- CVVHD Continuous Veno-Venous Haemodialysis
- CVVHDF Continuous Veno-Venous Haemodiafiltration
- DM Decision-Making
- ICUs Intensive Care Units
- KAAUH Abdul-Aziz University Hospital
- KDIGO Kidney Disease Improving Global Guidelines
- KRT Kidney Replacement Therapy
- MOH Ministry of Health
- NVivo 10 Qualitative Data Analysis Computer Software
- RIFLE Risk, Injury, Failure, Loss of Kidney Function, and End Stage Kidney Disease
- SNC Standard of Nursing Care
- TMP Trans-Membrane Pressure
- WHO World Health Organisation

Conference presentations

Alasmari, H, Coyer, F., Bonner, A. (29-31 October, 2015). Examining Intensive Care Nurses' Clinical Decision-Making Associated with Acute Kidney Injury and Continuous Renal Replacement Therapy in Saudi Arabia. Paper Presented at The 40th ANZICS/ACCCN Intensive Care Conference Centre, Auckland, New Zealand. (see Appendix A)

Statement of Original Authorship

The work contained in this thesis has not been previously submitted to meet requirements for an award at this or any other higher education institution. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made.

Signature: QUT Verified Signature

Date: _____17/10/2018_____

Acknowledgements

Numerous people have helped me along the way during my PhD journey and I would like to express my sincere gratitude and appreciation for their continuous support and kind help. The completion of this thesis was possible because of the people who helped me to professionally and personally learn and grow. First of all, many thanks to my supervisor Professor Ann Bonner for her encouragement, support and direction in drawing on her expertise and knowledge in the areas of kidney replacement therapy and for challenging me to think critically. Secondly, to Associate Professor Carol Windsor for her scholarly expertise in qualitative research and her generous support, critical and insightful feedback and constructive suggestions. I would also like to extend my special thanks to Professor Fiona Coyer for her expertise in intensive care nursing areas and support throughout my research.

Deep thanks go to my family in Saudi Arabia, who encouraged me to further my postgraduate studies overseas and achieve my goal. I would also like to express my eternal gratitude to my brother Muteb Alasmari, who is living with me in Australia, for his warm encouragement which gave me the strength and inspiration to complete my thesis. Thanks for your patience and "sense of humour" which helped me and made me laugh a lot through this exhausting journey. I would also like to gratefully thank my dear friend Dr. Meisa Al-Foraih. You were more a sister than a friend to me. You always welcomed me like a sister and I really felt at home with your company. I will never forget your positive and emotional support to complete my thesis. You were never tired of me and your kindness was overwhelming. I also wish to thank my dear friend and fellow doctoral student Dr. Tuti Pahria for her overwhelming support, encouragement and friendship. I want also to extend my gratitude to Dr. Martin Reese for his academic expertise, valuable advice, and emotional support which assisted me in completing this research process and to whom I will forever be

grateful. Thanks must also go to my Phd colleagues at QUT who were supportive and patience in listening to me about my PhD experience.

Heartfelt appreciation to our father King Abdullah Al Saud for supporting the Saudi Arabian educational system and providing the opportunities for overseas academic scholarship. My special thanks are extended to the Saudi Ministry of Higher Education, in particular, Taif University, which gave me this precious opportunity to complete my PhD study in Australia. I would also like to thank the Saudi Arabian Culture Mission in Australia for their generous academic support. A special thanks also to KAAUH's intensive care nursing staff who participated and shared their experience, without you, this work would not have been possible.

Most of all, thanks to God "Allah" for giving me the strength and determination to make my dream become reality and for giving me these wonderful people all through my PhD journey.

Dedication

This dissertation is dedicated to my father Ali Alasmari, my mother Thamraa Alasmari and my big brother Lieutenant Colonel. Mohammad Alasmari. They are my biggest supporters during this PhD journey and I cannot thank them enough. Their love, inspiration, motivation and encouragement have enabled me to devote my energy and time into this work, even when I was tired and frustrated. Thank you for always believing in me that I could reach this milestone, and consequently believing in my brother Muteb and my sisters Amal, Asmaa and Ghadi Al Asmari in following my academic footsteps. Without my family's constant love and support, this work would not have been possible.

Chapter One: Background

1 Introduction

This research was conducted in Saudi Arabia and examined intensive care nurses' clinical decision-making processes when providing care for critically ill patients with acute kidney injury (AKI) who receive continuous renal replacement therapy (CRRT). An earlier report suggested that large numbers of skilled intensive care nurses are needed to provide constant quality care in Saudi Arabia where the health care setting has become highly technical and sophisticated with the rapid expansion of intensive care units (ICUs) (Alalyani, 2011). The increasing numbers of patients with AKI in ICU settings and their complex treatments create a greater need for intensive care nurses to make timely and safe clinical decisions and to recognise clinical risks and reduce therapeutic errors in order to improve their patient conditions (Alalyani, 2011). To date there have been no studies examining intensive care nurses' clinical decision-making and practice when providing CRRT. This research examined the application, by intensive care nurses, of theoretical and practical knowledge in the Saudi Arabian context of caring for patients receiving CRRT.

This chapter introduces the research by providing an understanding of the Saudi Arabian nursing workforce, intensive care nursing practice with CRRT and the importance of nurse clinical decision-making. This is followed by the research aims and research questions. Finally, the significance of the research is addressed and an overview of the thesis structure provided.

1.1 Saudi Arabian Health Care System and Nursing Workforce

The Saudi Arabian Ministry of Health (MOH) is the main provider and funder of health care services in Saudi Arabia. The MOH oversees 331 hospitals (47,018 beds) and 2,838 primary health care (PHC) centres which account for 60% of total health services in Saudi Arabia (Al-Hashem, 2016; Albejaidi, 2010; Almalki, 2012; Alshammari, 2014; Alyami & Watson, 2014; 2006; Saudi Arabia Ministry of Health, 2016). There are other government health care providers including referral hospitals, the Ministry of Higher Education (teaching) hospitals, army medical services, security medical services, National Guard health affairs, Saudi Aramco medical service, the Royal Commission for Jubail and Yanbu health services, school health units of the Ministry of Education, and the Red Crescent Society (Al-Hashem, 2016; Almalki, Fitzgerald, & Clark, 2011). These government providers of health care services control 39 hospitals with a capacity of 10,822 beds (Al-Hashem, 2016; Alshammari, 2014). Health care services are also provided by the private sector with a total of 141 hospitals (15,664 beds) and 2,412 clinics and dispensaries (Al-Hashem, 2016; Saudi Arabia Ministry of Health, 2014). King Abdul-Aziz University hospital in Jeddah, a Ministry of Higher Education teaching hospital, was the setting for this research.

At the time of this research and in the public health sector, the government workforce comprised Saudi Arabian citizens and a large contingent of expatriate healthcare professionals (Aldossary, While, & Barriball, 2008; Alsaqri, 2014; Alyami & Watson, 2014; Hafiz, 2017). Saudi Arabian nationals comprise 54% of the total health workforce, with 32% and 22% employed as nurses and doctors, respectively (Hafiz, 2017; Saudi Arabia Ministry of Health, 2016). Expatriate registered nurses make up at least 68% of the nursing workforce (Alyami & Watson, 2014; Saudi Arabia Ministry of Health, 2016) and the average tenure of non-Saudi nurses is 2.3 years (Almalki, 2012; Walston, Al-Harbi, & Al-Omar, 2008). Expatriate healthcare professionals are recruited from India, the Philippines, North America,

the United Kingdom, Australia, South Africa, Malaysia, and other Middle Eastern countries (Al-Hashem, 2016; Alayed, Lööf, & Johansson, 2014; Aldossary et al., 2008; Almalki, 2012) to fill workforce shortages.

The Saudi Arabian health care system faces the same global challenges of nursing workforce shortages to meet the demands of staffing hospitals (Alyami & Watson, 2014; Miller-Rosser, Chapman, & Francis, 2006; Rycroft-Malone, Fontenla, Seers, & Bick, 2009). This situation is exacerbated by existing global nursing shortages and retention problems, which lead healthcare organisations in Saudi Arabia to depend heavily on expatriate nurses (Alasmari & Douglas, 2012; Almalki et al., 2011; Alyami & Watson, 2014). A fast growing population and the geographical spread of healthcare facilities also increases the demands on the Saudi healthcare system to improve local nurse recruitment and retention (Alasmari & Douglas, 2012; Alboliteeh, Magarey, & Wiechula, 2017; Almalki et al., 2011). Despite a policy of Saudisation of nursing (Al-Mahmoud, Mullen, & Spurgeon, 2012; Alyami & Watson, 2014), the continuing poor social image of the nursing profession as a suitable career for Saudi nationals, continues to impact on the nurse shortage (Aboul-Enein, 2002; Alboliteeh et al., 2017; Alyami & Watson, 2014; Hafiz, 2017; Tumulty, 2001). A study conducted by Alboliteeh et al. (2017), for example, found that Saudi nurses still perceived that they were subservient to doctors. Furthermore, the survey of over 1,000 Saudi registered nurses concluded that nurses were dissatisfied with the profession due to lack of promotion opportunities and a requirement to work long hours (Alboliteeh et al., 2017). The Saudi Arabian healthcare system thus continues to be reliant on nurses from overseas.

Expatriates bring a mixture of qualifications and experiences as well as different cultural values, languages, behaviours and attitudes to the Saudi Arabian context (Almutairi, McCarthy, & Gardner, 2014). Saudi Arabian culture is distinct, involving Arabic tribal traditions and costumes, Arabic language and Islamic influences (Almutairi, 2012). These

elements shape the Saudi Arabian people's mentality and behaviour. While expatriates mainly use English to communicate within healthcare teams (Almutairi, 2012; Lamadah & Sayed, 2014), cultural and language issues between nurses and patients remains an issue. Thus, the ability of expatriate nurses to practice competently and safely can be negatively affected (Almutairi et al., 2014; Cioffi, 2005; Høye & Severinsson, 2008).

In highly specialised areas such as intensive care, the nursing workforce is likely to comprise a greater proportion of expatriates because of the Saudi Arabian negative social perceptions of nursing as a profession, the poor remuneration and socially unacceptable shift schedules. Saudi Arabian nurses also perceive that working in ICUs involves heavy workloads, high patient-to-nurse ratios, patient care interruptions, emotional exhaustion and job dissatisfaction (Alalyani, 2011). It is typical to find wards and specialised areas such as ICUs, emergency departments, haemodialysis and operation rooms (Alshammari, 2014) staffed largely by nurses from Asian backgrounds. Not surprisingly expatriate nurses bring varied levels of knowledge, skills, and competences to the ICU.

1.2 Intensive care nursing practice

Due to the requirements for continuous monitoring and complex therapies, acute and critically ill patients require the high levels of care provided in intensive or critical care units (Aitken, Marshall, & Chaboyer, 2015; Crocker, 2007; Lakanmaa, Suominen, Perttilä, Puukka, & Leino-Kilpi, 2012; West, Mays, Rafferty, Rowan, & Sanderson, 2009). The World Federation of Critical Care Nurses (WFCCN) defines critical care nursing as:

> Specialised nursing care of critically ill patients who have manifest or potential disturbances of vital organ functions. Critical care nursing means assisting, supporting and restoring the patient towards health, or to ease the patient's pain and to prepare them for a dignified death. The aim of critical care nursing is to establish a therapeutic relationship with patients and their relatives and to empower the individuals' physical, psychological, sociological, cultural and

> spiritual capabilities by preventive, curative and rehabilitative interventions."(World Federation of Critical Care Nurses, 2007)

Intensive care nurses have a crucial role in ensuring the provision of high quality and safe patient care. These nurses need to be clinically competent in relation to decision-making and problem solving (Lakanmaa et al., 2013) and to hold specialised knowledge of intensive care unit nursing care and skills (Lakanmaa et al., 2012; Urden, Stacy, & Lough, 2014). Intensive care nursing therefore has a 'highly specific nature' (Lakanmaa et al., 2012) where nursing workforce is required to quickly adapt and develop advanced knowledge and skills according to the changing demands of critically ill patients' conditions (Rose, Goldsworthy, O'Brien-Pallas, & Nelson, 2008). It has been demonstrated that where a nursing workforce is knowledgeable, the role of nurses as decision-makers within the health professional team is enhanced (Rose et al., 2008). Thus, intensive care nurses should be highly competent in order to avoid patient complications, and to reduce morbidity and mortality (Lakanmaa et al., 2012; Robnett, 2006). There are challenges in intensive care nursing practice due to the complexity of care and the requirement of high levels of clinical competencies particularly in relation to managing technologies.

Increasingly, health care delivery in intensive care units has become dependent on medical technology as a supportive or interventional therapy (Aitken et al., 2015). The technological aspects of intensive care nursing care are crucial to manage critically ill patients, to support, treat and monitor their vital signs (Tunlind, Granström, & Engström, 2014). There are different levels of technical devices to manage patient's critical conditions such as monitors, ventilators, infusion pumps, and dialysis machines (Tunlind et al., 2014). Nonetheless, technical equipment overall dominates intensive care units deeming those units complicated and challenging practice environments. As a consequence, some studies have recommended that instituting a specific program to assure the minimum competence of

intensive care nursing staff is required (Gurses & Carayon, 2007; Schmalenberg & Kramer, 2007; Valentin, Ferdinande, & ESICM Working Group on Quality Improvement, 2011). Valentin et al. (2011) and Schmalenberg and Kramer (2007) have argued that intensive care nursing unit managers be responsible for educating and evaluating the competencies of nurses and these in charge to develop specific nurses' skills with equipment. These previous studies have examined the best operational guidelines and design recommendations for intensive care units and ICU staff (Valentin et al., 2011), the extent to which intensive care nurses experience difficulties in their work environment (Gurses & Carayon, 2007) and staff nurses' perceptions of work environment. However, the focus of these studies was the ICU work environment and not intensive care nurses' clinical experience or performance with advanced technology, such as CRRT machines, and their impact on the safety of patient care or nursing practice.

Technology is a combination of cognitive and physical tools which help to inform people's practices (Polkinghorne, 2004, p. 16). Thus, the term is used when people use technology to manage the physical world (Polkinghorne, 2004). The implication is that intensive care nurses use technical devices to make decisions and to act within the context of the situation, such as when a patient deteriorates. Hence, it is important to know and link the patient's condition with the technological equipment to provide safe care.

Patient safety is a crucial part of daily nursing care and intensive care nurses are responsible for early identification and prevention of potential clinical or technological problems that may cause adverse events (Chaboyer & Conroy, 2015; Kim, Lyder, McNeese - Smith, Leach, & Needleman, 2015; Talley, Wonnacott, Schuette, Jamieson, & Heung, 2013). It is also likely that many intensive care nurses face challenges in adapting to new equipment (Urden et al., 2014). For instance, nurses may face challenges when using advanced technologies such as CRRT, intra-aortic balloon pumps or mechanical ventilation.

Intensive care nurses are also expected to make crucial decisions to adjust inotropic or sedation drugs, and administer other therapies together with troubleshooting (Alalyani, 2011). In particular, inexperienced or new intensive care nurses with limited technical skills and knowledge struggle more than experienced nurses to understand, adopt and develop their technical skills (Ääri, Tarja, & Helena, 2008; Alalyani, 2011; Lakanmaa et al., 2014; Reader, Flin, Lauche, & Cuthbertson, 2006). These challenges can reflect on an ability to identify and link clinical problems in order to take action (Ääri et al., 2008). Galvin (2010) emphases that intensive care nurses also seem to have difficulty prioritising their human and technological care which in turn may reflect on patient outcomes. Intensive care nursing, therefore, requires a range of protocols associated with technical equipment (Galvin, 2010; Polkinghorne, 2004).

Intensive care nurses are responsible for the CRRT management in most Western countries (Baldwin, 1997; Baldwin & Fealy, 2009a; Langford, Slivar, Tucker, & Bourbonnais, 2008) (see Chapter Two). Similarly, intensive care nurses in the Saudi setting are responsible for managing CRRT technology. To date, while some studies have examined intensive care nurses' management of CRRT (Baldwin & Fealy, 2009a; Langford et al., 2008; Paton, 2003) no research that has examined intensive care nurses' clinical decision-making when managing CRRT and explored potential contextual influences in nursing performance.

1.3 Researcher Reflexivity

The researcher was an instrument of data generation and analysis in this research. It is therefore appropriate that I reflect upon my role as the researcher. Researcher reflexivity is important because qualitative research is essentially a reflexive process and the researcher's prior knowledge, beliefs, experience, and values are brought to the research (Cutcliffe, 2003). The self-reflexive recognition of the researcher is thus crucial for both auditability and trustworthiness of data analysis and ethical considerations. When the researcher, for instance,

fails to challenge new or different perceptions, it may lead to the researcher (perhaps unknowingly) to bring their own personal beliefs into the research (Lambert, Jomeen, & McSherry, 2010). In this research, I recorded my own thoughts, emergent ideas, and values, and maintained a separation of the data generated from my analytical memos from participant data and the context of interest. My analytical memos were used later as a resource contributing both to data generation and ensuring research rigour.

As an intensive care nurse, I have had to make my own clinical decisions in relation to CRRT practice and I have also observed many other intensive care nurses managing CRRT. Prior to this research, however, I had not thought deeply about my own or other nurses' reasons and rationales behind these clinical decisions.

My nursing journey started when I completed a bachelor degree in general nursing science (2004) at the University of King Abdul-Aziz in Jeddah, Saudi Arabia. I became a registered nurse and worked in Al-Hada Military hospital in Taif. My own professional practice has been in critical care nursing for over four years (2004-2008), working in adult ICUs, medical, surgical, burn and coronary cardiac units. During this time I developed knowledge and skills associated with CRRT technology. The challenges faced with using this advanced technology in addition to managing the critically ill patient's condition has had a strong influence in shaping my professional practice and research in critical care settings. To address my knowledge deficit, I attended an intensive CRRT training course for two weeks in one of the largest Ministry of Health hospitals in Dammam, Saudi Arabia. As a result, I organised and presented a two-day CRRT workshop with colleagues (nurses and doctors) at Al-Hada Military hospital in Taif. Following this occasion, I was frequently asked to assist new intensive care nurses or those who had less CRRT experience.

I have furthered my professional interests in critical care nursing practice for the past ten years. From 2010 to 2011, I completed a Masters of Nursing degree at Queensland University

of Technology, Brisbane, Australia. During my research I sought to further my knowledge in critical care nursing by completing specialisation in critical care nursing to strength my clinical background. From my clinical experience, I noticed that there was a limited understanding and a lack of standard tools and insufficient education and training with CRRT practice, which encouraged me to explore this area of interest through continuing my higher education (Doctor of Philosophy) to clarify the complexities associated with CRRT machinery or technological nursing practice and clinical decision-making processes.

1.4 Significance of the research

The fast-paced ICU environment creates a greater need for nurses to strive to improve continuously their knowledge, skills and performance with advanced technology so as to provide appropriate and safe nursing care in the intensive care unit. While there have been some studies examining intensive care nurses' management of CRRT (Baldwin & Fealy, 2009a; Langford et al., 2008; Paton, 2003; Przybyl, Androwich, & Evans, 2015), there has been no research examining nurses' clinical decision-making when providing CRRT.

This research is significant for two reasons. First, it is important to examine intensive care nurses' practice with patients with AKI and CRRT in relation to making clinical decisions in Saudi Arabia. Second, it will explore intensive care nurse decision-making processes around recognition of the clinical status of patients with AKI and/or deterioration, CRRT problems and subsequently nurses' responses and interventions. The outcomes of this research will help to identify barriers in relation to nursing decision-making and performance with CRRT machinery. The findings will contribute new knowledge to inform CRRT national standards of practice in Saudi Arabian ICUs. The recommendations derived from this research will help Saudi Arabian health care organisations to improve intensive care nursing practice with advanced technologies.

1.5 *Research purpose*

The purpose of the research is to:

- Explore clinical decision-making processes important for CRRT management in the Saudi Arabian ICU context.

1.6 Research Aims

The aims of the research are:

- To understand how and why intensive care nurses make particular clinical decisions that inform their nursing actions when managing patients with AKI and CRRT.
- To examine the contextual factors that shape the intensive care nursing performance and decision-making in CRRT practice.
- To provide insight into nursing roles and scope of intensive care nursing practice in Saudi Arabia.
- To generate findings and recommendations that will help health care organisations in Saudi Arabia and broadly to support nurses as decision-makers and facilitate nursing performance with CRRT.

1.7 Summary and thesis structure

This thesis comprises seven chapters. This first chapter provided a brief background of the context of this research by describing the Saudi Arabian nursing workforce particularly in the context of intensive care. The research focus and aims were explained and the significance of the research was articulated. Chapter Two provides a review of literature examining the AKI definition, classification and epidemiological characteristics, and technological advances for AKI, in addition to examining how intensive care nurses' clinical

decision-making is associated with AKI and CRRT. The chapter concludes with an identification of the gaps in knowledge in the research area.

Chapter Three explains the theoretical framework underpinning the research. The focus is on decision-making theories pertinent to nursing practice. In particular, O'Neill et al. clinical decision-making model is explained in detail and justified as the lens for the deductive conceptual analysis in this research.

Chapter Four addresses the research methodology in relation to the interpretive theoretical approach and it provides a justification for its application. This chapter also provides detailed descriptions and rationales for each method and the analysis plan. The chapter concludes with a discussion of ethical considerations in the research.

Chapters Five and Six turn to a presentation of the research findings. Chapter Five reports on the deductive analytical findings informed by O'Neill et al.'s clinical decision-making model. Chapter Six explores the conceptual outcomes generated through participant observation and semi-structured interviews.

Chapter Seven discusses the main findings in light of the prior nursing literature and offers new insights into the phenomena of interest, decision-making in clinical practice, acute kidney injury care, and CRRT practice. The final conclusions derived from the findings are then articulated as are implications for theory, practice and future research in the area and consideration of the strengths and limitations of the research.

Chapter Two: Literature Review

2 Introduction

Acute kidney injury is one of the most common medical complications among hospitalised patients (Srisawat & Kellum, 2011). In more than 60% of intensive care patient admissions, AKI is reported (Baldwin & Leslie, 2015) due to several significant reasons such as the growing aging population, diabetes mellitus and cardiac disease (Yaklin, 2011). This chapter will explore the incidence of AKI and identify AKI risk factors worldwide and specifically among Saudi Arabian hospitalised adults. This is followed by an analysis of current literature in terms of how intensive care nurses' clinical decision-making is associated with AKI and CRRT technology, nursing understanding of AKI and knowledge about kidney replacement therapy (KRT), nurses' recognition of CRRT indicators and problems, clinical deterioration and interventions employed for critically ill patients with AKI on CRRT. The gaps in and complexity of AKI care and CRRT practice research are also examined.

2.1 Epidemiology of Acute Kidney Injury

Worldwide, the incidence of AKI and resulting mortality is increasing (Bellomo, Kellum, & Ronco, 2012; Jones & Devonald, 2013; Li, Burdmann, & Mehta, 2013; Zuk & Bonventre, 2016). This growing problem is attracting research into areas such as AKI risk factors (Hoste et al., 2015; Patschan & Müller, 2015), patterns of AKI (Ostermann & Joannidis, 2016) and AKI clinical practices (Gaudry et al., 2016; Kellum & Lameire, 2013).

The KDIGO stages AKI according to its severity, as outlined in Table 2.1, whereas initial AKI staging is based on the risk, injury, failure, loss of kidney function, and end stage kidney disease, commonly referred to as RIFLE criteria (Bellomo, Ronco, & Kellum, 2004;

Fliser et al., 2012; Mehta et al., 2007; Srisawat, Hoste, & Kellum, 2010). The RIFLE and AKIN criteria were developed to standardise definitions of AKI and to assist in the assessment of AKI prognosis and incidence (Aitken et al., 2015; Bellomo et al., 2004; Fliser et al., 2012; Mehta et al., 2007).

Table 2. 1 Recommended KDIGO staging of AKI (2012)

Stage	Serum Creatinine (SCr) criteria	Urine output criteria
1	Increase ≥ 26μmol/l within 48 hours OR Increase ≥ 1.5 to 1.9 x reference SCr	< 0.5ml/kg/hour for > 6 Consecutive hours
2	Increase ≥ 2 to 2.9 x reference SCr	< 0.5ml/kg/hour for >12 hours
3	Increase ≥ 3 x reference SCr OR Increase ≥ 354μmol/l OR Commenced or renal replacement therapy (RRT) irrespective of the stage	< 0.3 ml/kg/hr for >24 hours or anuria for 12 hours

Acute kidney injury is categorised into three main causes: pre-renal, intrinsic, and post-renal (Aitken et al., 2015; Lameire et al., 2013; Nor et al., 2015). Pre-renal causes are commonly considered as the second cause of AKI in the elderly and account for almost one-third of total hospitalised cases due to hypovolaemia, cardiac failure, shock, or hypotension (Aitken et al., 2015; Lameire et al., 2013; Nor et al., 2015). Intrinsic causes of AKI are mainly due to infection or inflammatory illness (i.e. glomerulonephritis), or nephrotoxicity, or vascular insufficiency leading to acute tubular necrosis (ATN) (Aitken et al., 2015; Lameire et al., 2013; Nor et al., 2015; Zuk & Bonventre, 2016). Acute tubular necrosis is accountable for over 50% of AKI in hospitalised patients and more than 76% of ICU patients (Aitken et al., 2015; Lameire et al., 2013; Nor et al., 2015; Zuk & Bonventre, 2016). Finally, the post-renal causes of AKI are increased by patient age and conditions such as post-renal obstruction (Aitken et al., 2015; Lameire et al., 2013).

Acute kidney injury characteristics differ because of numerous geographical, aetiological, economic and cultural differences in developed and developing countries, and it is a significant challenge for clinicians (Bellomo et al., 2012; Liangos et al., 2006).

Worldwide, the reported incidence of AKI in ICUs ranges from 1% to 25% and the estimated mortality rate varies from 40 to 90% (Dirkes, 2011; Dirkes & Hodge, 2007; Lameire et al., 2013; Li et al., 2013; Samimagham, Kheirkhah, Haghighi, & Najmi, 2011). In the ICU setting, the incidence of AKI due to sepsis accounts for more than 40% of admissions to the ICU (Bagshaw, George, & Bellomo, 2008; Bellomo et al., 2012; Nor et al., 2015). Sepsis-induced AKI is associated with a higher short and long-term risk of death (Bagshaw et al., 2008; Bagshaw, Uchino, & Bellomo, 2007; Murugan, Karajala-Subramanyam, & Lee, 2010; Singbartl & Kellum, 2012). The causes of AKI in Middle Eastern countries is similar to those in Western countries to some extent, except for the higher incidence of community-acquired AKI (mostly due to urinary tract obstruction such as obstructive uropathy) because of the very hot, dry climate.

In Saudi Arabia, the incidence of AKI in the general population (28.83 million) ranges from 0.6% (Al-Homrany, 2003), 5% (Ghacha, Sinha, & Al-Khursani, 2000), 9% (Aldawood, 2010) to 29% (Alkhunaizi, Shah, Wesslen, Al Sadah, & Antony, 2011) whereas the prevalence and risk factors of AKI are largely unknown (Alkhunaizi et al., 2011). The increasing incidence of AKI over this period might be due to the changes in lifestyle of the Saudi population, for instance, increasing weight is associated with hypertension, diabetes mellitus, hyperuricemia or dyslipidaemia (Alkhunaizi, 2016) . In addition, metabolic syndrome has been implicated as a risk factor for obstructive uropathy (Alkhunaizi, 2016).

The mortality rate of AKI among hospitalised Saudi patients has been reported to be between 30-90% (Al-Homrany, 2003; Aldawood, 2010; Alkhunaizi et al., 2011). The main causes of AKI in the ICU are acute tubular necrosis (67.5%) due to uncontrolled sepsis (26%), after cardiac surgery (29%), and hepatic failure and drugs (7.3%) (Al-Homrany, 2003; Alkhunaizi et al., 2011; Ghacha et al., 2000). The incidence of post-partum AKI was reported to be 3.6% in Saudi Arabia and pregnancy related AKI 2.8% in developed countries (Pahwa,

Bharani, & Kumar, 2014). It appears that Saudi Arabia's incidence and mortality rates are similar to other Middle Eastern countries and Western nations.

2.2 Kidney Replacement Therapies for AKI

Since the 1960s, different methods of extracorporeal kidney replacement therapy (KRT) for AKI have evolved (Nor et al., 2015; Palevsky, 2013; Prowle & Bellomo, 2010). Since that time, KRT for AKI is now more likely to occur in the ICU rather than the dialysis unit (Prowle & Bellomo, 2010; Ronco, 2007a; Ronco et al., 2001). The reason for KRT is to maintain and improve the balance of fluids, electrolytes and acid-base, to prevent further progression of renal damage, and to restore normal kidney functions (Palevsky, 2013; Zyga, Sarafis, Stathoulis, Kolovos, & Theophilopoulos, 2009). Acute kidney injury patients in ICUs require appropriate KRT to maintain homeostasis when there is inadequate renal function. There are serious limitations to traditional intermittent haemodialysis for critically ill patients and it is not considered the best treatment option (Aitken et al., 2015; Lameire et al., 2013; Lins, 2012; Palevsky, 2013; Panagiotou, Gaiao, & Cruz, 2013). The main limitations are haemodynamic instability, unstable cardiac rhythm, hypotension, poor renal recovery, and malnutrition in critically ill patients (Bell, Granath, Schön, & Ekbom, 2007; Crawford & Lerma, 2008; Zyga et al., 2009). This has resulted in the development and improvement of CRRT.

The first CRRT used in ICU patients with AKI was reported approximately 39 years ago (Bellomo & Ronco, 1999; Kramer, Wigger, Rieger, Matthaei, & Scheler, 1977). In Germany, Kramer et al. (1977) developed the continuous arteriovenous haemofiltration technique which provided a technical simplicity and haemodynamic stability in ICU settings (Kramer et al., 1977). It had, however, severe limitations due to requiring both arterial and venous vascular access and the limited capacity to remove nephrotoxins (Burchardi, 1998;

Dirkes & Hodge, 2007; Kramer et al., 1977). It involved slow continuous ultrafiltration (SCUF) which allowed the removal of plasma water and wastes (Aitken et al., 2015). As a result, in the early 1980s, a veno-venous pump-driven technique or haemofiltration was developed (Burchardi, 1998). Different modalities of CRRT have since been established: slow continuous ultrafiltration (SCUF), continuous veno-venous haemofiltration (CVVH), continuous veno-venous haemodialysis (CVVHD), continuous veno-venous haemodiafiltration (CVVHDF) and sustained low-efficiency dialysis (SLED) (Aitken et al., 2015; Kidney Disease: Improving Global Guidelines (KDIGO) Acute Kidney Injury Work Group, 2012; Richardson & Whatmore, 2014).

The principle of KRT involves the process of removing blood from the body through a venous access catheter that is inserted in the jugular or femoral vein using a pump (Baldwin & Fealy, 2009b). The blood traverses along an extracorporeal circuit connected to a dialyser which allows the removal of solutes and wastes (i.e. through plasma water removal) (Baldwin & Fealy, 2009b). Haemodialysis or haemodiafiltration techniques were developed to improve solute clearance through combining haemofiltration and the diffusive transport of haemodialysis (Burchardi, 1998; Leber, Wizemann, Goubeaud, Rawer, & Schütterle, 1978; Ronco, 2007b). Both veno-venous techniques (CVVH and CVVHDF) can deliver better uraemic control by using a dialyser with an adequate surface area and ensuring adequate blood flow (Bellomo & Ronco, 1999). Regardless of the technique, CRRT is highly recommended for critically ill patients with AKI and initiation of the CRRT treatment is associated with greater recovery of renal function (Bell et al., 2007; Faber & Klein, 2009; Jacka, Ivancinova, & Gibney, 2005; Ronco, 2007a; Uchino et al., 2007). Currently, the appropriate method of KRT in ICU settings depends on each patient's clinical conditions and haemodynamic tolerance with AKI (Davies & Leslie, 2008; Dirkes & Hodge, 2007; Zyga et al., 2009). Appropriate skilled and safe performance with CRRT technology are required

because the machine only provides the therapy and may fail putting the patient at risk (Baldwin & Fealy, 2009a). Intensive care nurses therefore have an important role in managing CRRT technology.

2.3 Intensive care nurses' knowledge about CRRT

Technology is not a simple phenomenon to understand and nor its role or function in health care. Heidegger described technology as having 'authentic meaning', where individual uses and values technologies to serve a purpose or attain a task in a given context (Heidegger, 1977). Thus, health technologies may be understood in terms of their effectiveness of purpose and functionality (Stayt, Seers, & Tutton, 2015). Intensive care units have consisted of various developments in life-saving technological interventions, which may pose particular challenges, and experience difficulties using advanced technologies.

Intensive care nurses have therefore additional responsibilities and required more complex and varied skill sets to manage advanced technologies. Nurses need to autonomously apply technical (i.e. monitoring patient data through using a variety of technology) and non-technical skills (i.e. decision-making, problem-solving, teamwork, or communication) in order to recognise potential problems and take a viable course of action. Intensive care nurses, for instance, are expected to understand the renal system and recognise the difference between AKI and chronic kidney disease (Murphy & Byrne, 2010). In relation to AKI, intensive care nurses need also to have advanced knowledge in order to understand the different CRRT modes. The literature has demonstrated that when intensive care nurses receive training and education about AKI, chronic kidney disease and CRRT, there is a positive impact on nursing practice (Graham & Lischer, 2011; Kocjan & Brunet, 2010; Langford et al., 2008; Murphy & Byrne, 2010). Thus, in light of complex technological advances and related changes in healthcare delivery it is important to ensure quality of patient care and safety. However, the literature suggests that the presence of technology may

dehumanise patient care and distract the nurse from providing patients psycho-social needs (Stayt et al., 2015). Healthcare professionals are in danger of losing sight of the humanistic and interpersonal aspects of healthcare due to being blinded by the effectiveness of what technology proffers (Stayt et al., 2015).

Continuous renal replacement therapy involves complex technology and is high risk therapy. This means intensive care nurses must be knowledgeable and highly skilled in order to deliver quality patient care, which can lead to more successful outcomes (Lakanmaa et al., 2012). The role of intensive care nurses is to monitor and assess the patient's response to CRRT, set up and discontinue the dialysis circuit, adjust the fluid settings per doctor's order, correct electrolytes, administrate fluids, monitor hemodynamic status and acid base balance (Przybyl et al., 2015). However, learning about CRRT principles, patient assessment and monitoring, and being able to problem-solve can be difficult for some new or inexperienced nurses (Langford et al., 2008). It appears that the overwhelming presence of health technologies has an important influence on nurses, patients, and care (Locsin, 2010).

There are suggestions in the literature that fundamentals of education and training in CRRT nursing practice are crucial such as post-orientation mentorship, staff-lead education, formal preceptors, clear expectations and communication about initial and ongoing CRRT competence, and promoting interdisciplinary relationships (Baldwin, 1997; Baldwin & Fealy, 2009a; Graham & Lischer, 2011; Langford et al., 2008; Sclauzero et al., 2006). These educational essentials can improve ICU nursing practice with CRRT and contribute to the success of CRRT programs. For example, Sclauzero et. al (2006) reported that 88% of nurse participants wanted to learn more about management aspects of CRRT due to their limited working experience in CRRT practice. Sclauzero et. al.'s work noted that improving social aspects such as collaboration and communication skills between ICU and renal nursing could improve the quality of care and outcomes. However, Sclauzero et. al's (2006) study did not

conduct an evaluation or follow up workshops to meet nurses' demands with the use of technologies. Similarly, Langford et al. (2008), in a national survey of intensive care nurse educators about CRRT nursing practices, found that nurses required extensive initial CRRT training but that there was little follow up training. However, Langford et al.'s (2008) study did not examine in depth how these nurses manage or practice with CRRT technology or provide rationales for their actions. A further study, Graham and Lischer's (2011, p183) evaluation research, explored nursing issues in CRRT practice, "including organisation of educational programs, manpower assessment, competency evaluation, and quality improvement processes" through the use of a nursing collaborative model of care. The findings of this two year program showed a reduction in errors and increase in compliance with the CRRT protocol and greater confidence in managing CRRT (Graham & Lischer, 2011). Novice and experienced nurses were recruited in this evaluation program and assigned nurse mentors. The program has a limitation in relation to meeting the needs of novice nurses due to their limited working experience and difficulty in providing these new nurses with experience-based proactive opportunities. It has been concluded that social and organisational influences appear to be important factors to be examined within nursing practice.

In addition to underlying knowledge, intensive care nurses should have technical skills which include monitoring and documenting CRRT flow pressures, managing CRRT troubleshooting and maintaining circuit life (Baldwin & Fealy, 2009a, 2009b; Bourbonnais, Slivar, & Tucker, 2016; Przybyl et al., 2015). Nurses therefore need to be thoroughly trained and evaluated when they interact with advanced technology. A clinical review was conducted by Baldwin and Fealy (2009a) which set down the bases of a CRRT protocol for intensive care nurses. However, this clinical review only described how to manage CRRT machines and did not examine how intensive care nurses perform with CRRT. It appears that there is a gap in the literature with respect to intensive care nurses performance in CRRT practice and

contextual challenges when they manage CRRT machinery. A recent study involved the addition of a high-fidelity simulation exercise to an existing CRRT education program to assess, measure, and validate competency in CRRT practice which increased nurses' critical thinking skills and understanding of CRRT principles (Przybyl et al., 2015). A further study, conducted by Bourbonnais, Slivar, and Tucker (2016), noted that there is no a common effective method to train nurses working with CRRT and more attention is needed to identify better staff education and competence (Bourbonnais et al., 2016). The authors argued that it is crucial to ensure staff competence around the technology and care of patients with CRRT (Bourbonnais et al., 2016). However, it is also imperative to capture in-depth aspects of the complexity of nursing performance with CRRT technology.

According to Graham and Lischer (2011), some hospitals have developed CRRT competency tools (or evaluation tools) to assess nursing performance with CRRT machinery (Graham & Lischer, 2011). Graham and Lischer (2011) emphasise that many intensive care nurses follow what they are being told and taught by other nurses rather than ICU clinical instructors or mentors who have expertise in CRRT practice. CRRT educational classes, evaluation programs or workshops can help nurses improve their knowledge and skills, but may not completely provide nurses with the skills required to care for critically ill AKI patients with CRRT (Graham & Lischer, 2011). The Richardson and Whatmore (2014) work sought only to guide critical care nurses to manage patients with CRRT. Thus, further research is required to understand nurses' performance and clinical decision-making with CRRT technology and the contextual facilitators and barriers.

It is known that CRRT is core competency for intensive care nurses (Boyle & Baldwin, 2010). In relation to provide high quality and safe care, competencies act as a mechanism to support health professionals in a complex situation such as managing advanced technologies in the ICU setting. Norman (1985) drew a categorisation of clinical competence that

consisted of five competencies: clinical skills, knowledge and understanding, problem-solving, clinical judgement, interpersonal attributes or social role and technical skills (Norman, 1985). The construct of nursing competency "attempts to capture the myriad of personal characteristics or attributes that underlie competent performance of a professional person." (Melnyk, Gallagher-Ford, Long, & Fineout-Overholt, 2014, p. 7). Others have argued that competency is not a "skill or task to be done, but characteristics required in order to act effectively in the nursing setting." A particular competency "cannot exist without scientific knowledge, clinical skills, and humanistic values" (Dunn et al., 2000, p. 341). The success of nurses performing CRRT is therefore associated with high quality education, clinical expertise, availability, the ability to stay calm in difficult situations and correct selection of preceptors who desire to teach (Graham & Lischer, 2011). There is a need for continuing education for nurses about CRRT.

2.4 Nurses' early recognition of, or failure- to- recognise, problems

Early recognition of patient problems is considered a crucial aspect of nursing clinical judgment and decision-making (Minick & Harvey, 2003). Nurses have an essential role in the anticipation and prevention of adverse events by being able to recognise early signs of deterioration (Gazarian, 2008). Intensive care nurses can recognise potential deterioration in patients with AKI and CRRT problems through attentive monitoring for sudden change in or through an alarm system. Minick and Harvey (2003) argued that the skill of early recognition will be facilitated where nurses learn subtle patterns from individual patients as well as groups of patients. There are also workplace factors that might affect intensive care nurses' early recognition of patient abnormalities. A number of authors have argued that nurses might fail to recognise patient signs of illness due to contextual factors (Considine & Botti, 2004; Endacott, Kidd, Chaboyer, & Edington, 2007; Minick, 1995; Minick & Harvey, 2003).

Endacott, et al. (2007), for example, reported that inadequate communication between clinicians and lack of process for ensuring timely management when patients deteriorate were barriers effecting recognition of patient deterioration. Thus, Endacott, et al. (2007) suggested that nurses should improve their referral skills and junior medical staff need to be trained to accept the assessment of experienced senior nursing staff. Nurses- doctor relationships and collaboration appear a key factor to facilitate early recognition of patient deterioration and intervention.

A systematic review has demonstrated that non-technical skills such as teamwork, decision-making or communication skills were important factors in stimulating nurses timely responses to patient deterioration (Johnston et al., 2015). Another integrated review reported that when nurses knew and trusted the teams in which they worked, they responded better to patient deterioration (Massey, Chaboyer, & Anderson, 2016). It appears that social influences such as teamwork, support and communication skills associated with early recognition and intervention in the ICU nursing practice. When nurses fail to recognise a signs of patient deterioration the result may be poor patient outcomes or adverse events, which may cause death (Minick & Harvey, 2003). Thus, reducing adverse events and promoting patient safety have been associated with the influence of non-technical skills in a variety of specialised clinical settings (Johnston et al., 2015; Stubbings, Chaboyer, & McMurray, 2012). All of these considerations could account for, or contribute to, intensive care nurses' early judgement or failure to recognise patient deterioration with AKI or technological problems in CRRT practice.

One previous review has demonstrated nurses' recognition of AKI signs and treatment (Redmond, McDevitt, & Barnes, 2004). Nurses play an important role in prevention or early recognition of patient deterioration with AKI through the management of diagnostic tests (e.g. blood electrolytes, urinary sodium and electrolytes, renal ultrasound and

chest x-ray), measuring fluid balance, physiological observations, neurological changes, gastrointestinal problems, medications and infection control (Redmond et al., 2004). It has been recommended that a better understanding of the context is required in which the patient's clinical deterioration is recognised and identified (Odell, Victor, & Oliver, 2009).

Experienced nurses can early recognise patient problems, even before obvious changes in patient conditions and quickly intervene to prevent potential complications compared to novice or graduate nurses (Ashcraft & DiAgostino, 2004; Minick & Harvey, 2003). Ashcraft and DiAgostino (2004) suggested that experienced nurses should anticipate the unexpected, recognise the problem, and intervene early (Ashcraft & DiAgostino, 2004). Nevertheless, the required skills for early recognition should be more carefully defined within each clinical context. In intensive care nursing, a study by Hoffman et al. (2009) determined the differences between novice and expert nurses in selecting cues in addition to how they cluster cues together during making clinical decisions for post-operative patients in the ICU setting. The findings demonstrated that experienced nurses used their previous experiences and clinical knowledge to early recognise and prevent possible clinical deterioration or technical problems (Hoffman, Aitken, & Duffield, 2009). It appears that nurses' recognition skills vary which influence researchers to examine and improve nurses' skills in relation to early recognition of patients' clinical deterioration in different contexts with different contextual influences.

Numerous clinical errors occur in the ICU setting due to critical patient conditions and dynamic environments. Patient safety therefore has not substantially improved because of the difficulty in recognising and reporting events (Henneman, 2007). A case study was conducted by Henneman (2007) to discuss experienced nurses' failure to report medical/clinical errors who are also nursing educators and patient safety researchers in order to add understanding of some contextual and social factors. These factors may influence the incidence and

underreporting of medical or clinical errors. Without such knowledge, the author argued that nurses were unable to commit, detect, report or correct failures to reduce medical or clinical error as a strategy, in addition to time pressures (Henneman, 2007). These failures can risk patients' safety.

Patient safety continues to be a major challenge and hospital adverse events are an important public health issue. Healthcare-related adverse events is defined as an unintended patient injuries or complications due to health care management causing disability, prolonged hospital stay or death (Vlayen et al., 2012). Different studies have been conducted around patient safety and aimed to explore the rate of adverse events and characterising their nature, impact and preventability in several countries (Damen, Baines, Wagner, & Langelaan, 2017; Deilkås et al., 2017; Sousa, Uva, Serranheira, Uva, & Nunes, 2018) including Saudi Arabia (Alahmadi, 2010; Aljadhey et al., 2013; Alswat et al., 2017). Sousa, et al. (2018), for instance, argued that some patient and hospital characteristics influence the rate of adverse events. Thus, it has been noted that critically ill patients require more complex and riskier health-care delivery (Sousa et al., 2018). Although, the incidence of hospitalised patient adverse events is high, many causes of adverse events are found to be preventable (Damen et al., 2017; Gazarian, Henneman, & Chandler, 2010). Further research is needed to explore patient, organisation and care characteristics that may contribute to higher rates of adverse events.

In the Saudi Arabian healthcare, for example, Alahmadi (2010) reported that organisational learning/ continuous improvement, feedback and communication about errors and teamwork within units support patient safety at Saudi Arabian hospitals. However, there are some areas for most hospitals with potential for improvement such as underreporting of events, staffing, non-punitive response to error and teamwork across hospital units (Alahmadi, 2010). The difference between the countries in the rates and causes of adverse events require further examination and more attention by governing bodies to address patient safety issues

(Deilkås et al., 2017). Based on these results, more adequate solutions and knowledge of a set of characteristics to the structure of organisations are required in relation to develop and implement strategies to improve patient safety and reduce adverse events rates. Therefore, these prevention strategies might help in moving towards a culture and practice of quality and safety of care.

It was evident that when nurses work as team members, they shared decision making and adapted to rapidly changing conditions (Alswat et al., 2017). A subsequent study by Gazarian, Henneman, and Chandler (2010) reported that nurse characteristics such as previous experiences and the ability to function as part of a team assisted in interrupting an adverse event. In addition, organisational characteristics such as the availability of nurse-initiated monitoring equipment, working with a collaborative team, experience and flexibility of staff, and access to knowledge resources also supported nurses to identify and interrupt a potential preventable cardiopulmonary arrest (Gazarian et al., 2010). An integrative review was conducted by Massey, Chaboyer and Anderson (2016) stated that assessing the patient, knowing the patient, education and environmental factors such as equipment were significant factors in recognising patient deterioration. The review therefore suggested that it is important to ensure that there are system modifications in the workplace and educational development to improve the ability of nurses' recognition and responding to patient deterioration (Massey et al., 2016). It is complex and multidimensional to recognise and manage the deteriorating patient with technology.

Some key attributes needed by intensive care nurses are to understand the common problems of CRRT's extracorporeal circuits such as the filter clotting, abnormal access and return pressure and air sensor which, if ignored or not recognised in a timely manner, can lead to complications. Davies et al. (2008) suggest that intensive care nurses need to make-decisions, and recognise and understand the trans-membrane pressure (TMP) values when

high pressure readings apply to provide appropriate clinical decision-making when abnormal values exist. Furthermore, the decision to discontinue CRRT may require visual monitoring of the haemofilter or evidence of clotting developments (Davies, Leslie, Pereira, & Webb, 2008). While Davies et.al (2008) studied only the lifespan of CRRT circuits these authors did provide some recommendations for nursing practice with CRRT. This work recommended that intensive care nurses be required to capture appropriate data in the CRRT analysis software to monitor and examine troubleshooting. The use of a graphical display of readings should improve CRRT performance where nurses interpret data, identify the type of event and apply appropriate clinical decision-making and interventions.

Troubleshooting events involves around CRRT involve mechanical factors such as equipment malfunction and physiological factors associated with the patient (Davies et al., 2008). Collecting and archiving data on circuit functioning and/or reviewing pressure trends may be useful for teaching purposes or developing tools/protocols to improve nursing practice (Davies et al., 2008). Thus, ICU nursing practice may benefit from quality standardised tools/protocols or ongoing education and training in CRRT care. To date there have been only descriptive clinical reviews of CRRT machine and patient preparation, nursing monitoring and management of CRRT, comparing different types of CRRT, and recommendations for CRRT nursing practice (Baldwin, 2007; Baldwin & Fealy, 2009a, 2009b; Davies et al., 2008; Murphy & Byrne, 2010; Richardson & Whatmore, 2014).

The above review points to a significant gap in knowledge about CRRT nursing practice. Further studies are needed to examine how intensive care nurses make decisions, how they recognise and respond to changes, and how they intervene in situations involving CRRT. In the Saudi Arabian intensive care context, for instance, a standardised approach to teaching and evaluating nurse practice is required. Other underlying issues should also be examined and addressed in the Saudi Arabian healthcare.

2.5 Research Gap

Acute kidney injury is a complex disorder which impacts heavily upon patient morbidity and mortality, especially among critically ill adults. Intensive care nurses provide nursing care for critically ill patients who often have AKI and, when prescribed, are required to perform CRRT. As noted above, there have been some publications that explain the management procedures of CRRT for intensive care nurses (Baldwin & Fealy, 2009a, 2009b; Boyle & Baldwin, 2010) and others that address educational programs on CRRT (Graham & Lischer, 2011; Langford et al., 2008; Sclauzero et al., 2006). There has been no published research that examines intensive care nurse clinical decision-making around CRRT. Little is known about ICU nursing practice with CRRT technology and possible contextual influences or barriers. A better understanding of intensive care nurses' interactions with CRRT technology, barriers and facilitators, how problems are recognised, how relevant action is determined and how patient safety is maintained. The need for ongoing ICU nursing research is reflected in the problem of lack of standardised educational and training programs or courses on CRRT practice. The dearth of attention in this area is due to a limited understanding of AKI care and CRRT technology generally and among intensive care nurses.

2.6 Chapter Summary

Acute kidney injury is an increasingly common clinical problem and prevalent in developing and developed countries, including Saudi Arabia. It is associated with severe mortality and morbidity rates. Recently, the KDIGO drew up guidelines for clinical practice to support the management of AKI, including CRRT synthesis evidence to inform practice. To date, there have been few studies examining the intensive care nurses' management of CRRT, however, there has been no research examining intensive care nurses' decision-making processes, early recognition, experience or performance when providing CRRT. In

the Saudi setting, there is a significant lack of evidence to support ICU nursing education and practice for patients with AKI on CRRT. Also, there is little known about nursing performance, competency and multicultural nursing workforce practice in Saudi Arabia, especially in ICUs. This research can generate knowledge that will be used to improve ICU nursing practices in Saudi Arabia. The following chapter will appraise the research theoretical framework and the selected clinical decision-making model for this research.

Chapter Three: Theoretical Framework

3 Introduction

This chapter engages with theories on decision-making in nursing clinical practice. The foundation for these theories has its origins in cognitive psychology which seeks to explain how individuals behave when they perform different cognitive tasks (Anderson, 1990; Eysenck, 2009; Goldstein, 2015; Tanner, Benner, Chesla, & Gordon, 1993). Human thinking involves different processes such as: deductive and inductive reasoning, decision-making and problem solving (Eysenck, 2009; Goldstein, 2015). In nursing, these cognitive processes are referred to as clinical decision-making, clinical problem solving, the nursing process and clinical judgment; all of which are used to describe how nurses understand and solve patients' problems and intervene clinically (Banning, 2008a; Benner, Tanner, & Chesla, 2009; Doenges & Moorhouse, 2012).

In terms of making decisions, theories formulated from cognitive psychology have led to the development of hypothetico-deductive reasoning and intuitive decision-making theories. This in turn has influenced other theories and/or models on decision-making (DM), namely information processing (Banning, 2008b; O'Neill, Dluhy, & Chin, 2005; Thompson, 1999; Walsh, 2010). The above theories and/or models have been used to explain nurses' decision-making processes often referred to as clinical decision-making (CDM).

This chapter provides an overview of the fundamental tenets of cognition and the influential decision-making frameworks or models used in nursing. It then examines research addressing intensive care nurses' clinical decision-making. Also explored are the strengths and limitations of CDM theories such as the information-processing theory, the intuitive-humanistic model, cognitive continuum theory and O'Neill's clinical decision-making model, along with the relevant research that applies these models.

3.1 Overview of Cognition

The human mind has mental functions, such as memory, attention, perception, emotions, language, deciding, thinking and reasoning to create representations of the world, and it is these representations that enable individuals to act and achieve their goals (Goldstein, 2015; McBride & Cutting, 2015). In order to understand how an individual thinks and takes action, it is first necessary to explore the fundamental tenets of cognition that are important for this research. These have been specifically narrowed to four key aspects of mental function: memory representation, information processing and reasoning, problem solving, and decision making (Goldstein, 2015; Higgs, 2008; McBride & Cutting, 2015).

3.1.1 Memory

To understand how an individual performs cognitive tasks, the first concept to explain is memory representation. Cognitive psychologists suggest that an individual holds information in their mind in their working and long-term memories (Baddeley, 1992; Eysenck, 2009; McBride & Cutting, 2015; Tanner et al., 1993). The working memory has a limited capacity to hold and handle information (Baddeley, 1992; Eysenck, 2009; Goldstein, 2015). However, information can be transferred to the long term-memory if repetition occurs because the long term-memory has a larger capacity to hold information (Baddeley, 1992; Eysenck, 2009; Goldstein, 2015). Accordingly, memory representation is the cognitive process that explains how an individual processes perceptions of the world. Through this cognitive process, an individual's repeated experience can enable the mind to identify patterns, which develop the long-term memory. The concepts of memory representation, long-term memory and pattern recognition are crucial to understanding information processing and how decisions are made.

Information processing is the cognitive activity where individuals process information that they encounter everyday situations (McBride & Cutting, 2015). It explains how humans manage different tasks in the process of thinking. Processing information is the gathering, interpreting, and synthesising of information in the context of a particular cognitive action, such as decision-making (Goldstein, 2015; McBride & Cutting, 2015). As an example in the clinical context, experienced nurses use less time to differentiate and prioritise patient care due to previous experience or knowledge of a similar situation. This is so, it is argued, because knowledge and experience have been saved and organised in long-term memories (Abdel-Kader & Palevsky, 2009; Andersson, Omberg, & Svedlund, 2006; Benner, Tanner, & Chesla, 1992; Benner et al., 2009; White, 2003). In turn, memory representation and information processing have an effect on another cognitive activity, reasoning.

Reasoning is the inductive and deductive cognitive processes of drawing conclusions (Eysenck, 2009; Goldstein, 2015; Leighton & Sternberg, 2004). In the inductive reasoning process an individual draws a general conclusion from a statement based on evidence and in deductive reasoning a conclusion arises from premises or statements which are assumed to be true (Goldstein, 2015; Goswami, 2003; Leighton & Sternberg, 2004). Thus, the cognitive process of reasoning whether it is inductive or deductive uses information processing to form conclusions. The interrelated theories of information processing and hypothetico-deductive reasoning assist researchers to examine and understand cognitive reasoning that underpins the thinking, behaviours and actions initiated in real contexts such as clinical nursing practice (Carnevali, Thomas, Godson, & Waterloo, 1993; Standing, 2010; Taylor, 1997; Thompson & Dowding, 2009). In nursing research, information processing theory and reasoning have been used to examine nurses' clinical decision-making understanding the accuracy of decisions and diagnostic reasoning, the process of cue collection and usage among novice and expert nurses, and the quality of decision-making itself (Dowding & Thompson, 2003; Higgs, 2008;

Hoffman et al., 2009; Thompson et al., 2009). By using the theories of information processing and reasoning, researchers are able to better understand how nurses reason and subsequently make decisions about patient care. Indeed, reasoning can be viewed as a form of thinking in order to reach a rational conclusion (Banning, 2008a). In the nursing literature, the concept of diagnostic and clinical reasoning focuses on the thinking strategies that individuals use to make decisions or judgements and to solve problems (Banning, 2008a; Huckabay, 2009; Simmons, 2010). Thus, using this knowledge to build an understanding of how an individual processes information may contribute to a better understanding of nurses' cognitive processes.

3.1.2 Problem solving

Problem solving is a cognitive activity where an individual moves through a number of steps from recognising a problem, to reasoning about the problem, to reaching a solution (Eysenck, 2009; Goldstein, 2015; McBride & Cutting, 2015; Standing, 2010). The cognitive processes involved are memory representation, information processing and reasoning. Problem solving occurs in situations where an individual encounters purposeful or goal-directed problems that exist only when individuals lack knowledge to provide immediate solutions (Eysenck, 2009; Goldstein, 2015; McBride & Cutting, 2015; Sternberg & Frensch, 2014). These types of problems require individuals to generate their own options or solutions and then use their knowledge and skills to select the best solution.

One factor that can complicate an individual's ability to reach a solution is the nature of the problem itself. In goal-directed problem solving individuals need to be able to distinguish between well-defined and ill-defined problems (Eysenck, 2009; Goldstein, 2015; McBride & Cutting, 2015; Sternberg & Frensch, 2014). Well-defined problems are those in which the initial situation, the possible strategies, the goal and the available methods for solving are

clearly specified; whereas ill-defined problems are unclear and underspecified (Eysenck, 2009; Goldstein, 2015; McBride & Cutting, 2015; Sternberg & Frensch, 2014). A further factor is whether the problem is knowledge-rich or knowledge-lean. A knowledge-rich problem is when individuals use a considerable amount of specific knowledge to solve a problem and knowledge-lean problems do not require specific knowledge because the information needed is provided by the problem statement (Eysenck, 2009; Goldstein, 2015; McBride & Cutting, 2015; Sternberg & Frensch, 2014). For instance, knowledge-rich problems may come from textbooks or clinical theories that which require specific knowledge and skills, whereas knowledge-lean problems can be solved by using guidelines or instructions for the task. In addition to the type of problem an individual can encounter, it is also important to understand the reasoning used to solve the problem. For example, when individuals have an obvious goal but the solution is not clear, they tend to use deductive reasoning drawing conclusions from premises which are assumed to be true (Eysenck, 2009; Goldstein, 2015; McBride & Cutting, 2015; Sternberg & Frensch, 2014). Conversely, where the goal is not obvious and the solution is not clear, individuals use inductive reasoning to draw a general conclusion from a statement based on evidence (Eysenck, 2009; Goldstein, 2015; McBride & Cutting, 2015; Sternberg & Frensch, 2014).

When nurses process information to manage clinical tasks, problem-solving is a crucial everyday process. Examining problem-solving in nursing research is complicated due to the complex associations between different cognitive processes such as critical thinking, and reasoning (Hicks, Merritt, & Elstein, 2003; Higuchi & Donald, 2002). Problem-solving has been extensively examined in both clinical and educational nursing settings (Ehrenberg & Häggblom, 2007; Hewitt-Taylor, 2012; Tang & Sung, 2012; Taylor, 1997; Taylor, 2000). For instance, using problem solving strategies in nursing education is beneficial in examining problem-based learning environments (Ehrenberg & Häggblom, 2007; Oldenburg & Hung,

2010; Tiwari et al., 2006). Oldenburg and Hung (2010) used a qualitative case study approach to improve the understanding of the problem solving strategies through a problem based learning course used by a group of learners. Transcription of online discussion, reflective writing assignments and semi-structured interviews constituted the methods. Findings revealed that problem-based learning strategies assisted nursing students in problem recognition, information gathering and construction of meaning (Oldenburg & Hung, 2010). The findings show that the nursing students expanded use of multiple resources, identified relevant facts and clinical applications, and resolved cases. However, the study cannot be generalised to all nursing students. Thus, it is important to understand how nurses problem-solve, which includes understanding their underlying reasoning processes, in order to provide feasible, logical and realistic models of nurse decision-making in a range of contexts.

3.1.3 Decision-making

Problem-solving and decision-making share some common cognitive processes such as clinical reasoning and critical thinking; however problem-solving is considered to be a linear process, while decision-making is process-oriented (Hicks et al., 2003; Liaw, Scherpbier, Klainin-Yobas, & Rethans, 2011). In problem-solving theories, individuals are required to create their own solutions and/or alternatives (Eysenck, 2009; Henneman et al., 2010) and the focus is on the factors affecting the selection of solution strategies. In contrast, decision-making occurs when an individual selects one option out of several presented possibilities or alternatives and the decision is the result of the reasoning process. In making a decision, individuals use a rationale or justification for their decisions, which leads them to consider additional evidence to determine the best decision. Thus, decision-making theories take into account an individual's preferences which may be based on experiences and focused on the factors that influence these preferences (Eysenck, 2009; Goldstein, 2015).

Decision-making can be understood as three theoretical categories: normative, prescriptive and descriptive (Bell, Raiffa, & Tversky, 1988; Standing, 2010; Thompson, 1999; Thompson & Dowding, 2002). Normative decision-making is "primarily concerned with prescribing how decisions ought to be made and focuses on the outcomes and results of the process" (Bucknall, 2000, p. 26). Normative theories are associated with rational, logical, evidence-based decisions and scientifically informed through statistical analysis (Bell et al., 1988; Standing, 2010; Thompson & Dowding, 2002). In addition, normative theory only concentrates on how 'good' a judgment or a decision is as an outcome rather than how decisions are made in the real world (Bell et al., 1988; Standing, 2010; Thompson & Dowding, 2002, 2009).

The second category is prescriptive theories. These theories aim to improve specific decisions and judgement tasks through the application of frameworks and guidelines (Bell et al., 1988; Shaban, 2005; Standing, 2010; Thompson & Dowding, 2002). Prescriptive theories have been used in management sciences and operational research to train people to make good decisions. Prescriptive theories can be incorporated with normative theories, for instance, in developing assessment tools and/or nursing clinical guidelines by applying principles and findings from previous scientific research (Standing, 2010; Thompson & Dowding, 2002).

The final category is descriptive theories that explain how individuals reach their decisions through the process of decision-making in the real world (Bell et al., 1988; Crocker & Scholes, 2009; Standing, 2010; Thompson & Dowding, 2002). Information processing theory and hypothetico-deductive approaches are examples of descriptive theories which are naturalistic and behavioural in nature (Shaban, 2005). Descriptive theories are not restricted or limited to describing individuals as being rational and logical or irrational and illogical, but rather focus on the contexts, actual conditions, and environments in which decisions are made

(Shaban, 2005; Thompson & Dowding, 2002). Descriptive theories facilitate investigations into how individuals make decisions and judgements in clinical practice.

3.2 Clinical decision-making by nurses

Decision-making is a crucial component of the practice of nurses (Bakalis & Watson, 2005) and requires nurses to apply advanced knowledge (O'Neill et al., 2005; Simmons, 2010). When decisions are made during practice, the term clinical decision-making (CDM) is used. In clinical practice, to achieve accurate decisions and high quality patient care, intellectual operations such as knowledge, experience, application, comprehension, analysis, and synthesis are needed (Przybyl et al., 2015; Schneider, Rittle-Johnson, & Star, 2011; Thompson, Cullum, McCaughan, Sheldon, & Raynor, 2004; Thompson & Dowding, 2002). Clinical decision-making involves gathering and analysing both subjective and objective clinical information to make a decision about what nursing intervention is required (Pugh, 2002). Decision-making activities underpin everyday nursing practice. When making a decision a nurse selects from a number of possible alternatives drawn from underlying knowledge and previous experiences, which then informs what action to take (Thompson & Dowding, 2002, 2009). Clinical decision-making theory explains how nurses understand and respond to clinical situations and events, and how they recognise and make decisions. Their ability to make sound clinical decisions may vary and is related to the nurses' level of experience and knowledge. This in turn is influenced by their technical and non-technical clinical skills (Thompson & Dowding, 2002, 2009). For instance, nurses' technical skills consist of monitoring patient data by using different types of advanced technology, whereas, the non-technical skills include nurses' communication, leadership, teamwork and participatory decision-making abilities (Flin, O'Connor, & Crichton, 2008; Lewis, Strachan, & Smith, 2012; Reader et al., 2006). Recently, an integrative review was conducted to

identify and summarise factors and processes related to registered nurses' patient care decision-making in medical-surgical environments (Nibbelink & Brewer, 2018). The review demonstrated that there are key factors that shape the process of nurse clinical decision-making and nurses experience including education, organisational and unit culture, situational awareness, understanding of patient status, and autonomy (Nibbelink & Brewer, 2018).

The majority of research into nurses' clinical decision-making tends to focus on novice nurses' knowledge, understanding and capabilities to select and apply the best and most accurate clinical decision-making to their practice (Ferrario, 2003; Hoffman et al., 2009; Seright & Seright, 2011). Other research has compared novice and expert nurses' CDM (Ferrario, 2003; Hoffman et al., 2009). While novice and expert nurses have been found to use the available thinking strategies such as patient data, doctor or nurse notes, or protocols, when they care for patients in real situations, there are differences in CDM between novice and expert nurses (Hoffman et al., 2009; Levett-Jones et al., 2010). According to Benner, Tanner and Chesla (2009) experienced nurses have a better understanding from a patient's previous clinical experience, have stronger clinical knowledge and respond more appropriately and rapidly to a patient's issues and concerns in a particular situation. This is because these nurses have more experience of particular situations or events and these experiences have been collected and stored in their memory. Novice nurses select and focus on a narrower range of cues to inform decision-making than expert nurses (Hoffman et al., 2009) due to less experience and exposure to patient problems (Benner et al., 2009; McKinley, 2007).

3.2.1 Clinical decision-making by intensive care nurses

Nurses in ICUs need to make rapid multiple decisions in highly complex environments to ensure delivery of high quality care for each patient (Aitken, 2003; Bakalis & Watson,

2005; Bucknall, 2000; Currey & Worrall-Carter, 2001; Ramezani-Badr, Nasrabadi, Yekta, & Taleghani, 2009). Research highlights that the ICU context differs from other areas of nursing due to the nature of the working environment where rapid changes in critically ill patients require nurses to make quick decisions (Bakalis & Watson, 2005; Bucknall, 2000). To work effectively and safely in this context, intensive care nurses must be knowledgeable and highly skilled to achieve better and faster recognition of the sudden changes in a patient's condition, make rapid and accurate decisions and then quickly intervene. All of these cognitive processes occur almost simultaneously.

Some studies have examined clinical decision-making in intensive care nursing in relation to the influence factors on CDM processes, such as the ICU contexts, the nature of managing critically ill patients and high technology, interacting with families and health care teams, and rapidly changing ICU environment. One area of investigation has been the influence of environmental and/or contextual factors on CDM such as education, knowledge, and/or experience (Bakalis & Watson, 2005; Bucknall, 2003; Currey & Botti, 2003). Bakalis and Watson (2005), for instance, conducted an exploratory correlational study of 60 nurses to compare the different decisions made by nurses working in medical, surgical and critical care areas. This research reported that the decision-making of intensive care nurses occurs more in emergency situations (i.e. notifying patients about their prognosis, changing patient medication, organising other patient investigations, and making the decision to discharge a patient), whereas ward nurses only did this occasionally. Findings also indicated that clinical experience relates significantly to the occurrence of decision-making (Bakalis & Watson, 2005). However, not explored were the types and qualities of nurse decision-making. Another example was the Currey and Botti (2003) work which proposed an emerging model of naturalistic decision- making to examine when nurses make clinical decisions in the context of undertaking a complex task such as haemodynamic status of patients. Findings showed

that there were discrepancies in nurses' decision making in relation to the techniques of haemodynamic monitoring due to differences in nurses' knowledge and experience (Currey & Botti, 2003). The model, however, did not reflect on the multiple relationships between the nurses, the decisions and the environment (Currey & Botti, 2003). In ICU nursing literature, there is little focus on the context of real-world decision making.

A second area of investigation has been the effect of decision-making strategies on intensive care nurses' CDM and the subsequent impact on patient care (Aitken, Marshall, Elliott, & McKinley, 2009; Alfaro-LeFevre, 2015; Bruner & Austin, 1986; Kydonaki, 2011). These studies have demonstrated that the common decision-making strategies nurses use are related to knowledge acquisition of a patient's situation; that is observing, analysing and interpreting patient's cues (Aitken et al., 2009; Kydonaki, 2011). Aitken, et. al. (2009), for example, examined nurses' decision-making processes when assessing and managing sedation for a critically ill patient. The findings demonstrated that decision making integrated a variety of attributes which focus on the assessment aspects of care (Aitken et al., 2009). It was concluded that nurses need take into account the complexities of the process and use a wide range of information sources in making decisions (Aitken et al., 2009). Thus, intensive care nursing literature requires more attention about how and why nurses use guidelines or particular strategies to support their clinical decision-making.

A further research by Kydonaki (2011) examined intensive care nurses' decision-making processes when managing the weaning of long-term ventilated patients and explored the impact of the diverse elements of the clinical environment on this complex practice. Data were collected in two different countries. An ethnographic qualitative research was conducted in both Scotland and Greece, to examine nurses' decision-making processes when managing the weaning of long-term ventilated patients and to explore the impact of the diverse elements of the clinical environment on this complicated practice (Kydonaki, 2011). The findings

demonstrated that nurses with all ranges of experience showed similar decision-making skills indicating that the skill was unrelated to level of experience and knowledge. Kydonaki (2011) did find inconsistency in the weaning of long-term ventilated patient decisions due to the working relationships, lack of support, lack of nurses' accountability and unstructured information flow. Further, the work culture did not foster a shared decision-making approach or encouraged nurses' autonomy in decision-making; a finding in both study locations (Kydonaki, 2011). It seems that the workplace culture of intensive care nursing may influence the attitudes, behaviours, beliefs, interaction, communication associated with nurses' decision-making. In terms of the culture of intensive care nursing, Scholtz et al. (2016) found that the culture in the ICU occurred through patterns of patient adoption, armor display (i.e verbal and non-verbal communication, and coping skills and adaptation), despondency because of the demands to adjust, sibling-like teamwork, and non-support from management and medical doctors (Scholtz, Nel, Poggenpoel, & Myburgh, 2016). For that reason, it is crucial to understand the complexity of these patterns of behavior and interaction within the ICU nursing culture in order to facilitate and empower intensive care nurses in the transformation of their practice (Scholtz et al., 2016). It is here that understanding ICU nursing workplace culture assumes importance in the process of nurses' recognition and decision-making.

A third area of clinical decision-making exploration has focused on the complexities of decisions made by intensive care nurses (Currey & Worrall-Carter, 2001; Hicks et al., 2003). Currey and Worrall-Carter (2001), for instance, examined the types and complexity level of decisions made in everyday clinical practice of critical care nurses. Five types of decisions were identified; assessment, intervention, organisation, communication and education. These authors found that communication decisions (i.e communicating with other staff members, patients or distressed family members) are the most difficult to make in

relation to the degree of decision complexity in critical care environments. In addition, knowing the patient was identified as an important factor to facilitate and reduce the complexity of decision-making (Currey & Worrall-Carter, 2001). This research has implications for further investigations in terms of the importance of communication skills with patients, colleagues and families in the ICU. Understanding how these nurses make their clinical decisions in addition to exploring the complexity of decision-making might provide more insight about influences or barriers in the intensive care decision-making. Establishing a healthy interpersonal relationship between health professionals is crucial to improve the communication levels in critical care environments due to the group (or team) decision-making that occurs in this context (Bucknall, 2003; Jones & Devonald, 2013). It appears that nurses' knowledge, experience, pattern recognition (e.g. knowing the patient), attitudes and communication have a role in reducing decision complexity. Despite the range of research into intensive care nurses' CDM, there is not yet a clear understanding about how intensive care nurses make clinical decisions, the factors affecting nurses' CDM and the contextual influences of nurses' CDM on patient outcomes.

One of the areas that researchers have examined is how factors can influence CDM is "situation awareness" (SA). Situation awareness is "the perception of the elements in the environment in a volume of time and space, the comprehension of their meaning and the projection of their status in the near future" (Endsley, 1995, p. 36). Situation awareness is combination of social and cognitive skills (i.e. non-technical aspects), which influences CDM. Thus, developing situation awareness in CDM is a crucial skill for all health professionals (Fore & Sculli, 2013; Stubbings et al., 2012). There are three levels of SA linked to decision-making; first, perception of the current situation (gathering information), second, comprehension of the current situation (interpreting information), and third, the ability to project what can happen in the future (anticipation of future states) (Stubbings et al., 2012).

Cognitive factors (memory, ability, preconceptions and information processing) influence each of these SA levels (Stubbings et al., 2012). Situation awareness is a factor that can influence CDM, especially in environments that are complex and dynamic (Stubbings et al., 2012; Taylor, 1997). The ICU context, for instance, is a stressful environment with frequent alarms, flashing lights, advanced technological equipment and critical patient conditions (Bakalis & Watson, 2005). In addition, there are different levels of individual's experience and knowledge. If nurses lack SA then their CDM will be less effective because they may make decisions that have not considered all of the relevant data or cues. For example, research into adverse clinical events has highlighted that nurses' suboptimal CDM can be due to lapses or gaps in SA in clinical practice (Goldstein, 2015; Stubbings et al., 2012). These two studies of SA and decision-making demonstrate the importance of SA and recognition for intensive care nurses in selecting the appropriate CDM in complex clinical situations. Thus, recommended are ongoing training and using beneficial clinical strategies to avoid lapses or decision errors. It seems that SA is part of the way cognitive processing occurs and may contribute to explaining nurses' CDM processes. Making informed and rapid decisions under stressful complex situations (e.g. the ICU context) requires health professionals, including nurses, to recognise the relevant information and environmental data to efficiently manage complex systems of care (Standing, 2010; Stubbings et al., 2012).

In summary, despite the three decades of CDM process research among intensive care nurses and the diverse factors influencing CDM processes such as experience, critical thinking abilities, educational level, and decision complexities, intensive care nurses' CDM processes cannot be completely explained. This research will add to the knowledge about the CDM process of intensive care nurses and investigate the factors that influence their decisions about critically ill patients with AKI and CRRT practice.

3.3 Decision-Making Theories and Models

Historically, there have been three predominant theoretical approaches to studying CDM processes; the information-processing theory, the intuitive-humanistic model and the cognitive continuum theory (Banning, 2008b; Thompson, 1999). More recently, O'Neill et al. CDM model (O'Neill et al., 2005) has been developed and used in some nursing contexts. This section will examine these theories and models.

3.3.1 Information-Processing Theory

Newell and Simon (1972) developed the information processing theory to describe the cognitive processing that occurs during decision-making (Newell & Simon, 1972). Information processing theory suggests that patient data or cues are received from both motor and sensory sources and this data is processed in the working memory. Previously pre-encountered data is retrieved from the long-term memory and leads to outcomes (i.e. a decision is made) (Anderson et al., 2004; Hoffman et al., 2009; Rush et al., 2009). Information-processing theory uses a hypothetico-deductive approach to facilitate a better understanding of reasoning (Carnevali et al., 1993; Standing, 2010; Taylor, 1997; Thompson & Dowding, 2009). In clinical contexts, information-processing theory can be used to describe how nurses collect clinical information, generate hypotheses, interpret cues, and evaluate the hypotheses in relation to previous experiences and education (Banning, 2008b).

In the 1980s and 1990s, nurse researchers adopted information-processing theories and models to develop discipline specific CDM models (Banning, 2008b; Carnevali et al., 1993; Jones, 1988; Tanner, Padrick, Westfall, & Putzier, 1987; Taylor, 1997). These models used decision trees to analyse the hypothetico-deductive reasoning of nurses. Each decision tree had potential outcomes, which were assigned with a numerical value. The possibility of achieving the outcome was then measured (Banning, 2008b). The hypothetico-deductive

approach applied two main types of reasoning; inductive and deductive (see section 3.1.1). Information-processing theory and the hypothetico-deductive approach can assist researchers to describe nurse's ability to diagnostically reason through using decision trees and the analytical decision-making model. However, there is a limitation in using this approach in the current research. The information processing theory is a linear model whereas in real-world nursing practice, nurses often overlap stages in their cognitive processes, and consequently change or revise their decisions (Jenkins, 1985; Thompson, 1999) due to the complexity of patient conditions, managing different therapies, and environment disruption. As a result of the complexity of decision-making in ICU contexts and especially for nurses working with critically ill patients with AKI whose CRRT management requires multiple process-oriented CDM, information processing theory alone is not appropriate for this research.

3.3.2 Intuitive-Humanist Model

The focus of the intuitive-humanist model is on intuition and on the relationship between nursing experience and knowledge (Banning, 2008b). It focuses on how clinical decisions are intuitively made. Intuition is believed to explain the ability of individuals to know and recognise the potential outcomes of a given situation which may involve risk and uncertainty (Shaban, 2005; Thompson & Dowding, 2002). Rew (2000, p.95) defined intuition in nursing practice as "the deliberate application of knowledge or understanding that is gained immediately as a whole and that is independently distinct from the usual, linear, and analytical reasoning process." (Rew, 2000, p. 95). This indicates that intuition is an element of complex reasoning and decision-making.

The concept of intuition in relation to judgement and CDM has attracted nurse scholars' attention for many years (Rew & Barrow, 2007; Roberts, 2004; Thompson & Dowding, 2009). The concept of intuition has been argued to be a legitimate basis for nurses'

decision-making (Benner, 1984; Benner, 2001; Benner, Hooper-Kyriakidis, & Stannard, 1999; Thompson & Dowding, 2009). Nurses' intuition is explained in Benner's seminal work (Benner, 1984; Benner, 2001; Benner et al., 1999; Benner & Tanner, 1987; Benner, Tanner, & Chesla, 1996 ; Benner et al., 2009). Benner argued that nurses develop expertise along five stages (i.e. novice, advanced beginner, competence, proficiency, and expertise) in contexts where expert nurses are able to judge situations better than novice nurses because experts rely on intuitive thinking. Some studies in nursing practice have found that these stages are weak. For instance, Benner's most extensive empirical study of nursing practice (Benner et al., 2009), undertaken in the 1980s, used years of experience and supervisor judgements as criteria to assign nurses to stages which, according to Ericsson and Smith, was not a reliable way to judge expertise as it is not always associated with expertise (Ericsson & Smith, 1991). Indeed, a recent study used Benner's "From Novice to Expert" model as theoretical framework to examine the relationships among registered nurses' clinical experiences and clinical decision-making processes in the ICU setting (Stinson, 2017). The findings reported that there was no strong correlation between clinical experience in intensive care and clinical decision-making (Stinson, 2017). In terms of the Benner stages of clinical experience, there were no differences found in relation to the overall clinical decision-making process (Stinson, 2017). However, there was a contributing factor that reduced the strength of the correlation was the recruitment of the study sample through a professional organisation, the American Association of Critical Care Nurses (AACN), which had a high number of experts. It appears that there are important contributing factors to the process of nursing decision-making at the individual, social and organisational levels in addition to the degree of nursing experience.

According to Benner's theory, an individual's knowledge moves along two dimensions; from explicit to implicit, and from abstract to concrete in relation to becoming an expert (Gobet & Chassy, 2008). However, there are difficulties related to the list of

competencies identified by Benner (1984) that contains the pre-requisites for accessing explicit knowledge (Gobet & Chassy, 2008). Some examples of competencies from Benner's work are; “Providing an interpretation of the patient's condition and giving a rationale for procedures” (Benner, 1984, pp. 86-89), “Contingency management: Rapid matching of demands and resources in emergency situations” (Benner, 1984, pp. 113-116) and “Getting appropriate and timely responses from physicians” (Benner, 1984, p. 142). Competencies go beyond intuition and implicit recognitional ability to overt explanation and organisational and communication skills. Thus, Benner’s theory appears a simplification of complex phenomena associated with CDM. The intuition-humanist model does not offer a complete explanation of how nurses make decisions, the decision types or qualities, influencing factors such as nurses’ characteristics (i.e. skill, mix or different clinical and cultural backgrounds), and the context in which nurses manage technology.

This research sought to understand the process of intensive care nurses' clinical decision-making when they provide care for patients with AKI on CRRT. The concept of decision-making is individual, social, and organisational and hence more than a cognitive process. As argued above, individual, social, technological and organisational influences might affect nursing decision-making and actions when managing advanced technology. Thus, to understand nursing performance with CRRT machinery, it is crucial to consider the workplace culture and working conditions. Benner’s theory focuses on the development of expertise (Benner, 1984; Benner, 2001; Benner et al., 2009; Gobet & Chassy, 2008). All the participants had different and enough experiences and there were not junior nurses, however, it did not positively influence their decision-making process.

3.3.3 Cognitive Continuum Theory (CCT)

Another decision-making theory is the 'cognitive continuum' theory developed by Hammond (1978; 1980; 1981).This theory explains that 'reasoning is neither purely intuitive nor purely analytical', but located 'in between' (Dowie & Elstein, 1988; Thompson & Dowding, 2002, 2009). In nursing, Thompson (1999) suggested using a 'middle ground' in CDM by drawing on Hammond's CCT to consider strategies for understanding practice and opportunities for research (Hammond, 1978; Harbison, 2001; Thompson, 1999). Hammond et al.'s (1978) framework discusses how humans alternate between an intuitive and analytical mode of processing that depend on whether the task is ill structured or well-structured. Cognitive continuum theory is also referred to as a prescriptive model designed to examine individual judgements through operating on a continuum of cognitive modes involving different levels of analysis and intuition (Cader, Campbell, & Watson, 2005; Hammond, 1978; Shaban, 2005). This theory has three essential characteristics; the structure of the task, the number of information cues and the time available to make judgments or decisions (Cader et al., 2005; Shaban, 2005; Thompson & Dowding, 2009). From the perspective of this theoretical framework, intuition is the cognitive process used when the task is completely unstructured, when there are various information cues, and when there is little time to judge or decide (Cader et al., 2005; Shaban, 2005; Thompson & Dowding, 2009). At the other end of the continuum, the analytical approach is used when the task is highly structured, there are few information cues, and there is adequate time to make a decision (Cader et al., 2005; Shaban, 2005; Thompson & Dowding, 2009). Thus, CCT offers a framework in which cognition and task parameters are connected.

Cognitive continuum theory has been used to explain CDM processes in nursing and other health care areas (Cader et al., 2005; Standing, 2008; Thompson & Dowding, 2009). In one study, for example, researchers examined how nurses make decisions about documenting

patient care in progress notes (Tower, Chaboyer, Green, Dyer, & Wallis, 2012). Nurses used think-loud research methods to assess the needs of newly admitted patients (i.e. nurses' decision-making regarding documentation was based on cues from patients' diagnoses and background information) (Tower et al., 2012). The decision-maker needs to be situationally aware in order to make an effective decision, and Tower et al.'s (2012) study revealed that nurses organise their tasks and gather the relevant information and environmental data in ways that stimulate modes of cognition which can result in accurate decision-making and better patient outcomes. Nurses, however, probably use several analytical strategies in their decision-making (i.e. following a mental model for assessments), when clinical complexity and urgency demand quick thinking. Other studies have used CCT to explore various nursing contexts such as exploring nurses' prescribing pharmacological knowledge and decision-making (Offredy, Kendall, & Goodman, 2008); and analysing the relationship between the processes used and decision tasks by heart failure specialist nurses to make decisions.

In practice, CCT helps nurses in two different ways. First, it assists nurses to predict appropriate modes of cognition in relation to the number and nature of patient cues to make decisions, and second, it provides a framework to improve accuracy in nurses' decision-making processes (Cader et al., 2005; Hamm, 1988). However, one limitation of CCT is that it focuses on verifying which patient cues are appropriate and how they connect to the prediction of the condition in reality rather than focusing on the nurses or decision makers' cognitive processes (Buckingham & Adams, 2000). Another limitation is that the CCT examines the relationship between the concepts or nature of tasks and modes of cognition, which is not the focus of this research. In the current study, the aim is to understand how intensive care nurses make clinical decisions that inform their nursing actions when managing patients with AKI and CRRT.

3.3.4 O'Neill's et al. Clinical Decision-Making Model

A more recent nurse decision-making model was conceived by O'Neill et al. (2005). The CDM approach by O'Neill et al. (2005) consists of a multidimensional model which recognises the importance of understanding and analysing nurses' decisions about patient conditions in appropriately determining care (Banning, 2008b; O'Neill et al., 2005). The CDM model includes information processing theory and pattern recognition to explain nurses' CDM. O'Neill et al. developed this model through the synthesis of findings from four previous studies that examined how graduate students (O'Neill, 1999; O'Neill, Dluhy, Fortier, & Michel, 2004), qualified nurses (O'Neill, 1997), and novice nurses make inferences and decisions (O'Neill & Dluhy, 1997). Pattern recognition occurs when nurses compare signs and symptoms of patient responding to treatments or clinically deteriorating in order to recognise and restore clinical patterns to match the current situation (Banning, 2008b; O'Neill et al., 2005). There are crucial elements involved in activities that include identifying similarities, understanding the condition based on prior knowledge, and recognising significant (salient) aspects of the situation (Benner et al., 2009; O'Neill et al., 2005).

The O'Neill et al. CDM model was introduced as a theoretical framework to inform a project on nurse computer decision support (N-CODES) to assist novice acute care nurses when they make clinical decisions (O'Neill et al., 2005). The model can explain the ways in which nurses think in practice and develop their clinical reasoning skills at a conceptual level (O'Neill et al., 2005). O'Neill and her colleagues argued that when the basis of the decision support system originates from a theoretical model of nurse decision-making, it can strengthen the use and acceptability of the system for decision-making (O'Neill et al., 2005). Thus, the CDM model has been used in different nursing contexts. As noted it, it has been applied in novice nurse-computer decision support projects (Chin, Sosa, & O'Neill, 2006; O'Neill, Dluhy, Hansen, & Ryan, 2006) to assess novice nurses in making assessments,

anticipate changes in patient's conditions, and apply early and appropriate interventions. These two studies used computer scenarios and focus groups, but no research has been undertaken in the real world of nursing practice where clinical decision-making occurs.

Within the O'Neill et al. CDM model (Figure 3.1) there are multiple interrelated components. These components are pre-encounter data, assessment of risk and risk reduction, the situational features that affect decision-making, salient concerns, hypothesis generation, hypothesis-driven assessment, hypothesis selection, and then nursing action (O'Neill et al., 2005). Each component is examined in turn below.

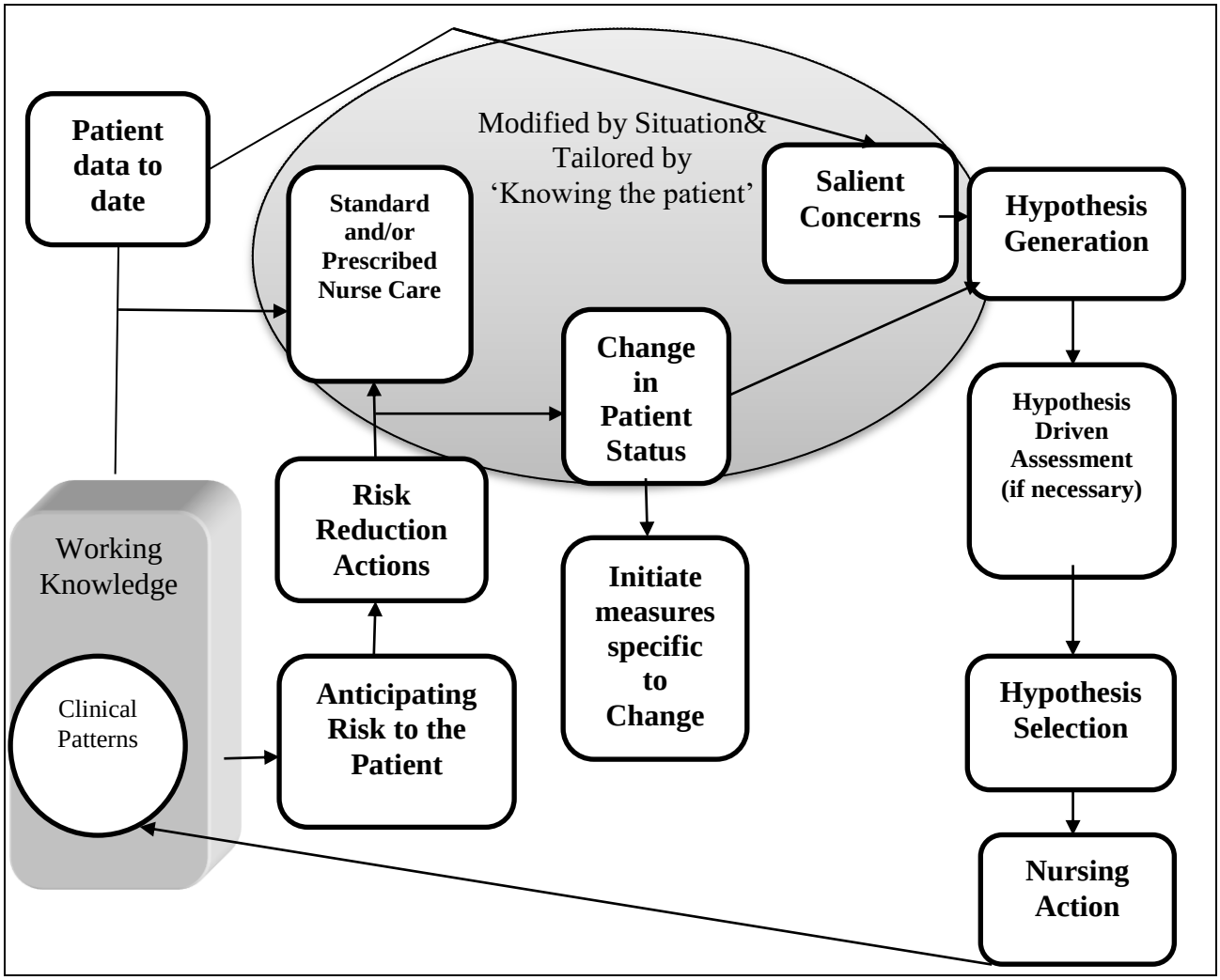


Figure 3. 1 O'Neill et al. Clinical Decision-Making Model (CDMM) (O'Neill et al., 2005)

Patient data, working knowledge and clinical patterns

The above CDM model begins with pre-encounter data or the information or data that nurses have before interacting with the patient. This data combines both specific patient information and the working knowledge of nurses (O'Neill et al., 2005). Patient information may include nursing reports, data generated from communication/verbal exchanges with health personnel and the patient's family, and written information in records and flow sheets (Banning, 2008b; O'Neill et al., 2005). Further, part of reporting patient progress may also originate from staff discussions, textbook knowledge, assumptions, experiences, and interests which may be performed by using open discussion techniques (Banning, 2008b; O'Neill et al., 2005; Shearer et al., 2012). In terms of patient data, nurses have knowledge (Banning, 2008b) about various patient patterns stored in their long-term memory which become available to the working memory to use (O'Neill et al., 2005).

Working knowledge is stored in the long-term memory and it is the organised knowledge that is used regularly and spontaneously in the context of an individual's work (Manias, Aitken, & Dunning, 2005; O'Neill et al., 2005). The collection of text-book knowledge, assumptions, experiences, and interests are considered part of the working knowledge that influences nurses' behaviours (O'Neill et al., 2005). Based on cognitive theory, working knowledge is subject to change and revision when new knowledge is encountered (O'Callaghan, 2005). Hence, this knowledge involves two essential clinical patterns; memory of previous patients and background memories of common problems. This knowledge provides a basis for CDM.

In terms of pattern recognition, in this research for example, intensive care nurses ought to recognise a change in urine volume that is often associated with developing AKI. For example, it is assumed that when intensive care nurses record the hourly urine volume,

they will recognise changes (e.g. trending down) and this will trigger their memory because it is recognised as a pattern associated with the early development of AKI. In this research, the researcher will observe the intensive care nurse's interaction with the CRRT. If, for example, there is a CRRT alarm, it should activate a nurse's working memory to recognise the possible reason for the alarm based on a range of possible situations or patterns stored in the working memory. In this research, pre-encounter data were generated during observations of and interviews with intensive care nurses.

Anticipating Risk and Risk Reduction

The second and third components of O'Neill et al. CDM model are anticipating and controlling risk. Using pre-encounter data helps nurses to anticipate patient risks. These risks may relate to a patient's history or clinical situation which can increase the likelihood of a health complications (O'Neill et al., 2005). In this component, nurses use pre-encounter data to predict the likelihood of health problems that patients may develop (O'Neill et al., 2005). Further, nurses can consider and prioritise the degree of risks of each possible health problem to lessen the likelihood of the most threatening risk (Banning, 2008b; O'Neill et al., 2005; Thompson & Dowding, 2002). For instance, observing nurses communicating with other nurses or doctors could indicate when a nurse has used pre-encounter data to predict potential problems for patients with AKI or CRRT problems. Another example, is where nurses use some techniques or strategies (i.e. frequently flushing the circuit or patient positioning) to prevent or reduce CRRT problems, such as filter clotting or abnormal access pressure.

Standard nursing care

This fourth component assesses the standard of nursing care (SNC) according to intensive care nursing' practice, procedures, and protocols habits prescribed by the Saudi

Arabian intensive care nursing (Banning, 2008b; O'Neill et al., 2005). The setting of this research was King Abdul-Aziz University Hospital (KAAUH) in Jeddah, Saudi Arabia, which was accredited as meeting the Canadian Council on Hospital Accreditation. Knowing the patient and the clinical care setting are indicators to modify the SNC (O'Neill et al., 2005). In addition, health care provider preferences and nursing policies and procedures can influence the selection of care (O'Neill et al., 2005). In this research, the model was applied in interpreting intensive care nurses' decisions on care as CRRT in terms of existing protocols (see Appendix B). For instance, when a patient with cardiogenic or septic shock induced AKI is admitted, this diagnosis ought to trigger a management procedure (e.g insertion of Swan-ganz catheter, or vascular access for CRRT).

Salient Concerns

The next two features of O'Neill et al. CDM model are situational and patient modifications which occur in the midst of patient crises, such as caring for more than one patient at time, and constant and repeated interruptions (Banning, 2008b; O'Neill et al., 2005). O'Neill et al. describes these two features combined as the salient concerns of nurses. There are critical factors that influence nurses' clinical decision-making. Such factors include availability of supervision support, positive interactions among staff in a rapidly changing environment, awareness of work roles and responsibilities, sufficient nursing staff in both numbers and skill mix, adequate time to collect information, think and interact, and knowing the patient in relation to their physiological and psychological processes (Banning, 2008b; O'Neill et al., 2005).

Knowing the patient is a crucial aspect in relation to making clinical decisions in practice. Where nurses understand their patient's experiences, values and behaviours and can individualise their care, this is described as 'knowing the patient' (O'Neill et al., 2005;

Radwin, 1995). When situational and patient changes occur, nurses use their previous working knowledge and experience in order to identify or recognise causes of the patient's clinical deterioration to select the appropriate clinical decision and intervention. When patients with AKI, for instance, develop rapid changes in vital signs (e.g. hypotension) while receiving CRRT, it may activate nurses' long term memory in knowing the patient as a key strategy to recognise and identify possible causes or risks in order to make decisions and take action (e.g. discontinue CRRT, increase vasoactive therapy or intravenous fluid volume). Observational episodes and interview sessions captured how nurses know the patient, or are able to identify possible causes and risks, and consequently make clinical decisions in the ICU context when the patient status changes.

Hypothesis Generation, Selection and Nursing Action

During clinical decision-making, nurses generate and 'test out' hypotheses in relation to pre-encounter information or important cues to the patient status (Banning, 2008b). These cues could be the appearance of new symptoms, deterioration or improvements, or a change in the patient behaviours, which influences the generation of hypotheses and the selection of an appropriate action (Banning, 2008b; O'Neill et al., 2005). During the process of care, nurses use pre-encounter data in addition to other information that is collected from the patient to generate a hypothesis (O'Neill et al., 2005). For instance, in this research, when there was a CRRT alarm due to low return access pressure, it activated the nurse's long-term memory to consider possible causes that threatened the patient such as low blood pressure, patient positioning, filter clotting, bleeding or the vascular catheter is kinked. These hypotheses will initiate assessment to seek signs or symptoms related to these conditions. If the patient's blood pressure is low, the nurse will focus on the patient (e.g. vital signs, vasoactive therapies, or the site of the catheter) and take the appropriate action. Hypothesis

generation results from nurses' sense of saliency (i.e. what is important) in relation to changes in the patient condition. When nurses become more experienced in patient care, they consequently develop the ability to recognise if a patient's clinical condition is deteriorating or improving (Banning, 2008b; O'Neill et al., 2005). More information can be collected during hypothesis generation. Evaluation is then needed for each hypothesis to select the most appropriate information (O'Neill et al., 2005). According to the level of clinical experience, a nurse may select patient-specific information and use pattern recognition to accept or reject the best hypothesis (Banning, 2008b). A recognised pattern in working knowledge needs to be matched with the current information through the process of selection and ought to result in an appropriate action (O'Neill et al., 2005). Moreover, the level of nurses' experience and knowledge can determine the level of complexity in generating a hypothesis and appropriate actions because the unique characteristics of each patient situation can have an effect on the search for the most appropriate hypothesis (O'Neill et al., 2005).

Benefits and limitations of O'Neill et al. CDM Models

Importantly, O'Neill et al. CDM model reveals how nurses' cognitive process works in a loop to achieve appropriate decisions and successful actions. Firstly, the CDM model is applicable because it is a general model that can be applied to any clinical setting. As there is no specific CDM model for intensive care nursing, it was appropriate to use the model to inform this research of nurses caring for patients with AKI receiving CRRT issues in ICU settings. Secondly, this model can describe differences between experienced intensive care nurses' working knowledge (e.g. knowing the patient), confidence and technical and non-technical skills in CRRT practice. Thirdly, the O'Neill et al. model was used to understand how intensive care nurses make multiple clinical decisions in relation to AKI care and CRRT problems. The model therefore covered the individual features of the CDM process in the

ICU setting in which a central element was intensive care nurses quickly activating their working knowledge. Anticipating risk and risk reduction concepts, for instance, can answer and explain how intensive care nurses demonstrate their working knowledge in relation to AKI patient care and CRRT technology in routine practice. It can be used to explore intensive care nurses' early recognition of potential clinical deterioration or detect CRRT problems and guide subsequent responses. Thirdly, Banning's (2008) review noted that the O'Neill et al. CDM model was hybrid approach or model that utilised hypothetico-deduction and intuition to examine inexperienced nurses' decision-making processes. The O'Neill et al. model therefore provides a framework to guide the deductive analysis, in exploring and analysing the CDM process of nurses. Lastly, it is asserts that this research will add to the utility of O'Neill et al.'s CDM model in experienced nurses. The work of experienced nurses working in a variety of contexts has not yet been examined through the lens of O'Neill et al. CDM model.

In terms of limitations, the CMD model has only been tested by O'Neill and colleagues. More research is therefore required to assess its maturity. Experienced intensive care nurses, for instance, working with CRRT technology, may use their rich working knowledge, preventive techniques and pattern recognition to quickly make clinical decisions and take action following all of O'Neill et al. components but doing it quickly and smoothly.

Several studies have found that expert nurses were more proactive in collecting and clustering relevant cues, and anticipating problems to quickly recognise patient deterioration (Aitken, 2003; Dowding & Thompson, 2003; Hoffman et al., 2009; Reischman & Yarandi, 2002). Thus, accurate detection of problems might be an important aspect of the decision-making process (Hoffman et al., 2009). In addition, the O'Neill et al. CDM model has many interrelated components that render it difficult to capture the real world of the ICU setting. Thus, the current research was conducted in the real world of practice, which involved nurses

making multiple clinical decisions, troubleshooting advanced technology and managing complex patients with AKI. It is for this reason that patients with AKI who were receiving CRRT were the specific focus of this research, rather than nurses' CDM around total patient care.

3.4 Chapter summary

In summary, this chapter has provided a review of the cognitive processes of memory including information processing, problem solving, decision-making and nurses' clinical decision-making, to assist in understanding how nurses make decisions in clinical practice. Theoretical models of decision-making were critically discussed to better understand the conceptualisation of nurse decision-making in real world practice. There is an emerging consensus that the theoretical approaches to studying clinical decision-making processes can help researchers understand how nurses problem solve and make decisions (Banning, 2008b; Thompson, 1999).

In this interpretive research, the O'Neill et al. model was applied from data collected through participant observation and interviews which were subsequently subjected to deductive content conceptual analysis. The same data was re-analysed from an inductive conceptual approach to build an in-depth understanding of the phenomenon of clinical decision-making of intensive care nurses while they provide CRRT for patients with AKI. The latter analytical phase was important to reach in-depth understanding beyond the constraints of the O'Neill et al. model. Chapter Four, which follows, explains in detail and justifies the underpinning research assumptions and methods applied in the research.

Chapter Four: Research Methods

4 Introduction

The research, in examining intensive care nurses' clinical decision-making associated with providing nursing care for patients who have AKI and who are receiving CRRT, applied an abductive approach that incorporated both interpretive and deductive methods. The purpose of this chapter is to present an overview of the methodological design of the research. The chapter addresses in detail the research design, the processes of sampling, data generation and data analysis, and ethical considerations.

4.1 *Design*

As noted above, this work drew on an existing theoretical framework of clinical decision-making (O'Neill et al. clinical decision-making theory) that is concerned with information processing theory and pattern recognition (O'Neill et al., 2005). Data generation involved interviews and observations and analysis consisted of two processes of interpretation. The first approach was deductive content analysis where the O'Neill et al. CDM model informed an exploration of what had been observed in the real world of the intensive care nurse's practice with technology and decision-making. A second approach sought to expand the analysis through a conceptual approach that allowed for an in-depth explication of the nature of intensive care nurses' clinical decision-making processes.

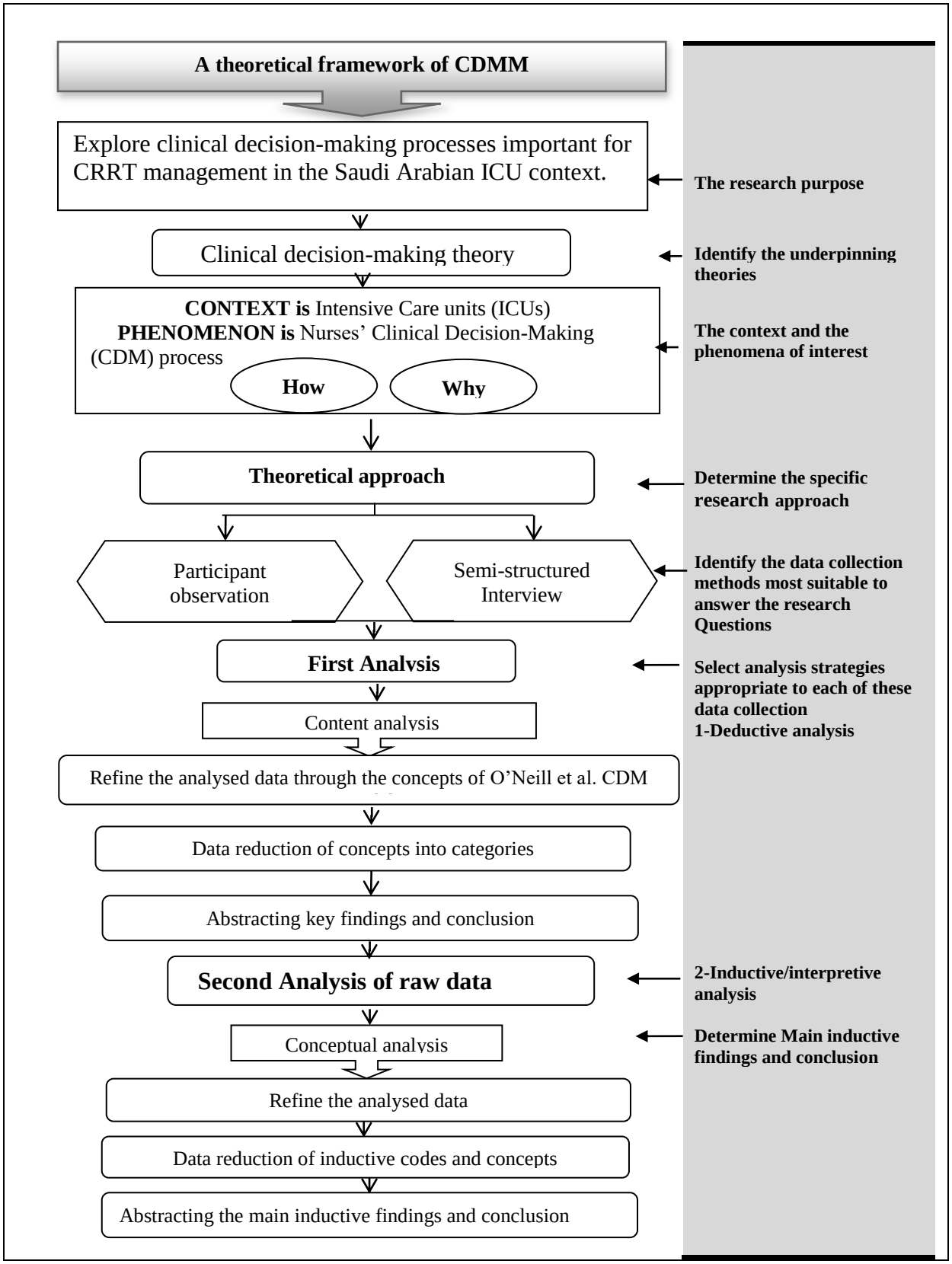


Figure 4. 1 An interpretive theoretical qualitative framework of O'Neill et al. CDMM (2005)

The O'Neill et al. CDM framework was appropriate to the research because the purpose was to understand the phenomenon of nurse decision-making and performance within an ICU clinical context in Saudi Arabia made increasingly complex by advanced technologies. The application of the theoretical analytical process is depicted above in Figure 4.1. The dimensions of the model were used as a frame for categorisation and analysis of observational and interview data. Thus, a deductive conceptual content analysis was firstly conducted to explore O'Neill et al. CDM model that considers nurses' decision-making is linear (O'Neill et al., 2005), however, in reality clinical decision-making may not be and is more than cognitive process. An inductive conceptual approach was then applied to allow for a broader exploration of the processes that shaped intensive care nurses' decision-making in managing CRRT problems and to explore possible contextual influences.

4.2 *Setting*

The site for the conduct of the research was King Abdul-Aziz University Hospital (KAUH) managed by the Ministry of Health and located in Jeddah, Saudi Arabia. KAUH is an 895 bed tertiary health care hospital with ambulatory care services and 1,152 nursing staff. In addition, KAUH is a teaching and learning institute for nursing and medical students from King Abdul-Aziz University and other universities in Saudi Arabia. King Abdul-Aziz University Hospital is one of the largest Saudi hospitals and has been accredited as meeting the international standards of excellence in quality care and health services by The Canadian Council on Hospital Accreditation (Beaumont, 2002; Kilfoil, 2000; Walston, Al-Omar, & Al-Mutari, 2010). Most Saudi Arabian hospitals are externally accredited to achieve high standards of clinical practice (Walston et al., 2010). The KAUH is a government public hospital provides free services to people living in the western region of Saudi Arabia as well as those from surrounding regions.

The KAUH has two adult ICUs comprising a medical intensive unit (16 beds) and a surgical intensive unit (10 beds) that receive all medical/surgical and cardiothoracic referrals from the western region of Saudi Arabia, including trauma and post road traffic accidents. The total number of adult ICU admissions across the medical/surgical ICUs is approximately 1,800 per annum. The KAUH hospital has also been accredited by the Canadian Council on Hospital Accreditation (CCHA), which meant that the ICU policies and procedures in the research site were considered equivalent to Canadian ICU standard. Intensive care nurses follow these policies and procedures (see Appendix B, the CRRT protocol). There was no specific education program provided on CRRT. Rather, senior intensive care nurses provided orientation and training around CRRT for new or novice nurses. There were, at the time of the research, approximately 80 full time equivalent nurses working across the two adult ICUs.

4.3 *Sample and Recruitment*

The methodological grounding of the current research deemed sample size of far less importance than the generation of meaningful and in-depth data (Liamputtong, 2013b; Thorne, Kirkham, & MacDonald-Emes, 1997; Thorne, Kirkham, & O'Flynn-Magee, 2004). Thus data were generated until there was a conceptual density (Dey, 1999; Nelson, 2016) sufficient to facilitate an in-depth exploration of the research focus. Purposive sampling was used to recruit individuals with experiences appropriate to the research aims (Liamputtong, 2013b). In this research, therefore, the sample constituted intensive care nurses who were currently providing nursing care to patients receiving CRRT. Sampling also sought to obtain a range of characteristics (i.e. gender, age and years of experience with CRRT) to maximise the diversity of experiences and views. A consent was also signed by a relative/family member of a patient with AKI and CRRT who is unable to sign to allow observation (see Appendix C).

Following ethics approval at both the Queensland University of Technology and KAUH (see Appendix C), registered nurses were recruited through a systematic process as follows. The researcher explained the purpose of the research to the nursing director and the intensive care nurse manager and obtained permission from both to display a flyer with the researcher's contact details in nursing areas (e.g. tea-room, and communication book). The researcher also distributed a letter explaining the purpose of the research to all relevant nursing staff and invited them to contact the researcher for further information (see Appendix C). Potential participants were provided the contact details for the researcher. When a nursing staff member contacted the researcher by calling or texting, a mutually convenient time and place was arranged to explain the research and to answer any questions or concerns. If the nurse agreed to participate, a consent form was signed. Ultimately, 29 intensive care nurses consented to observation of their routine nursing practice with AKI patient care and CRRT technology and to undertake individual audio-taped interviews.

Demographic characteristics of participants (e.g. gender, age, education level, length of work experience in the nursing profession, and length of work experience in ICU and clinical experience with AKI patients and CRRT) were collected (see Table 4.1). Of the 29 participants in this research, the majority were female (89.6%) and all were expatriate nurses from the Philippines, India and Pakistan. Indian nationals represented the majority (69%) and their ages ranged between 26-36 years. Nearly half (41%) of registered nurses working in the ICU were aged between 31-35 years. Only 3.4% of those nurses were aged over 45 years. The majority of participants held acquired a Diploma of Nursing (65.5%) qualification and only 34.5% a Bachelor degree. Almost all (96.5%) of the participants had not attended postgraduate (or post-basic) nursing courses in intensive care nursing. All nurses had more than 5 years' experience. Fifteen nurses (51.7%) had ICU working experience between 6 and 10 years. For the participants experience of CRRT clinical practice was obtained in Saudi

Arabia over a period from 6 to 13 years (55.2%). Participant characteristics are summarised in Table 4.1.

Table 4. 1 participant Demographics (n=29)

Demographic Characteristics	Number (%)
Sex	
Female	26 (89.6%)
Male	3 (10.3%)
Nationality	
Philippine	8 (27.6%)
India	20 (69%)
Pakistan	1 (3.4%)
Age	
Less than 30 years old	7 (24%)
31-35	12 (41%)
36-40	7 (24%)
41-45	2 (6.9%)
Over 45 years	1 (3.4%)
Level of Education (duration)	
Diploma (3years and 6 months)	19 (65.5%)
Bachelor (4years- and 1 year internship)	10 (34.5%)
Intensive care course	
Yes	1 (3.4%)
No	28 (96.5%)
Registered Nurse Experience	
5-10 years	21 (72.4%)
11-15 years	6 (20.7%)
16-20 years	2 (6.9%)
Intensive care Nursing Experience	
1-5 years	6 (20.7%)
6-10years	15 (51.7%)
11-17 years	8 (27.6%)
CRRT clinical practice experience	
< 1 year	2 (6.9%)
2-5 years	11(37.9%)
6-13 years	16 (55.2%)

Over a six-month period, a total of 77 hours and four minutes of participant observations were undertaken in the ICU. Thirty-one periods of observation were carried out occurred and detailed hand-written field-notes were recorded. One participant declined to participate in an interview and hence a total of 28 participants were interviewed. However,

two participants participated in two observations and two interviews during the 6 month data collection period (e.g. labeled as participant 9A and B, and participant 14A and B). The majority of observations and interview sessions were conducted during the 12 hour day shift as more activities (e.g. procedures, interactions between participants and other health professionals) related to the CRRT and patient conditions, coincided with the morning rounds of doctors. The night shift was only to continue the nursing management plan. Conducting the majority of observations and interviews during the day shift had not had any relation or effect on protecting nurses' identity or having more staff to cover for participants. Table 4.2 summarises the shifts, observations and interviews.

Table 4. 2 Participants' observations and interviews.

Participants / Shifts	Observations Number, percent	Interviews Number, percent
Day (07:00-19:00)	**26 (83.9%)**	**25 (89.2%)**
Night (19:00-07:00)	**5 (16.1%)**	**3 (10.7%)**
Total	**31**	**28**

A minimal amount of patient data was also recorded during the observational episodes and interviews. Such data comprised age, gender, diagnoses, medications, and different therapies that AKI patients were receiving in their CRRT. Patients with end-stage kidney disease (ESKD) were also included because they had AKI and were receiving CRRT (none of these patients received haemodialysis). Table 4.3 summarises the patient data and identifies which nurse was observed providing care to that patient.

Table 4. 3 Patient information

Patients	Patient information	Participants
Pt 1	27 years old/ Male patient with burns covering 75% of his body developed AKI, Managed with CRRT (CVVH/left femoral). LOS in ICU is 8 days. Other treatments: TPN, IVF, 2 sedations (Fentanyl and propofol), 2vaso-active therapy (nor-adrenaline and levophad), MV via ETT, NGT, IDC,CVC, and arterial line.	Ns1-day shift
Pt 2	54 years old/Male patient diagnosed with post CABG and developed septic shock due to respiratory infection (7th day in surgical ICU). Other treatments: CRRT, 3 vasoactive therapies, one IVF, 2 sedations, Heparin/anticoagulation rate 4.5, CRRT (CVVH/day7) vascular access (Lt femoral), MV via ETT, chest tube (drainage) and TPN.	Ns2-Day shift
Pt 3	57 years old/ Female patient had sepsis and post-operative managed with the CRRT (CVVH/day) with heparin, Rt femoral vascular catheter, (IFVs 1, sedations 1, vasoactive therapy 1, MV (ETT), IDC, one negative pressure drainage from patient's abdomen).	Ns3-Day shift Ns4- Day shift
Pt 4	55 years old/ Female patient had septic shock, Lt Arm fasciectomy (plasters), ESRD, and low level of conscious LOC." is ETT, NGT, 3 IFVs, vasoactive therapy 2 (vasopressin and nor-adrenaline), CRRT (CVVH), CVC, and vascular access (Lt femoral).	Ns5- Day shift
Pt 5	80 years old/Male patient had septic shock, (AKI and ESRD), low PH, GCS is 6/15, anuric, and DM. Other treatments: MV (ETT), CVVH (Lt femoral/day2), 3 IVFs, NGT, CVC, 2 vasoactive therapies (levophed and nor-adrenaline).	Ns 6- Day shift
Pt 6	71 Years old/Male patient had post-operative (Rectal cancer RC) with septic shock necrotic fasciitis, ARDS, and DIC. Other treatments: intubated on MV, has IVFs and blood transfusion, 3 vaso-active therapies (nor-adrenaline, levophed and vasopressin), 3 sedations (propofol, Nembex and Fentanyl), IDC, arterial-line and CVC, vascular access (Lt femoral), CVVH (no fluid removal).	Ns 7 –Day shift
Pt 7	45years old/ Male patient had septic shock, IHD, congested and anuric. Other treatments: MV, NGT, 3vasoactive therapies, sedation, CRRT (CVVH/1days), IDC, vascular access (Lt femoral), arterial line, and CVC.	Ns 8- Day shift Ns 9A-Day shift
Pt 8	72 years old/male patient had septic shock, obstructive jaundice transferred from other hospital with DIC. Other treatments: 1 vaso-active therapy (nor-adrenaline), 1 sedation (Fentanyl), NGT, MV (ETT), CRRT (CVVH with fluid removal/day1) vascular access (Rt femoral), CVC, arterial-line, Blood and FFP transfusions and IDC.	Ns 9B- Day shift
Pt 9	83 years old/Male patient had septic shock, MI, upper GI bleeding, old Cerebrovascular accident (CVA), DM, HTN, and severe metabolic acidosis. Other treatments: 2 vaso-active therapies (nor-adrenaline, Dobutamin),	Ns 10- Day shift

	Pantazola infusion, IVF (D5NS), MV (ETT), IDC, NGT, A-line, CVC, Vascular access (Lt femoral) and CRRT (CVVH) (A day/clotted last night).	
Pt 10	50 years old/Male patient had septic shock, HF, hypoglycaemic and hyperkalaemia. Other treatments: 2 inotropes (dobutamine, nor-epinephrine), NGT, MV (ETT), 1 IVFs (D10), IDC, CVC, A-line, vascular catheter (Rt femoral), CVVH with fluid removal.	Ns 11- Day shift
Pt 11	78 years old/Male patient admitted last night and transferred from medical ward to the ICU with chest infection, septic shock and his BP suddenly dropped. Intubated, low urine output and high serum creatinine and urea. The doctor was planning to start intermittent haemodialysis but the patient haemodynamically unstable (low BP despite high amounts of nor-epinephrine). Other treatments: CRRT (CVVH/12 hours) without fluid removal, MV (ETT), IDC, arterial line, CVC, vascular access (left jugular), Swan-Ganz (right femoral), inotropes 3 (dobutamine, vasopressin and nor-epinephrine), IVF and sedation (Fentanyl).	Ns 12- Day shift
Pt 12	78 years old/male patient had cardio-genic shock. Other treatments: inotropes (Dobutamine), CRRT with fluid removal (36hours), sedation (Fentanyl and propofol), Swan-Gaz cath., CVC, A-line, IDC and vascular access (Rt femoral).	Ns 13- Day shift
Pt 13	53 years old/Female patient had cardiogenic shock with Glasgow coma scale (GCS of 3). Other treatments: mechanical ventilation, inotropes (Dobutamine), CVVH with fluid removal, NGT and feeding, IDC, swan ganz, CVC, A-line, vascular Cath (Rt femoral), warm blanket.	Ns 14 A-Day shift
Pt 14	31 years old/ Female, patient diagnosed with septic shock, Thalassemia, HCV positive. Other treatments: mechanical ventilation, NGT feeding, arterial line, CVC, vascular access Rt femoral (CVVH/day2), 2 inotropes (nor-adrenaline and vasopressin), sedation (Fentanyl), Na Hco3, and 1 IVF D50.(Pt died)	Ns14 B- Night shift Ns 28- Day shift
Pt 15	56 years old/ male patient had septic shock and diagnosed with liver and spleen meningioma. Pt was admitted to the ICU with low BP and low LOC with high lactic acid, thrombocytopenia (platelet is 1), and autoimmune disease. Other treatments: Inotropes (nor-epinephrine and dobutamine), Heparin infusion, sedations (propofol and Fentanyl), IVFs Ns0.5, IDC, MV (ETT), and CRRT Rt femoral cath. (CVVH/day1).	Ns 15- Day shift Ns 16 -Night-shift Ns 17 -Day shift Ns 18- Day shift Ns 19- Day shift
Pt 16	56 years old/ male patient had acute coronary syndrome and developed cardiogenic shock. Other treatments: Inotropes (nor-epinephrine and dobutamine), Heparin infusion, sedations (propofol and Fentanyl), IVFs (Ns0.5), IDC, MV (ETT), and CRRT Rt femoral cath. (CVVH/day1).	Ns 20- Day shift Ns 21- Day shift
Pt 17	45 years old/Male patient had septic shock, acute abdominal pain and subtotal colectomy. Other treatments: Inotropes (nor-epinephrine), sedations (Propofol and Fentanyl), 2 IVFs (D51/2Ns and Na Hco3), blood transfusion, IDC, formation stoma and 2 drainages from abdomen, MV (ETT) and CRRT right femoral vascular access.	Ns 22- Night shift Ns 23- Day shift Ns 24- Day shift

Pt 18	78 Years old /Male patient admitted to the ICU with septic shock, Post laparotomy-colonsectomy, HTN, DM, RT leg fracture, lower extremities ischemia. Other treatments: CVVH (Lt Jugular/3day), MV (ETT), sedation (Fentanly), IDC, one drainage, body warmer, NGT, vasoactive therapies (vasopressin, nor-adrenaline and dobutamine).	Ns 25- Night shift Ns 26- Day shift Ns 27- Night shift
Pt 19	75 years old/Female patient diagnosed with septic shock, ESRD, HTN and DM. Other treatments: CVVH (CRRT), MV (ETT), arterial-line, CVC, Foley cath., NGT, Quinton catheter (premcath/ superior vena cava/Rt subclavian vein), vaso-active therapy (nor-adrenaline 100meq/min and vasopressin 0.03u/ml), and one IVF sodium bicarbonate (NaHco3) 25meq/hr	Ns 29- Day shift

* ESKD case included because of using CRRT, and the need to recruit ICU nurses who work with CRRT. *All Abbreviations: Length of stay (LOS), Total peripheral nutrition (TPN), Intravenous fluids (IVFs), Mechanical ventilation (MV), Endotracheal tube (ETT), Naso-gastric tube (NGT), indwelling urinary catheter (IDC), Central venous catheter (CVC), Diabetes militates (DM), Coronary artery bypass graft (CABG), Disseminated intravascular coagulation (DIC), Hypertension (HTN), Heart failure (HF), Glasgow coma scale (GCS), Acute respiratory distress syndrome (ARDS), Rectal cancer (RC), Cerebrovascular accident (CVA), Fresh frozen plasma (FFP), gastrointestinal (GI), Myocardial infarction (MI), blood pressure (BP), ischemic heart disease (IHD), Hepatitis C virus (HCV), Normal saline (Ns), Right (Rt) and Left (Lt

4.4 *Data Generation Methods*

As noted above, data were generated through observation and interviews over a six-month period (August 2013-Junuary 2014). Participant observation in the research involved the researcher interacting with a participant, asking them some questions and recording what was happening, including participant interactions. Observations allowed the researcher to observe how the participant acted and reacted in practice (DeWalt & DeWalt, 2011; Hennink, Hutter, & Bailey, 2011; Silverman, 2010). In the research, observation of practice was designed to capture nursing practice as it occurred while a nurse was managing a patient with AKI who was receiving CRRT. The focus of early observation periods was broad in scope. Increasingly, however, observations were refined to factors and events that were directly related to AKI and CRRT care (e.g. patient positioning, ventilation parameters, vasoactive therapy and vital signs). Field-notes were used to record what a participant said and did as well as provide a contemporaneous record of the patient's status (e.g. ventilation, vasoactive therapy, vital signs, and patient position) and demographic information. For example, if an alarm sounded was noted and the subsequent actions (or inaction) of the nurse recorded.

All participants were informed that the purpose of observation was not to evaluate their work but to observe current nursing practice more generally. The researcher ensured the participants that data generation would not disrupt patient nursing care. During participant observation the presence of the observer may have an effect on what is observed (i.e 'reactivity') (Liamputtong, 2013b; Silverman, 2010) and hence, strategies were instituted in this research to minimise the effect. The researcher, for example, observed participants at different times and for prolonged periods to normalise her presence. Other strategies were ensuring adequate distance between the researcher and the participant, changing the researcher's location during each observation (e.g. observing from a closed area such as a nursing station, and outside the patient's room through a glass window), and developing a

healthy professional relationship with participants. Informal questions were also posed during observations and documented in field-notes.

Field notes were typed into word documents at the conclusion of each observation period and these became data for the purposes of analysis. Observational notes can be used to adjust interview questions and writing memos for analysis purposes (Corbin & Strauss, 2008; Miles, Huberman, & Saldaña, 2014). During observation, the researcher recorded observational notes including who was involved in each event, what decisions nurses made and what actions they took with CRRT machinery and what interactions occurred with other nurses and doctors. To write field-notes during observations can be challenging for the researcher but there are some helpful strategies such as observing for two to four hour periods, taking short breaks from observing to write field notes, developing shorthand techniques to note brief points and labeling each field-note with a date, time and place. In so doing, field notes were generated during usual routine nursing practice and consisted of detailed memos about intensive care nurses' clinical decision-making events which included the complexity of participant performances with CRRT and actions participants when patients were deteriorating. The field notes for each observation were entered in the qualitative data analysis computer software NVivo 10 and labeled as Field note No 1, Field note No 2...etc. The use of the software NVivo 10 was for management purposes only and not analysis. The program helped to organise the types of data and to draw on excerpts of data as relevant to the analysis (Bazeley & Jackson, 2013).

The second data generation strategy was individual participant interviews. Following a period of observation, questions were developed for subsequent semi-structured interviews. A semi-structured interview sought to gain an understanding of specific issues from the perspective of participants (Hennink et al., 2011; Liamputtong, 2013b). An interview was conducted to explore the reasons and rationales for nursing actions observed. Participants

were encouraged to give detailed explanations of their actions and, when necessary, additional probing questions were posed to seek clarification. The researcher asked how rather than why questions to avoid creating defensive or self-protective behaviour on the part of participants (Liamputtong, 2013b; Silverman, 2010). The duration of the interviews ranged from 10-30 minutes. It was difficult to extend the interview time length due to ICU environment interruptions, the need for nurses to attend their acutely sick patients, and nurse shortages. The researcher therefore selected suitable time and place for each participant to conduct the interview after each observation. Length of interview did not strongly affect the depth of participants' explanations; they answered each question according to their level of clinical knowledge and experience with advanced technologies. The researcher had to ask more questions to gain more information from each participant. However, questions were consequently prepared from the observations and the interview slowly started focusing on the participant's experience with AKI and advanced technologies including CRRT. Additional questions were added to obtain in-depth understanding and more insight into the issue, and to facilities further exploration by the participant. The researcher used questions to trigger participants to talk freely about their experience, decisions and actions during CRRT management and critical patient care. The following example questions were used to direct interviews:

1- Could you please tell me about your patient diagnosis and why was the patient needing the CRRT?
2- I noticed you doubled check the patient electrolyte results and how to do the electrolyte corrections with another nurse, tell me about it?
3- You discussed with the doctor how to modify the dosage of vasoactive therapies? Do you think it will help you to manage the CRRT?
4- Tell me about CRRT troubleshooting? what are the common difficulties you faced with the patients on CRRT?

Interviews were conducted either in a private office located inside the ICU, at the nurses' station or outside a patient's room and views were audiotaped for subsequent verbatim transcription. The interviews were scheduled and conducted after each observation so that nurses were more likely to recall the rationales for their actions when they managed the patient on CRRT. Very few interviews were conducted by the end of nurses' shifts or the next day because nurses were busy and helping each other. The researcher did not notice any differences related to the different times of the interviews. The researcher checked all interview transcripts for accuracy after a professional transcriber completed the transcripts. After each observation and interview, the researcher prepared an analytical memo and transcribed it into Microsoft Word and then recorded it in NVivo 10 (e.g analytical memos). Analytical memos were used to record the researcher's thoughts that arose from participant observations and interviews. The memos were treated as data and served as a record of an unfolding analysis.

As an ICU nurse and researcher it was hard to observe or listen to participants making inappropriate clinical decisions or did not know what to do. I tried to make my observation sessions stress-free for participants and did not need to often intervene in any important situations because the team leader or the doctor was around. I intervened few times such as 'Calling the nurse if there is an alarm, when she went to bring medications or helping others' and I did not explain what was right or wrong to do about the CRRT alarms before the participants explained their decisions and actions. I for example asked "What do you thing the problem is?" so the participants can explain and justify what and why they made their decisions and actions in order to prevent any changing on their answers, behaviours or actions, while I am observing or interviewing them around the patients. Then, I can tell them my thoughts and suggestions in friendly way if it is risky for the patient or not and discuss it during the observation or interview. This technique helps to let them feel relax and

comfortable around me in the ICU, however, those participants usually listened and followed the team leader decisions even if I tell them my concerns about the machine and the patient. For instance, there was an alarm because the filter clotted and I asked the nurse "is not risky if you continue CRRT, the clot my go to the patient", she said "its ok the clot will stay inside the filter and it's up to the team leader's decision I have to ask her if can discontinue the CRRT". In addition, all participants were expatriate and there are no local Saudi nurses working in this ICU.

There was no protocol in place that the researcher could enact if there was a need to 'raise a concern' and it was not included on the research aims, objectives, or ethics. It was not the study attention to include the researcher reflexivity in relation to intervene or interact during the participants' decision-making process and documented in the thesis. It was the first exploratory study to examine ICU nurses' clinical decision- making process with advanced technology in particular CRRT in the SA context. So, the researcher with her supervisory team did not consider the reflection part during the data collection or analysis. The study aimed to explore what is happening between intensive care nurses, clinical decision-making and CRRT practice. However, the researcher did interact in few occasions and the participants either listen or did what they believed it was right with the team leader. It is an interesting point (researcher reflexivity) and it might be useful to do it in future.

4.5 *Data management*

In qualitative research, data management requires a systematic, categorical and filing process that made for efficient the retrieval of data (Hennink et al., 2011; Liamputtong, 2013b). Data management and data analysis are integrally related (Hennink et al., 2011; Liamputtong, 2013b). In this research, data were created from the field notes and interview transcripts and these data were allocated to structured file folders. Field-notes and interviews

were formatted with the participant's name [pseudonym], researcher's name, and date. These details helped to organise and manage all generated data and to facilitate analysis. Field notes and interviews transcripts were entered in a qualitative software program NVivo 10 to facilitate data management. While the NVivo 10 program did not generate codes or categories (Edhlund & McDougall, 2013), the software helped to provide rapid access to conceptual and theoretical knowledge generated from the research data.

4.6 *Data analysis*

Excerpts of narratives from observational field notes and interviews were used to demonstrate the development of all concepts. In addition, the researcher used and treated literature as data. The conceptual analysis was undertaken to explain data in relation to why and how intensive care nurses made clinical decisions and took actions when they provided care for patients with AKI who were receiving CRRT. Thus, the analytical process sought to identify categories/concepts that explained intensive care nurses' reasons for making particular clinical decisions and rationales for selecting specific interventions in order to manage CRRT problems.

English was the second language for all the participants and therefore transcripts of interviews or informal questions in field notes during the observation events contained examples of their language use. The researcher made some alterations such as commas, question marks, full stops, or word/abbreviation in between brackets in order to make participants' quotes understandable. In addition, the researcher used ellipsis points […] that demonstrated omissions of non-essential parts of data to maintain the meaning carried by participants. To maintain the integrity of the data, the researcher used this technique to concisely and completely in the presentation of participant words.

Content analysis and conceptual analysis are often used by nurse researchers as two analysis approaches in qualitative research (Burla et al., 2008; Elo et al., 2014; Vaismoradi,

Turunen, & Bondas, 2013). Both content and conceptual analytical processes were applied in this research to provide a broader understanding of the phenomena. Content analysis was initially conducted and subsequent conceptual analysis was undertaken by returning to the raw data. Content analysis was useful because it allowed for an exploration of the elements of the O'Neill et al. CDM model. It has been argued that content analysis is a methodology that requires researchers to make a strong case for the trustworthiness of their data (Elo et al., 2014; Gale, Heath, Cameron, Rashid, & Redwood, 2013; Wahyuni, 2012). Thus, the reporting of the content analysis process is based on self-critical thinking at each phase of the analysis (Elo et al., 2014), The availability of rich, and appropriate data in this research increased the trustworthiness of content analysis results. Gale et al., (2013), argued that when the data are rich enough, the findings can go beyond description of particular phenomena to explain or identify areas that are not functioning well within an organisation. The content analysis approach helps in predicting how an organisation or other social actor able to prompt or respond to a situation. It also provides a more systematic way to the data in order to identify any emerged differences (Boeije, 2010; Wahyuni, 2012).Therefore, it is preferred to use content analysis if the objective is to reveal important processes, concepts, and the overarching professional experiences within organisations (Wahyuni, 2012).

In the deductive approach, categories are pre-determined from O'Neill et al's model. Polit and Beck argued that researchers use the available data and generate codes when the concepts fit into one of the available categories (Polit & Beck, 2012). Thus, in this research, deductive content method was applied when only the identified concepts fit into the available categories. To check the reliability, it is important to ensure that the concepts capture what was intended for the categories (Schreier, 2012). For instance, in the reporting phase, the researcher obtained the results that based on categorisation and those categories were able to describe the phenomenon (Mandal, 2018). However, the researcher might only follow pre-

determined codes and did not do open coding on the transcripts to ensure important aspects of the data are not missed. In addition, premature codes might be used to fit in previous theoretical concepts. Thus, inductive conceptual analysis was used to achieve in-depth understanding of the raw data and enhance the rigour and credibility of the study.

The latter approach was important in moving beyond the existing theoretical model to consider any other factors or concepts that might extend the theoretical understanding of nurse decision-making in the research context. Each process is addressed in greater detail below.

Deductive conceptual content analysis

The first phase of analysis was undertaking drawing on raw data and previous knowledge from the literature to test the concepts of the O'Neill et al. CDM model in the context of intensive care nursing practice with CRRT. Hsieh and Shannon (2005, p1278) assert that "qualitative content analysis goes beyond merely counting words to examining language intensely for the purpose of classifying large amounts of text into an efficient number of categories that represent similar meanings". The method of qualitative content analysis involves a systematic classification process of coding text data to produce key concepts. The method puts emphasis on the content and contextual meaning (Hsieh & Shannon, 2005; Krippendorff, 2013). Content analysis proceeds through coding, data abstraction/condensing, and creating concepts to link the meanings together in categories (Elo & Kyngäs, 2008; Graneheim & Lundman, 2004; Krippendorff, 2013). This process of analysis can achieve a condensed and extensive description of a phenomenon.

The process of content analysis involved three phases; preparation, organisation and reporting (Elo et al., 2014; Elo & Kyngäs, 2008; Vaismoradi et al., 2013). The preparation phase required the researcher to select the unit of analysis or unit of meaning (Elo & Kyngas,

2008). The chosen 'meaning units' for the analysis were drawn from the O'Neill et al. model as demonstrated in Table 4.5 and included using patient information, intensive care nurses' previous knowledge and working experience, recognition and responding skills, following ICU standard care, environmental interruptions, identifying clinical causes of problems, making decisions and taking action.

The second analysis phase was the organisation of data where the researcher coded, created categories/outcomes and grouped data (Elo & Kyngäs, 2008; Vaismoradi et al., 2013). The process of generating deductive codes from the O'Neill et al. concepts was organised systematically as outlined in Tables 4.4 and 4.5. The coding were derived from O'Neill et al. model (presented in Chapter three, section 3.3.4). The process of content analysis was established through developing and gathering similar codes or meanings which were combined and labeled based on O'Neill et al. concepts (see Table 4.4). Developing analysable units through a process of coding, categorising and then re-contextualising promoted the researcher's insights and interpretations (Ayres, Kavanaugh, & Knafl, 2003; Elo & Kyngäs, 2008; Vaismoradi et al., 2013). The researcher undertook the coding process by reading each interview transcript and observation field notes several times to understand and link the codes with the data. In addition, the researcher constantly checked the data (e.g. field notes and interview transcriptions), codes and categories with her supervisors to maintain and increase the rigor and credibility of the content findings. For example, data around the concept of pre-encounter data were recorded in field notes and how nurses used that information while practicing was captured during observations and subsequent interviews. Where a participant explained a patient's condition (e.g. ICU diagnosis, CRRT indications or signs of clinical complications), this information was coded as pre-encounter data and may have also been coded as anticipating and controlling risks. If the text described the patient's ICU diagnosis, needs for CRRT, nurses' use of clinical knowledge and

experience, it was coded as nurses' pre-encounter data (patient data to date, working knowledge, and clinical patterns). Nevertheless, where the text described linking patient information, prevention techniques and using clinical pattern or previous experience, this was coded as anticipating and controlling risk.

In terms of standard nursing care (SNC) field notes were examined for instances when intensive care nurses adhered to CRRT protocols that helped with recognition of any indicators that could affect the CRRT (e.g. filter lifespan or circuit clotting, and fluid-balance error), or patients with AKI and normal physiological parameters (e.g. blood pressure, vasoactive therapy adjustment, etc). Situational features related to knowing the patient and managing any environmental interruptions in order to make clinical decisions and solve the patient's clinical deteriorations or CRRT problems. Field notes were recorded on the extent participants interacted with ICU staff or any social support with CDM they received from the intensive care nurse manager or medical staff, in order to recognise and solve CRRT issues.

Finally, hypothesis generation, hypothesis-driven assessment, hypothesis selection, and nursing actions were explored in the observational and interview data. For example, observing intensive care nurses revealed how a hypothesis was generated when a clinical change occurred and what further assessment or actions were performed. Table 4.4 lists the O'Neill et al. concepts and the content analytical codes generated.

Table 4. 4 Deductive content analytical codes

O'Neill et al. concepts	Content analytical codes
Pre-encounter Data	• ICU and CRRT knowledge and working experience Patient information
Anticipating and Controlling Risk	• Early recognition and responding • Late recognition and responding • Did not recognise • Pattern recognition • Prevention techniques • Linking to pre-encounter information
Standard Nursing Care	• Following ICU and CRRT protocols • Practice habits: checking with team leaders or doctors • Linking to pre-counter information
Situational and Client Modifications	• Knowing the patient • Environment interruptions: Patient related or ICU environment • Interaction support
Triggers to Hypothesis Generation	• Clinical indicators or causes • Salient concerns: Problem recognition
Hypothesis Assessment	• Gathering more information
Hypothesis Selection	• Appropriate or inappropriate decision's selection
Nursing Actions	• Successful or unsuccessful actions

The significance of Table 4.5 below is that it provides a description of the frequencies of the manifested elements of O'Neill et al. model in the research.

Table 4. 5 Deductive content analytical concepts

(O'Neill et al. concepts)	Meaning units	*Number of statements N=29	Categories/Outcomes
Pre-encounter Data: patient data to date, working knowledge and clinical patterns	"I have a good experience with CRRT" "Troubleshooting is sometimes the most difficult experience" " From my experience" "No heparin infusion. So, we flush" "Once you start the CRRT you adjust the dose of the antibiotics" "I did not encounter any clots and access problems" "We observe the patient's vital signs and everything" "To know the patient conditions: why you need to start the CRRT" "To know the patient history, diagnoses and medical examinations." "First we should know the patient then we only can manage this CRRT."	28	• ICU and CRRT knowledge and working experience • Patient information

Anticipating and Controlling Risk	"we flush every hour" "so we have to flush the lines" "It was not completely clotted" "It [CRRT] `is smoothly going" "When I noticed it was already too much air bubbles" "There always that thing during dialysis: hypoglycaemia or electrolyte imbalance such as potassium dropped." "It is according to the patient's conditions" "the flushing we do to prevent any clotting" "we usually flush every hourly or second hourly according to the patient clotting factors" "I did flushing to keep the chamber/lumen clear without clots." "We will not do the nursing care now because the patient is not stable**."**	29	• Early recognise and respond • late or unable to recognise and respond • Pattern recognition • Preventive techniques • Linking to pre-encounter information
Standard Nursing Care	"we monitor the potassium six hourly" "I asked the team leader to help" "any changes in the patient's conditions, we inform the doctors"	28	• Following ICU and CRRT protocols • Practice habits: checking with team leaders or

	"We have to follow the doctor's order" "usually during dialysis we expect hypoglycaemia"		doctors Linking to pre-counter information
Situational and Client Modifications	"We cannot continue CRRT with low blood pressure" "The CRRT was going nicely but the patient's condition was not good" "Because the patient is in septic shock" " The patient is not stable" "I will go to help my colleague" "Team leader was asking" "The doctor wants to monitor it [lactic acid serum]every 6 hour" "I am not sure I will ask the doctor at the round time." "I changed the fluid replacement bags" "I don't have much experience with repriming CRRT." "I asked just to verify"	24	• Knowing the patient • Environment interruptions: Patient related or ICU environment • Interaction support
Triggers to Hypothesis Generation	"May be because of the vascular access and return blood pressure is low." "Because of vascular access and the patient's positioning."	22	• Identify clinical indicators or causes

	"I just pressed the fluid balance system it was off." "To reduce and prevent system clotting." "Low access pressure due to the problem with the catheter not the patient."		
Hypothesis Assessment	"Maybe there is still sign of clotting. I already did the flushing. Also maybe because the vascular catheter positioning."	5	• Gathering more information
Hypothesis Selection	"We correct hypoglycaemia" "We change the patient positioning" "My first priority to refill inotropes" "I increase nor-epinephrine from 8 to 12 meq/min." "It was showing the low access pressure so we tried to increase the blood flow"	26	• Appropriate decision's selection • Inappropriate decision's selection
Nursing Actions	"He is improving so we can start [fluid removal]" "Recycle /re-circuit again." "I will flush [the circuit] and return the blood."	24	• Successful actions • Unsuccessful actions

The researcher placed all coded text and participant quotes and filed notes in a structured matrix table of analysis to make them comprehensible and to draw initial conclusions. Thus, the researcher generated both analytical codes from the data that fitted the matrix of analysis from O'Neill et al. concepts and other codes that did not fit the model. According to Elo and Kyngas (2008), researchers can choose the features from data that fit the elements/concepts of the model or those features that do not fit. This research looked for both the features from the data that did fit the concepts of O'Neill et al. model and those features that did not fit. Hsieh and Shannon (2005, p. 1283) stated that "newly identified categories either offer a contradictory view of the phenomenon or might refine, extend, and enrich (a) theory". The researcher therefore re-reviewed and re-examined the data that did not fit into coding/categories in order to consider whether these data could add to the findings, extend the model or address the aims of the research. After reducing and presenting data in one matrix, the researcher started the interpretation process.

The third phase was abstraction and synthesis. This phase demonstrated the analysis process, interpretation and the representation of findings in the form of tables or categories/outcomes (Elo et al., 2014; Elo & Kyngäs, 2008; Vaismoradi et al., 2013). The reporting phase demonstrates the findings in a clear way. In this research, data were abstracted and meaning generated by contextualising the texts/ instances or interrogating the coded data.

Conceptual analysis

A conceptual analysis was used to explore more broadly the research phenomenon without the constraints of an existing theoretical model. The use of the second analytical approach freed the analysis from being controlled by structured methodologies or approaches (Thomas, 2006). Inductive conceptual analysis is a systematic approach to the generation of

categories (Barnard & Sandelowski, 2001). Integral to the analysis was an ongoing process of critical thinking and the creation of links between categories and concepts. The researcher also engaged with literature during the analytical period to achieve in-depth contextual understanding.

In terms of process, data were analysed by allocating initial codes which reflected the words or phrases participants used. Miles, Huberman and Saldaña (2014) describe inductive analysis as a process of three components; data reduction, data display and finally conclusion drawing/verification. Data reduction was the process whereby the researcher selected, focused, and abstracted data from both the observation field notes and interview transcriptions. Codes were then developed and labeled in order to initiate and test categories as reflected in Table 4.6.

Miles, Huberman and Saldaña (1994, 2014) define codes as tags or labels that are attached to chunks of words, phrases, sentences or paragraphs (Miles & Huberman, 1994; Miles et al., 2014). Coding labels were used to organise data and then facilitated the identification of categories. Codes were grouped depending on their similarities or differences. Similar codes or meanings were combined in order to develop categories.

It is important to note that decisions were made quite early in the analysis process on what appeared as the most analytically significant codes and subsequently categories. This method reflects the concept of focused coding as articulated by Glaser (1978) and Charmaz (2014) where the most useful initial codes direct ongoing analysis. Hence, the process demanded that the researcher focus on, organise and discard data in order to draw and verify conclusions (see Appendix E) (Charmaz, 2014; Glaser, 1978).

As depicted in Table 4.6 below, data display of inductive analysis examples is where the researcher organises or compresses the amount of information in order to facilitate the drawing of conclusions. As analysis continued, codes were rearranged within each category

through a continuous process of moving from descriptive to conceptual analytical meaning (see Appendix E). In order to understand how intensive care nurses made clinical decisions around AKI patients and CRRT categories and concepts were reviewed and verified for strength of evidence. Table 4. 6 provides an illustration of how each category was identified and developed. Final categories were conceptually developed to interpret and describe the phenomena of interest.

Table 4. 6 An example of inductive coding procedure

Extract from data	Codes	Categories	Concept
Interview *In relation to the CRRT when we start the dialysis this patient blood pressure usually drops very low. This was challenging for me to maintain the blood pressure and we gave a lot of fluid and high levels of inotropes…the patient's condition was not good… We could not continue CRRT because of the patient's low blood pressure. We could not, that is why first I consulted the doctor, and then I discontinued CRRT, because without an order from the doctor, I cannot do anything. My observation was the patient's blood pressure was low and, so I informed the doctor and following him, I discontinued the CRRT*	-Delayed DM and action - Doctors or team leaders support and authority -Nursing positions -Nurses role and responsibility	-A hierarchy in healthcare	- Negotiating CRRT practices
Observation At 3:00 pm Participant 5 started to flush the circulation with normal saline while it was connected to the patient and with the help of another nurse. She then discontinued the CRRT while she was doing the evening care. I asked her "why did you do that?" She said "to prevent an incidence of clotting while turning the patient when we do evening care." 3:30pm after she finished her evening care she reconnected the CRRT and continued the treatment."	-Using different techniques -Routine practice, disconnecting the patient - Acceptable standard of performance or care - Repetition and fail to notice errors -Patient safety	-Socialisation	- Normalising CRRT practices

Finally, conclusion drawing and verification was undertaken. Verification can be as brief as a second thought or consideration crossing the researcher's mind during the process of writing. In this research, data reduction (e.g. coding) lead to data display and subsequently categories and concepts (see Appendix E). In addition, as categories were developed, the

researcher engaged in an ongoing conversation with her supervisors to maintain the rigour and credibility of the findings.

It has been argued that if new insights into the studied phenomenon have been provided, the study might increase the understanding of particular phenomena or informed practical actions (Krippendorff, 2004, 2009; Vaismoradi et al., 2013). Using O'Neill et al's theoretical model can enhance the trustworthiness during the process of data. The researcher considered different and broader concepts that might extend the theoretical understanding of nurses' decision-making, and also assisted in reporting deductive content analysis in comprehensive and understandable manner.

4.7 *Ethical Considerations*

The following ethical considerations were required for the research. Permission was sought from both QUT and KAUH human ethics committees prior to commencing the research (see Appendix C). The participants in this research were intensive care nurses. A participant information sheet explaining the aims of the research, an overview of rights, details of the procedures involved and measures to be taken to ensure anonymity and confidentiality of data were distributed to interested intensive care nurses (see Appendix C). Verbal information and any questions/concerns were addressed prior to consent being obtained. Assurance was given to participants that their participation in the research would in no way influence their employment status. Participants were also advised of the voluntary nature of the research and withdraw from the research at any step without any penalty (see Appendix C). Voluntary, informed, written consent was obtained from each participant prior to commencing the research. Anonymity was maintained through the use of pseudonyms.

Patients and other healthcare professionals were not contributing directly to this research; they were considered as informal 'onlookers'. The purpose of the researcher's

presence was explained to other healthcare professionals and permission was sought to observe the nurses. Patient and/or family member consent forms were submitted to both QUT and KAUH ethics committees (see Appendix C). The KAUH (local Saudi Arabian) ethical committee did not require patient consent for this research because the research purpose was to observe and interview intensive care nurses' practice with CRRT, that information was not being directly sourced from the patient's hospital records, and that patients were unconscious and ventilated. For this reason, patient (and/or family) written consent was not obtained although verbal permission was sought. Anonymity of patients was maintained by referring to patients as patient 1, patient 2, etc. in the field notes. If a participant identified a patient by name during an interview, the patient's name was deleted from the verbatim transcript and substituted with Patient 1, etc. A similar procedure was undertaken when a participant was interacting with other nursing and health staff. Hospital staff were identified in field notes as RNs (Registered Nurse), doctors, and pharmacists. Similarly, if a participant identified another staff member by name during an interview, the name of the staff member was deleted from the transcript and substituted with a position title (e.g. RN, intern, etc).

If the nurse (participant), other health professional or the researcher believed that the patient's well-being or nursing care was being compromised in any way during the observation period, data collection ceased immediately. In addition, if the researcher encountered unsafe practices during the observation period, the data collection would immediately cease and the ICU nursing manager would be informed. Neither of these situations arose during the research.

4.8 *Trustworthiness*

To evaluate qualitative studies, several authors (Denzin & Lincoln, 2011; Hennink et al., 2011; Liamputtong, 2013a; Morse, 2015; Thorne et al., 2004) recommend using the

criteria of trustworthiness, credibility, transferability, dependability and confirmability. Credibility is the most important criterion for the assessment of qualitative research because it relates to the question: "How believable are the findings? or Can these findings be regarded as truthful?" (Liamputtong, 2013b, p. 18). Credibility therefore demonstrates the question of 'fit' between the participants' perceptions and the researcher's representation of these views (Liamputtong, 2013b; Morse, 2015). Several techniques were used that arguably enhanced credibility. The first was recruitment of participants with various perspectives and a mixture of genders, ages, and experience. The second technique was to conduct lengthy observations of intensive care nurse practice with CRRT and to undertake interviews following observation episodes to clarify any aspects of practice. A third strategy was the use and generation of concepts and subcategories from the O'Neill et al. CDMM to conduct deductive content analysis. A final credibility technique was the selection of the most suitable meaning, codes and categories by using quotations from transcribed texts and/or seeking agreement from the researcher's supervisors regarding the way data were labeled and sorted.

Secondly, transferability focuses on the question: "Do the findings apply to other contexts?" (Liamputtong, 2013b, p. 18). Transferability is where qualitative findings inform insights within another context or population than the original research (Liamputtong, 2013b; Morse, 2015). Providing a clear and distinct description of context, practice, selection of relevant information, characteristics of participants, data collection, and process of analysis enhances the research transferability such as collecting rich descriptive data through observations of nurses' practice and from subsequent interviews.

Dependability refers to whether the findings fit the collected data or the findings can apply at other times (Liamputtong, 2013b; Morse, 2015). Dependability aims to address the consistency of the findings when the process of research is reasonable, derivable and clearly documented (Liamputtong, 2013b). Some proposed procedures that enhance credibility, can

also provide dependability such as an audit trail of data collection and analysis processes conducted during the research (e.g. discussions with the researcher's supervisors documented and recorded as part of the audit trail) or detailed explanation of methods.

Lastly, confirmability attempts to demonstrate that the findings and their interpretations are strongly connected to the data and are not simply drawn from the imagination of the researcher (Liamputtong, 2013b; Morse, 2015).When both credibility and transformability are established, confirmability can be achieved. In this research, reflective writing (analytical memos/diarising) was undertaken after each observation and interview where the researcher recorded personal feelings, thoughts, biases, insights and/or preconceptions during both data collection and analysis. Trustworthiness increases when the findings are obtainable in a way that allows other researchers to inquire about alternative interpretations (Graneheim & Lundman, 2004).

4.9 *Chapter Summary*

Chapter Four addressed in detail the research assumptions, design and methods that were employed in this research. It was understood that the clinical decision-making process was complex and contextual and as such, the theoretical framework of O'Neill et al. CDMM (2005) was applied to help explore how intensive care nurses make their decisions during the management of advanced technology. Sampling and data generation were described in detail. The analytical processes were then addressed in terms of the deductive content and conceptual analysis. Ethical considerations and research rigour were given consideration in the final sections of this chapter. The following chapter depicts and explores the findings from the deductive content analysis and the subsequent chapter provides the conceptual analytical findings.

Chapter Five: Analysis Findings

5 Introduction

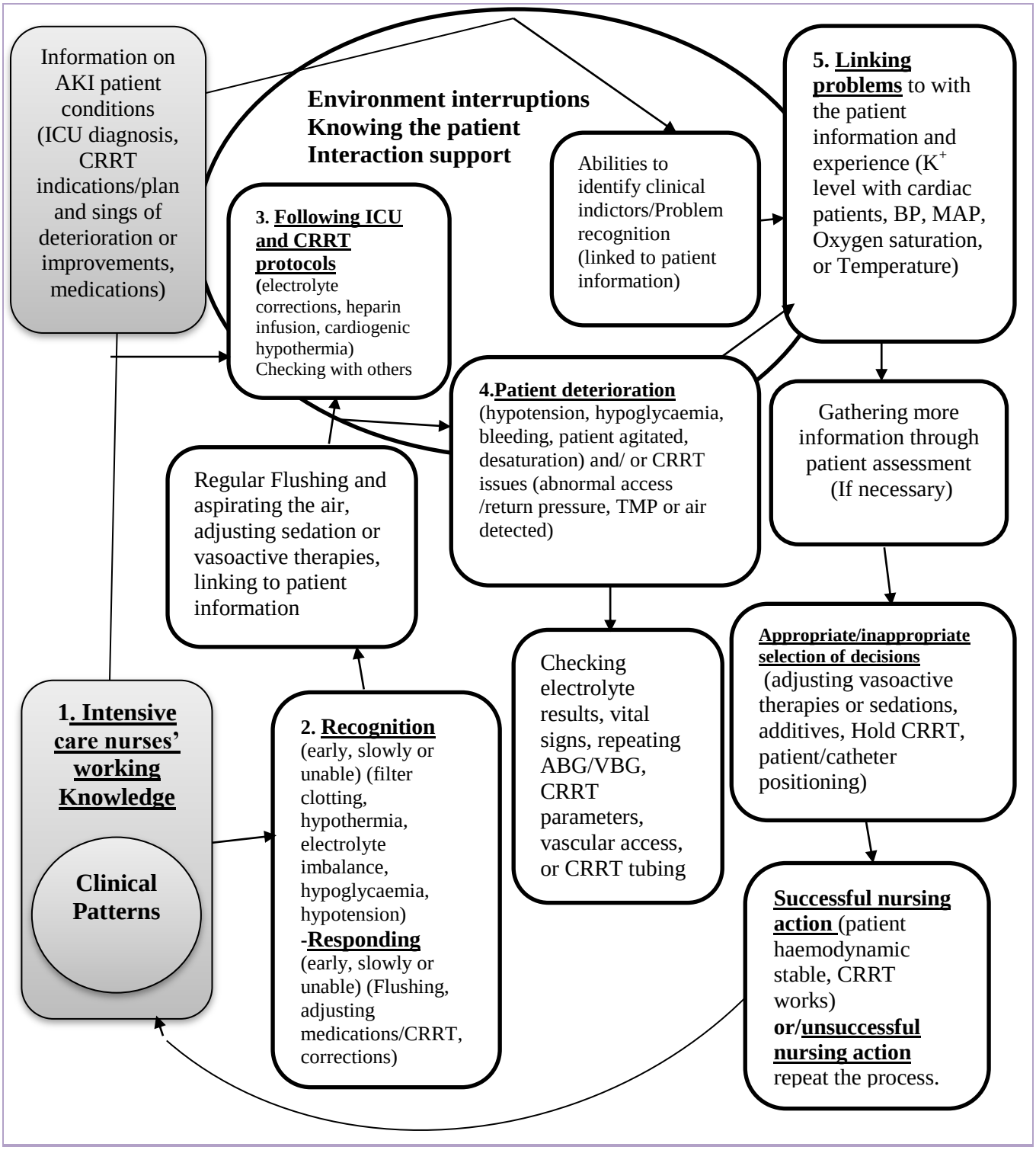
The purpose of this chapter is to explain how intensive care nurses use patient information, demonstrate their working knowledge of AKI care and CRRT technology, and act in real practice in relation to clinical decision-making. All processes were examined through the lens of the components of the CDMM. As noted in Chapter Three, the components of O'Neill et al. CDMM (2005) are pre-encounter data, assessment of risk and risk reduction, the situational features that affect decision-making, salient concerns, hypothesis generation, hypothesis-driven assessment, hypothesis selection and nursing action. Deductive content analysis was applied to critically explore the components of the conceptual framework of the CDMM. As Hseih and Shannon (2005) point out, a directed deductive approach supports current research or an existing theoretical framework in order to verify the theory or framework within a new context. This chapter presents the conceptual analytical findings.

Important categories were generated through the lens of O'Neill et al. CDMM concepts (see earlier in Chapter Four Tables 4.4 and 4.5) and were based upon predetermined definitions of each concept/category. First, the concept of *pre-encounter data* incorporated the subcategories of “previous experience and knowledge" and "nurses' perceptions of technology". Of the second concept, anticipating *and controlling risk,* the categories generated were “recognition and responding”, “preventive techniques”, and “linking to pre-encounter information”. The categories reflected the ways in which intensive care nurses anticipated and controlled risks and differences in individual intensive care nurses' decision-making skills.

A third concept drawn from the O'Neill et al. CDMM is *standard nursing care*, the dimensions of which became "safe nursing practice", " ICU and CRRT protocols", "decision-making skills" and "relying on others". The fourth concept, *Situational and client modifications,* is depicted in relation to the categories of "knowing the patient" "interaction support" and "environmental interruptions".

The final concepts are triggers to hypothesis generation, selection and nursing action which were explained through "identifying clinical indicators or causes", "the appropriateness of decision-making" or "decision-making outcomes", and "the effective of nursing actions" or "successfulness of nursing actions". The analysis applied the CDMM concepts to generate codes from both observation field notes and interview data (see Chapter Four Tables 4.4 and 4.5).

The following Figure 5.1 depicts the concepts of the O'Neill et al. CDMM and illustrates the decision-making process of the intensive care nurse participants in the provision of care for patients with AKI who were receiving CRRT. The figure depicts how working knowledge, clinical experience and patterns, and using standard care shaped the ways in which nurses used and linked important patient information in order to recognise and respond to patient deterioration and CRRT problems. Numbering was used to demonstrate the sequences of the CDM process and to link categories to the key concepts of the O'Neill et al. CDM model. The process is one way direction according to O'Neill et al., however, the decision-making process is not a linear nor structured in complex practices.



***1-Pre-encounter Data: patient data to date, working knowledge and clinical patterns,2. Anticipating and controlling risks, 3. Standard nursing care, 4. Situational and Client Modifications,5. Triggers to Hypothesis Generation, Selection and Nursing Action**

Figure 5. 1 Intensive care nurses as decision-makers: The O'Neill et al. CDMM (2005).

There were variations in how intensive care nurses collected and used a variety of patient information sources, in cue recognition and clinical patterns, and in their previous experience with critically ill patients with AKI and CRRT practice. More specifically, three

levels of decision-making were generated from the research analysis. The three levels were *independent decision-making, gaining independence as a decision-maker, and dependent decision-making*. Independent decision-makers efficiently and independently used appropriate and relevant patient information, previous clinical patterns and their working experience to recognise and identify problems, and to make quick and safe clinical decisions. While those gaining independence as decision-makers had acceptable working knowledge and experience of clinical pattern, they, at times, required assistance and more time to recognise problems and to act. Dependent decision-makers had difficulties in using and linking relevant patient information and consistently required or relied on assistance to make decisions and take action. The different decision-making levels were developed from the key concepts of O'Neill et al. CDM model.

While the analysis concluded that the intensive care nurse decision-making process was congruent with the CDMM there were some variations from the model in terms of how intensive care nurses made clinical decisions about the provision of care for patients with AKI who were receiving CRRT. There was, for example, some ambiguity around the clinical decision-making process. A possible reason for the ambiguity is that O'Neill et al. model primarily explicates the cognitive process but does not explore or consider contextual factors such as workforce characteristics, management practices, socialisation and organisational cultures in relation to the nurse's clinical decision-making process. These factors may have an influence on how and why nurses make or select a particular decision or intervention. In other words, understanding the process of intensive care nurse clinical decision-making goes beyond understanding or examining the cognitive processes used in practice. Nurses use skills that are shaped by both cognitive and social influences to achieve safe and effective practice (Lewis et al., 2012; Mitchell & Flin, 2008). These skills include interpersonal or social skills such as teamwork, leadership, communication and cognitive skills such as

situation awareness, decision-making and task management (Lewis et al., 2012; Reader et al., 2006).

5.1 *Pre-encounter Data: patient data to date, working knowledge and clinical patterns*

As noted above, the three levels of decision-making demonstrated how patient information was gathered, used and interpreted in complex practice. The nurse participants used their theoretical and experiential knowledge differently and developed particular clinical routines from previous and similar experiences. The O'Neill et al. model posits that intensive care nurses use patient information, clinical patterns and their working knowledge in relation to making clinical decisions and taking actions (O'Neill et al., 2005). Thus, in this research, different techniques or strategies manifested in relation to the use pre-encounter data.

The category of *nurses using previous clinical knowledge and experience* is relevant to this research. The concept refers to the ways in which cognitive processing occurs and may contribute to an explanation of the nurse's clinical decision-making process. The concept defines how nurses gather, interpret and link relevant patient information in relation to clinical decision-making. Also of importance is the way in which social factors influence decision-making processes in complex practice.

There were various cognitive interpretations of how nurses process information in relation to making decisions. Independent decision-makers, for instance, demonstrated how nurses independently gathered, interpreted and used relevant patient information and linked this information with their previous working knowledge to make decisions and solve problems. The following field note describes the experience of an independent decision-maker who understood the common changes of patient conditions on CRRT by gathering and linking appropriate information that required an urgent decision for electrolyte replacement to solve a problem and to prevent further complications:

> At 10:00 pm Participant 22 went to bring intravenous fluid and potassium correction.
> I asked her "Why are you giving a potassium correction?"
> Participant 22 said: " The patient's potassium level is 3.2 mmol and the patient is already with CVVH. So, I have to correct it now." (Participant 22, Field note, 16 December, 2013)

Nurses who were developing independence as decision-makers and dependent decision makers, faced difficulties with numerous patient information, such as being unable to gather or detect patient clinical information, misinterpreting cues due to insufficient knowledge or experience, or being unable to anticipate potential risks or make decisions within the available time. Those nurses required assistance and time to gather and link relevant information to make decisions. A further field note depicts a participant who appeared unable to independently gather information and who misinterpreted cues due to insufficient knowledge, training or experience around CRRT technology:

> I asked Participant 26: "Is the patient hypothermic?"
> Participant 26 said: "Yes, I put the blanket warmer on at 37C".
> I asked her: "What about the CRRT Temperature?"
> She said: "There is no CRRT temperature."
> I said: "That means that you did not change any CRRT temperature parameters."
> Participant 9B: said "No, I only covered him with a body warmer blanket."(Participant 26, Field note, 24 December, 2013)

Nurses as decision makers struggled to use the patient technological information to provide optimum care; this could be due to unrecognised obscure factors related to social, workplace and/or organisational conditions. As a result, these nurses appeared to depend on other senior nurses or team leaders to support their decisions with technologies.

Previous work experience and knowledge was important to the nurse participants. Clinical nursing experience refers to participants' previous clinical knowledge and experience with AKI care and CRRT technology, such as indications of CRRT, patient vital signs (e.g. mean blood pressure or central venous pressure [CVP] level), and early recognition of CRRT problems (e.g. filter clotting, air bubbles in the chamber, or requiring fluid removal, or electrolyte imbalance). Furthermore, observing patient signs of improvements (e.g. urine output, stable vital signs without vasoactive therapy, or normal biochemistry results), and changes in lactic acid and arterial blood gas (ABG) results are crucial in nursing practice and decision-making.

Benner and her colleagues (1984, 1992, 2001, 2009) theorised that experience involves cognitive skills in order to challenge present knowledge and improve ideas. Indeed, independent participant decision-makers were able to independently retrieve previous clinical knowledge and link this knowledge with the current situation as a pattern. The interpretation of cues comes from nurses' knowledge of specific details related to patient complexity and patterns of response in addition to their previous clinical experience (Tower et al., 2012; Wøien & Bjørk, 2013). Information, including the indications for CRRT, was important to the participants in understanding patient conditions with AKI and possible clinical deterioration. The following participant explained in detail a patient's condition, indications of CRRT and consequently signs of improvement using previous clinical experience and knowledge to gather and link patient information.

> *He is a 56 year old male. He was admitted to ER with chest pain, shortness of breath, hypertension, flu and cough…. he might have H1N1 which Doctors suspect according chest sounds… the patient was electively intubated in the emergency room and then transferred to coronary care unit [CCU] and Echo done 60% the ejection fraction with some diastolic dysfunction…The patient developed cardiogenic shock. High lactic acid, anuric with metabolic and respiratory acidosis and hypothermia. So, high inotropes have started with*

> *dobutamine to support the heart function. CRRT has started with heparin according to the protocol and we started fluid removal 50ml/hr. Today the patient's blood pressure is improving, inotropes reduced and dobutamine discontinued and low settings of mechanical ventilation. (Participant 21, interview)*

Clinical knowledge and previous experience were thus critical in managing CRRT. As a participant noted:

> *Sometimes you will lose all those things about managing the CRRT but then when you are doing the priming, everything will come to your mind. Yes because sometimes you will forget. But we have done the priming previously so we can remember from our previous experience. (Participant 9A, interview)*

Variations in clinical knowledge and experience of the nurse participants were evident in the research where, for example, nurses who were less independent, less experienced and dependent on others took longer to evaluate and assess a patient's condition and/or communicate with doctors or experienced nurses, which in turn delayed patient treatment. The following observation, recorded as a field note, refers to a participant who delayed decision-making:

> The team leader asked Participant 9B "is your patient hypothermic 33.5C?"
> She said: "Yes, he is 35".
> The team leader said: 'Why don't you put a blanket on?"
> Participant 9B said: "I will put it on".
> She covered the patient with a blanket at the end of her shift. (Participant 9B, Field note, 8 August, 2013)

Nurses with little experience and confidence in caring for CRRT patients might act similarly to inexperienced or new nurses. The above example indicated that a less experienced nurse may often rely on more experienced nurses to avoid situations where they

need to make decisions (Gillespie & Peterson, 2009). Yet, the decision itself was not the key to action. When time pressure increases due to the complexities of a patient's condition, the confidence of a nurse to act may decrease (Yang & Thompson, 2010). Moreover, nurses today often function with little management support and few mentors (Gillespie & Peterson, 2009) and hence more of the work environment influences practice settings. It is also difficult to predict when nurses will have developed sufficient experiential knowledge to guarantee safe and appropriate decision-making skills.

Nurse participant perceptions of and experience with technology also varied because it depended upon their level of knowing and skills in intensive care. Interpretation of the meaning of CRRT alarms or other CRRT function parameters appeared to be confined to observed complications such as a clotted filter rather than understanding how possible complications might occur and how and why they could be prevented or pre-empted. One participant, for example, thought that when the transmembrane pressure was already high she needed to add anticoagulation infusion (e.g. heparin) and a clot would be dissolved. The participant did not mention that she could closely observe the parameters of the access pressure and/or transmembrane pressure before it increased. The patient had upper gastrointestinal bleeding and it might not have been safe to use heparin infusion. On the other hand, the patient had previously suffered a cerebrovascular accident (CVA) and myocardial infarction (MI) and he might have received subcutaneous heparin as a prevention management.

> *If the filtrate pressure increases and the Transmembrane pressure [TMP] increases accordingly, we can manage, because if TMP is high then there are some clots. So we can add some heparin or anything. Because actually that patient last night already a clotted system and so we added heparin then. So that time we used heparin. (Participant 10, interview)*

An over-reliance on technology is problematic. In a research exploring how staff members in an intensive care unit made sense of technology in their everyday practice, Wikstrom et al. (2007) argued that technology cannot be completely trusted because it can complicate everyday practice. In addition, meaning attributed to technology depends on how different nurses perceive the same phenomenon in different ways because of levels of knowing in practice such as what is relevant to a particular practice and, how to act, understand and make sense in a responsible and skilled way (Wikström, Cederborg, & Johanson, 2007). Technology, in other words, is not neutral. In this research, nurse participants had differing levels of knowing about CRRT practice and at times limited experience and understanding. There were already signs of a clogged filter and constant alarms and the participant thought that there was still a chance of maintaining the circuit by further flushing and reducing the blood flow rate. Yet, these actions might have harmed the patient if the clots had passed into the patient's blood circulation. The justification from the participant was as follows:

> *The filter was not completely clotted….. It was only a small one [clot]…we [me and the team leader] just checked whether the lumen was totally clotted. If it is totally clotted it means it will not develop air and, it means we cannot return the blood. So there was not that much clotting… But we just tried to reduce the blood flow to check whether was going or obstructing the lumen. Anyway it was not that much obstructed so it is running now. (Participant 4, interview)*

From the above, it appeared that the nurses were in need of ongoing education and training to support their knowledge and skills around CRRT technology. Nonetheless, the trajectory to experience and skill attainment cannot be guaranteed and not every nurse wants to become an expert (Altmann, 2007).

Continuous renal replacement therapy is a highly challenging intensive care nursing intervention which requires comprehensive knowledge, experience, skill and ongoing training

(Langford et al., 2008). Having adequate work experience and comprehensive understanding of AKI care and CRRT function and parameters will help intensive care nurses as decision-makers to understand, predict, and recognise patient deterioration and CRRT problems. This involves knowing the patient by linking relevant patient information with the signs of patient complications or CRRT problems. Hence, intensive care nurses' situational awareness and prior knowledge and experience are interrelated concepts that shape how nurses gather and link patient information to make decisions in real CRRT practice. The challenge here, therefore, was to examine the cognitive processes and environmental influences that informed how intensive care nurses used pre-encounter information to make clinical decisions.

5.2 Anticipating and Controlling Risk

The nurse participants used and applied pre-encounter information variously, and with differing levels of skill to anticipate and reduce or prevent possible complications in critically ill AKI patients with CRRT appeared. The differing levels of anticipation and risk minimisation skills mirrored the extent to which participants were independent decision-makers, gaining independence as decision-makers, or dependent decision-makers. The three levels of decision-making were reflected in how and why the nurse participants used different prevention techniques such as regularly flushing the circuit, aspirating the air from the chamber, or adjusting sedation or vasoactive therapy in order to anticipate and reduce risk in CRRT practice. The prevention strategies were useful in some cases, such as increasing the life span of the filter or circuit, or maintaining the patient's blood pressure.

As noted above, recognition of clinical situations occurs when nurses draw on similar experiences from previous patient care to make act upon decisions. For the nurse participants, recognition and response skills varied where nurses acted early, or late, or were unable to recognise and respond. For example, characteristic of independent decision-makers was early

recognition and response that led to better patient outcomes around CRRT. This process was reflected in the following participant's words:

> *Okay, the flushing we do is to prevent any clotting to keep the line patent and we usually do it every hour or second hour. It depends on the patient's clotting factors and we use normal saline to flush and keep 50 ml per hour removal because we use for the flushing. (Participant 7, interview)*

Patient deterioration studies have demonstrated that nurses remember cues from similar patients and use a variety of cues (i.e. physiological and technological) to make clinical decisions (Cioffi, 2000; Cioffi, Conwayt, Everist, Scott, & Senior, 2009; Ramezani-Badr et al., 2009). One study found that recognising similar clinical situations is used by intensive care nurses as a reasoning strategy in order to determine patient problems and to decide how to appropriately care for patients (Ramezani-Badr et al., 2009).

There are technical/manual and non-technical skills (i.e. interpersonal communication, clinical leadership, team working and clinical decision-making) that nurses require in order to manage CRRT. Intensive care nurses are required to manage CRRT through ongoing monitoring of the patient (e.g. haemodynamic status) and tolerance of therapy and securing the CRRT system to prevent unintentional disconnections (Baldwin & Fealy, 2008; Baldwin & Fealy, 2009a, 2009b; Kaplow & Barry, 2002). In addition, it is expected that intensive care nurses will predict and control possible CRRT complications by maintaining the system's patency, including intermittent flushing with normal saline; kinks in the tubing; replacing fluids; monitoring for bleeding, troubleshooting the system and alarms (Baldwin & Fealy, 2008; Baldwin & Fealy, 2009a, 2009b; Kaplow & Barry, 2002). In practice, the participants demonstrated differing skills in the management of CRRT and thus varied levels of decision-making.

The participants who were developing independence as decision-makers and the dependent decision-makers faced difficulties about when and how to recognise or predict patient clinical deterioration and technological problems with CRRT and to respond by applying appropriate prevention strategies. The available time and experience and continuity of nursing care were crucial to early recognition and response and yet those components did not help all nurses. The nurse participants at times relied on previous experience and recalling stored information in recognising potential problems and applying interventions rather than relying on other professionals. This was reflected in a field note that demonstrated dependent decision-making level:

> 4:30pm Participant 4 and her helper finished nursing care.
> At 4:35pm the CRRT alarm is on. Participant 4 turned it off and did the flushing and explained: "I do flushing hourly to reduce clotting". The CRRT alarm continues, TMP and access pressure are low and return pressure is high. She called the team leader to help (Participant 4, Field note, 10 September, 2013)

On the other hand, independent participants were able to recognise and reduce risks in immediately responding to a patient's abnormal electrolytes, vital signs, blood glucose level, or body temperature with CRRT functions. Those nurses managed the CRRT patient well and demonstrated the importance of using available time and continuity of care to predict and recognise possible risks and to make preventive and quick decisions. As one participant explained:

> *Yes for CRRT patients and all ICU patients we are keeping the mean arterial pressure [MAP] at 65mmHg and our target to keep MAP at 65mmHg. If MAP is more than 65mmHg we are escalating the rate of reducing inotropes. So when I came the patient blood pressure was low so I increased levophad and after half an hour he had improved so we discontinued vasopressin and escalating levophad rate is 6 mcg/min. Actually we are keeping central venous pressure*

> *[CVP] in the ICU between 10-14 mmHg and for this patient CVP is 10-12 mmHg. It is OK they [Doctors] do not want to give more fluid…for this patient. (Participant 22, interview)*

The above data converges with the Peden-McAlpine and Clark (2002) study that points to recognition of changes in a patient situation over time as a crucial in reducing and preventing complications. Thus, continuity of care is important where continuity refers to the "use of information on past events and personal circumstances to make current care appropriate for each individual" (Haggerty et al., 2003, p. 1220). This reflects the significance of time in early recognition of patient clinical deterioration (Peden-McAlpine & Clark, 2002). Indeed, continuity of care facilitates the process of decision-making in a complex settings (Tingsvik, Johansson, & Mårtensson, 2015).

When there was an alarm, for example, the nurse participants would check the screen and respond immediately. However, the response itself was dependent upon the nurses' understanding and skills. The nurse participants might have recorded an abnormal pressure value on the flow chart and observed this again, or not, because of other nursing care demands or, patient needs and whether a reassessment was considered important if the patient had initially responded well. Thus, external influences may give rise to a failure to recognise risks during the management of CRRT. It is recommended that nurses record CRRT pressure from the circuit to monitor the function, on an hourly basis, such as transmembrane pressure (TMP) (Baldwin & Fealy, 2009a) although most nurses do not document the values when an alarm is triggered but review the pressure measurements from a screen display and respond (Baldwin & Fealy, 2009a). It appears that the nurse participants who were developing independence as decision-makers, or who were dependent decision-makers, may require support from the team leader, doctors or institutions to understand and respond to advanced technologies. This was evident in an informal conversation with one participant as follows:

> The CRRT alarm continues, the transmembrane pressure [TMP] and access are low and return pressure is high.
> I asked Participant 4 "What do you think?
> She said: "It is clotted" and she went to the doctor and he told her: "You need to continue the CRRT for 72 hrs and today she completed only 48 hrs. Recycle /re-circuit again." (Participant 4, Field note, 10 September, 2013)

A participant also explained that the level of workload prevented nurses from appropriately recording patient information including CRRT, when there were changes within an hour:

> *Our workload is too great. Hourly we have to write down the CRRT parameters, flush the line, we have to send samples, we have to do everything. This is all so difficult and the bag we also have to change maybe every hour or a half an hour… They are very heavy bags. (Participant 15, interview)*

> *Because the situation was really bad that's why I just disconnected and reconnected the CRRT after bringing the patient from the CT scan department alone. But the thing is I disconnected that one with clean gloves but I did the dressing and everything in a proper sterile manner. First I finished with the machine. We are supposed to do it with two nurses but because of the critical situation at that time nobody was available. (Participant 19, interview)*

In addition, the nurse participants manifested different practices in interpreting potential risks. Some believed that they could predict filter clotting by observing the membrane and/or venous chamber for noticeable clots after or during the flushing technique (Baldwin & Fealy, 2009a; Joannidis & Oudemans-van Straaten, 2007). However, there is no reference in the guidelines (Kidney Disease: Improving Global Guidelines (KDIGO) Acute Kidney Injury Work Group, 2012) to support this method. Global guidelines state that circuit pressure measurements are influenced by treatment modality, fluid settings and blood pump speed

(Baldwin & Fealy, 2008; Baldwin & Fealy, 2009a). Similarly, the nurse participants appeared to be not fully aware of appropriate or evidence based CRRT practice. One participant believed that she could predict the filter clotting:

> *Every hour we can check to see if there are any clots and then we use saline flushing. At that time we can see from outside the filter or venous chamber if there are any blood clots inside… That is my experience. (Participant 4, interview)*

Thus, nurses as decision-makers appeared to lack understanding of the function of the advanced technology and could not appropriately link and recognise relevant patient information with technologies. Nurses may miss patient signs of clinical deterioration and fail to make timely clinical decisions to reduce possible complications such as a clotted filter, poor haemodynamic status and other CRRT issues. When nurses do not undertake a comprehensive patient assessment and rely only on recording vital signs, they may not recognise other cues to clinical deterioration (Cox, James, & Hunt, 2006). Hence, in order to understand nurses' anticipation and controlling skills in relation to decision making about technology, clinical knowledge and experience, preventive strategies and available time are all critical in linking patient information and ensuring continuity of care.

5.3 Standard Nursing Care

In generating patient information and in anticipating and controlling risks, all participants referred to ICU nursing protocols and/or clinical practice guidelines as source of information and supporting evidence to minimise risks (e.g. reducing medication or clinical errors), ensure safe practice and to make clinical decisions. The extent to which formal resources were actually applied, however, varied between participants across the three levels of decision-making. The use of protocols may support intensive care nurses in making

clinical decisions because of the complex ICU setting, acutely ill patients, the range of patient information, and advanced technologies (e.g. ventilator, fluid pumps, and CRRT). Although clinical practice guidelines provide recommendations in relation to the provision and management of CRRT in intensive care units, there is limited research on nurses' use of clinical guidelines or protocols in CRRT practice. This concept will be examined beyond the benefits of using standardised nursing care in relation to the decision-making process.

In this research, the nurse participants considered ICU and CRRT protocols, in addition to doctor's orders, crucial in making safe clinical decisions. Using ICU and CRRT protocols helped in the correction of electrolyte imbalance, adjustment of anticoagulation and other medication dosages, and managing CRRT parameters. One participant explained a standard protocol:

> *We have to check, for example, electrolytes imbalance because the patient will lose electrolytes with the CRRT especially potassium. So the potassium levels we monitor every six hours by collecting, and also haemoglobin plus the coagulation profile is important …all these investigations we do and we correct according to the protocol. (Participant13, interview)*

The CRRT circuit, for instance, needed to be changed and managed according to the CRRT protocol. The following participant was confident in describing the policy of the CRRT circuit:

> *Continuous renal replacement therapy CRRT was going smoothly but it was started three days ago. Our protocol is to keep the CRRT set continuously for 48-hours but it was more than 72-hours. So we changed the set and then we restarted again to reduce infection. (Participant 17, interview)*

The objective of protocol based tools is to standardise care and simplify clinical decision-making processes (Rycroft-Malone et al., 2009). The argued benefits of standardised care are to demonstrate a unit's standard of care and to allow nurses to spend more time

delivering care (Lee, 2005). There is a small body of research that has focused on how protocol-based care influences nurses' decision-making (Blackwood & Wilson-Barnett, 2007; Manias et al., 2005; Rycroft-Malone et al., 2009). Manias et al. (2005), for example, examined how graduate nurses use protocols to manage patient medications concluding that structured protocols assisted nurses to independently practice by making clinical judgements without having to follow up with doctors.

Independent and experienced participants were observed using protocols less than other inexperienced or dependent nurses. Protocols tend to reduce practice to discrete element and yet, in the ICU environment, the nurses needed to quickly assimilate theoretical and clinical knowledge, experience and skills in order to make effective decisions and take actions. A participant stated:

> *This patient, normally, there will be purification of blood that is going on and all blood sugar, electrolyte levels will deplete. It is quite normal. So we are expecting these issues and monitoring every 6 hourly all the investigation, lab results and blood sugar everything we are doing, (Participant 20, interview)*

The nurse participants were expatriates with differing clinical backgrounds and therefore the use of protocols and guidelines may have guided decisions. Yet, it is unclear whether the use of standardised care approaches can simplify clinical decision-making in complex practice. Three and a half decades ago, McLeod Clark and Hockey (1981) argued that nurses needed to develop the ability to "defend their decisions and actions on a scientific rather than intuitive or conventional basis (McLeod Clark & Hockey, 1981). It is on this ability that their claim to professionalism rests." (McDonald, Waring, & Harrison, 2005, p. 407). More recently, McDonald et al. (2005) highlighted that while nurses often use checklists and protocols to update clinical practice, nurses also follow protocols to defend their clinical decisions more so than seeking good outcomes (McDonald, Waring, Harrison,

Walshe, & Boaden, 2005). Nurses may make decisions that protect themselves rather than see patient outcomes as the more important factor. In this research, such actions might have been shaped by the complexity of intensive care environment and/or personal factors such as fear of loss of employment as expatriate nurses, lack of autonomy and poor clinical knowledge in CRRT practice.

The concept of the development of decision-making skills manifested when nurses had limited decisions-making skills and needed to develop their clinical knowledge in practice. Independent nurses demonstrated appropriate level of decision-making skills in CRRT practice. Nevertheless, the nurse participants, who were developing independence as decision-makers and dependent decision-makers, relied on other professionals or constantly checking standardised protocols in order to make clinical decisions. Nurses who were developing independence as decision-makers used ICU protocols and relied on others less than dependent decision-makers. The dependent nurses had underdeveloped decision-making skills for complex practice and avoided independent decisions in patient care around adjusting vasoactive and sedation therapies according to the patient needs or managing CRRT without assistance. A study by Flynn and Sinclair (2005) examined the perceptions of intensive care nurses to policies, protocols and guidelines. The authors concluded that nurses were afraid that protocols were 'taking the thinking out of nursing' and disadvantaging inexperienced nurses from developing their clinical decision-making skills (Flynn & Sinclair, 2005). In this research, the nurse participants followed guidelines but were unable to link relevant patient information with technologies to make appropriate judgement on the patient's conditions. The nurse participants also preferred to make decisions after reference to doctors. An observation demonstrated a participant who relied on others rather than checking the protocol for adjusting vasoactive therapy, or when to discontinue CRRT:

> Participant 10 said "I will call and ask the doctor if he wants to stop CRRT." (Field note, 5 November, 2013).

There are critiques around nurses' use of protocol-based care or guidelines in different clinical contexts. While the nurse participants, used ICU protocols to support decisions there were clinical situations that required critical thinking and assimilation of relevant patient information, which would not be available in protocols or guidelines. Making decisions in complex practice is not a linear nor structured process. Lee (2005) for instance, revealed that nurses overlook the need for individualised interventions and are unable to recognise unpredicted additional problems. According to Lee (2005), nurses match patient conditions with the designated protocols to meet hospital requirements rather than for patient care (Lee, 2005). Nurses might not be aware of possible interrelated factors or risks and thus draw on protocols in selecting inappropriate interventions. It has also been argued that standardised care approaches are not appropriately used in practice (Rycroft-Malone et al., 2009). Several other studies have demonstrated that nurses use clinical information and rely on colleagues (e.g. nurses or doctors) and communication to clinical decisions more so than formal sources such as protocols or guidelines because it is easier to access information from colleagues (Bucknall, 2000; Estabrooks, Chong, Brigidear, & Profetto-McGrath, 2005; McCaughan, Thompson, Cullum, Sheldon, & Thompson, 2002; Thompson et al., 2001).

In this research, participants interacted with doctors to seek advice on a patient's condition or treatment plan, and to confirm or modify orders. As one participant stated:

> *Only here in our ICU… if it is injection it is high risk medications. If you noticed hypoglycaemia, no need to wait for the doctor. Later, we only will take the signature and….doctors agree because almost all of the time doctors will be busy or outside in ER... We are correcting hypoglycaemia, and even if the doctor is not around, we should ask the team leader herself. (Participant 20, interview)*

The team leader, for example, was checking the patient's conditions and updated information with the participant to ensure safe practice and patient care:

> *The team leader was asking, it means with high inotropes usually we are not removing fluids, just hold the removal and we will watch if blood pressure is improving that time only usually we are removing fluids. Otherwise again blood pressure will drop with high inotropes not removing. Doctors should remove the fluids. But the patient has cardiac failure and means he also has pulmonary oedema before and when he was admitted so means more fluid overload it means more congestion for this patient that's why they want to remove the fluids. (Participant 8, interview)*

Thus, the variation in practices implies that there are implications for organisational goals of protocol-based care. However, health organisations often focus only around standardisation. It appears that using ICU nursing protocols has both advantages and disadvantages which need to be considered in relation to nurse decision-making.

The analysis concluded that most of the nurse participants who managed CRRT cases had never received any specific training. When nurses do not understand, read updated clinical guidelines due to limited training or educational sessions, or inadequate orientation programs; poor practice may result and particularly around advanced technology. There are practical barriers to implementing CRRT protocols in an ICU, which require further examination in relation to intensive care nurses' decision-making. It appears that nurses need to understand the principles underlying renal replacement therapy and the equipment functions (Boyle & Baldwin, 2010) in relation to warrant safe nursing practice. However, there is a lack of standardised training for nurses who provide care for the patient's with CRRT (Ricci et al., 2015).

5.4 Situational and Client Modifications

Situational and client modifications in the O'Neill et al. CDM model refer to how environmental complexities of a clinical situation influence patient care and how knowing the patient individualises care. Both forms of knowledge, in the current research, helped nurses to manage and control changes in patient conditions and/or address CRRT problems. In the midst of patient crises, participants had to manage acute patient conditions even though different procedures and care were required for a number of patients. O'Neill et al. (2005) argued that knowing the patient, positive interaction between staff and sufficient workload and time resources all affect the capacity of nurses to recognise and identify cues and hence the quality of clinical decisions. Specialist knowledge gained through experience and formal learning, rapid and effective communication skills, and maintaining cohesiveness in stressful and complex environment are considered crucial components that can influence the quality and safety of nursing care (Storesund & McMurray, 2009).

Despite the above, participants faced challenges in decision-making due to the complex environment of the intensive care unit. Factors such as knowing the patient, interactions between staff within a rapidly changing environment (e.g. availability of management supports), and environment interruptions (e.g. awareness of work roles and responsibilities, insufficiency of nursing staff in both numbers and skill mix, workload or inadequate time to collect information) are acknowledged in the CDMM. However, in this research, these factors manifested in a variety of ways at the different levels of decision-making and are explored in greater depth below.

Knowing the patient

The concept of knowing the patient was crucial to every participant in relation to decision-making and interventions. Independent decision-makers quickly noted changes in

patient conditions or identified CRRT problems because of cumulative knowledge about potential patient responses to different treatments. Independent decision-makers were thus able to control situations without requiring support from others. Knowing the patient is described as a source of information whereby nurses are able to use knowledge of clinical patterns from previous clinical experiences in assessing new patients (Kelley, Docherty, & Brandon, 2013; Zolnierek, 2014). Where the participants knew the patients, problems were readily recognised and potential complications and clinical errors avoided. One participant explained how she managed a patient's blood pressure:

> I asked: "What is the patient's blood pressure now?"
> Participant 20 said: "After patient positioning, the patient's blood pressure dropped to75/54mmHg."
> I asked: "What did you do??"
> Participant 20 said: "I increased nor epinephrine from 8 to 12 mcg/min."
> I asked: "What is the patient's blood pressure now?"
> Participant 20 said: "84/60mmHg and it's coming up". (Participant 20, Field note, 15 December, 2015)

As the above data suggest, skilled clinical judgement is enhanced through knowledge of the patient. The concept of knowing the patient has been well established as an indispensable element in the clinical decision-making process (Jenks, 1993; Jenny & Logan, 1992; Mantzorou & Mastrogiannis, 2011; Tanner et al., 1993; Whittemore, 2000). An early and noted interpretive phenomenological research of the development of expertise in critical care nursing identified that knowing the patient as a strong recurring theme. The authors interpreted nurses' meaning of knowing the patient as knowing the patient's typical pattern of responses and knowing the patient as a person both of which assisted with clinical judgement (Tanner et al., 1993). Minick and Harvey (2003) also noted that where nurses know a patient and attend to subtle changes in a patient's conditions early recognition of patient deterioration

is more likely to occur. Knowing the patient requires nurses to bring all patient information and personal experience and knowledge together to be effective in clinical decision-making.

Yet, developing independence and dependent decision-makers did not appear to know patients quite as well. To recognise and identify causes of patient clinical deterioration and/or CRRT problems, those participants either misinterpreted the signs of clinical deterioration, or were unable to link relevant information to understand the possible risks or causes. Thus, the importance of knowing the patient was emphasised. A field note demonstrates this point:

> I asked: "Why do you want to ask the doctor to discontinue vasopressin?" Participant 12 said: "Because the patient is on high levels of inotropes, and we are afraid that the patient will develop cardio-genic shock" (Field note, 13 November, 2013)

The above example demonstrated a case where the patient was already experiencing cardiogenic shock induced AKI and was receiving CRRT. The doctors prescribed vasopressor therapy (e.g. vasopressin intravenous infusion) to improve vasoconstriction (e.g., arterial blood pressure) and water retention due to the cardiogenic shock. Vasopressor therapies dosage needs to be gradually reduced according to a patient's response; a nurse will be closely monitoring for haemodynamic instability. The above example demonstrated dependent decision-making skills where the participant did not know the patient and did not have appropriate knowledge about the patient's diagnosis and medications. In a further example, a participant was unable to explain the reason for a doctor's order to reduce nor-epinephrine and levophad therapies which was because the patient had ischaemia in both legs:

> *Because the doctor wanted to know and assess the Ph level for CRRT and he wanted to see arterial blood gas [ABG] level. Now the patient is on high inotropes and so we will see that we gradually are tapering. (Participant 25, interview)*

Thus, knowing the patient appears to be important in the delivery of high quality patient care and positive patient outcomes (Kelley et al., 2013; Zolnierek, 2014). Having limited knowledge about a critically ill patient's conditions and technologies can lead to misinterpretation of patient information which, in turn, undermines the capacity of a nurse to recognise problems at an early point (Henneman et al., 2010; Kelley et al., 2013; Peden-McAlpine & Clark, 2002). Henneman (2010) found that intensive care nurses used 'knowing the patient' as a strategy to identify real medical or clinical errors. Failure to recognise and identify causes and significant changes in a timely way in patient conditions with AKI and CRRT may result in adverse patient outcomes (Minick & Harvey, 2003; Tait, 2010) such as hypotension, hypokalaemia, and abnormal access/return pressures in CRRT. Increasing understanding and appropriate support are therefore required for nurses to be better prepared for early recognition and quick response to patient clinical deterioration (Cioffi et al., 2009).

Staff interaction

Participants looked to support from doctors, team leaders and others in order to make decisions. Support through interaction is shaped by socialisation and by organisational culture and will inform a nurse's ability to make clinical decisions (Ajeigbe, McNeese-Smith, Leach, & Phillips, 2013; Kalisch, Curley, & Stefanov, 2007; Kalisch & Lee, 2010). Participants relied on each other or other professionals in making clinical decisions and so there appeared to be a strong element of teamwork and team norms. The CDMM, however, has limited capacity to explain the complexities of this factor as a possible influence on the use of patient information and decision-making in the ICU and in different contexts. For example, the developing independence and dependent decision makers may have conformed with existing norms in depending on each other to respond and act rather than sharing information or improving their skills, or learning about CRRT practice. Hence, nurses who are newcomers

may tend to follow the patterns or norms of others and adapt their behaviours to ensure approval (Kalisch, Landstrom, & Hinshaw, 2009). Conversely, a lack of shared team norms or teamwork behaviours can undermine decision-making and information sharing and particularly where nurses are afraid to speak out or to act independently. This is reflected in the following participant words:

> *The doctor said if the blood pressure mean fell below 50 mmHg to stop CRRT. Now it is 50-49 mmHg and the fluid challenge is going. Let me see and then I will ask the doctor and we can decide. (Participant 29, interview)*

Situations such as the above may have occurred because all participants were expatriates working in the Saudi Arabian intensive care unit. Furthermore, most participants were from the Philippines and India and felt privileged to work in Saudi Arabia where they received relatively good salaries (Alzahrani, 2015). Alzahrani, (2015) also noted that some expatriate nurses were hesitant to express dissatisfaction due to fear their contracts might be terminated. Thus, management support and motivation to improve clinical knowledge and skills might strengthen confidence in decision-making. As one participant explained:

> *Sometimes we need help because actually we are not fully knowledgeable about things such as the CRRT functions. So sometimes we need the senior nurse to help. I do not have that much experience because when I came here [the Saudi Arabia intensive care unit] I learnt from senior nurses and worked with CRRT without professional education or training. (Participant 28, interview)*

Nurses who were working in Saudi Arabian ICUs largely come from different clinical backgrounds. It is crucial to understand how these nurses interacted as a reflection of the ICU workplace culture. Different professional cultures may give rise to barriers to effective inter-professional teamwork, due to educational experiences and socialisation processes (Hall, 2005; Kuhlmann, Burau, Khokher, Lynn Bourgeault, & Sainsaulieu, 2009). Cerdá et al (2016)

and the Acute Dialysis Quality Initiative (ADQI) group recommended that technical skills of staff need to be considered do demands related to organisational, social and patient needs during the management of CRRT (Cerdá et al., 2016). This means that effective treatment depends on the ICU workplace culture and nurses' interactions with and adaptation to working conditions within that culture. The availability of both effective working conditions and qualified nursing staff was essential. Participants routinely relied on each other when there was a patient undergoing CRRT. As one participant noted:

> *I don't want to disturb nurses if in our unit we have one CRRT patient. We understand this patient with CRRT is sick and this is the last chance for the patient and so everyone knows this patient is critical. If I am caring for such a patient all will offer to help me. If somebody is free to help they will come without being asked and I will do the same. (Participant 29, interview)*

The above reflects the importance of interactive support and team decisions despite staff shortages. The Alalyani (2011) study explored factors in the Saudi Arabian setting that influenced the capacity of nurses to provide quality care in intensive care settings. The author concluded that there were internal, intermediate and external environmental factors such as demanding workloads, the stresses of professional responsibility for continuous patient care, continuously monitoring vital signs for long periods, and staff shortages which affected the degree of collegial support (Alalyani, 2011). Other barriers were unit management, limited resources, and minimal or no orientation (Alalyani, 2011). In addition and as has been noted, the Saudi Arabian intensive care context is unique in terms of a high dependence on expatriate nurses. These factors may have been influential in the research context as some participants noted and as is reflected in the following field note:

> I asked: "Do you think you need help?"

> Participant 26: “Yes, the bags and the workload are heavy for nurses. In the Philippines, we have special renal nurses who care for CRRT patients from the dialysis department.” (Participant 26, Field note, 24 December, 2013)

A further participant implied a lack of orientation and unit management and educational resources:

> *Yes, I need help sometimes if I can't fix the machine or I need to start or prime the machines. Sometimes I need someone also to help me to troubleshoot or manage the situation. (Participant 26, interview*)

The above suggests that aspects of the work environment were unexpected, challenging and affected nurses' clinical decision-making processes in different ways. There may have been an issue of adaptation to the Saudi Arabian intensive care nursing environment and the complexities of CRRT practice exacerbated difficulties. Scholtz et al. (2016) reported that the intensive care culture can be identified through patterns of patient adoption, nursing coping skills and adapting, teamwork, non-support from management and medical doctors. Awareness and understanding of the complex patterns of behaviour and interaction in the ICU add to the knowledge base of intensive care nurses and can empower in transforming their practice (Scholtz et al., 2016). The challenge here, therefore, was to explore the social influences and processes that supported the adaptation experienced by nurses in the research ICU culture in relation to decision-making.

Environmental interruptions

The ways in which environmental interruptions affected decision-making was also evident in this research. Although environmental factors included limited awareness of work roles, insufficient nursing staff and skills, and lack of time to manage all patient procedures, independent decision-makers managed patient changes and CRRT parameters in addition to

controlling risks in different critical events. However, the nurse participants sometimes felt frustrated when they perceived that doctors were not doing their work in a timely way for patients. One participant stated that:

> *Until now I have no problem except I faced difficulty where the vascular access was not good and I had other patient's procedures to deal with at the same time. Nurses, however, can't do anything about the vascular access except patient repositioning or flushing because it is the doctor's responsibility is to insert new one. The clotting you can flush but the vascular access if it is not good, we can't do anything. (Participant 23, interview)*

Even for independent nurses decision-makers the respective roles of nurses and doctors shaped decision-making processes. The differences in how doctors and nurses interpreted their roles impacted on nurses' autonomy to make decisions. In addition and in the research context more broadly, both Saudi national and expatriate doctors perceive that they are the most important decision makers and that the role of nurses is to implement doctors' orders (Alzahrani, 2015). In this research, the nurses' roles were not only limited to following doctors' orders, or implementing care, but extended to sharing information and making decisions about and applying interventions in response to sudden or unpredictable patient clinical deterioration and CRRT problems. The positioning of nurses is reflected in the excerpts below which indicate a degree of autonomy:

> *If I am the one handling this critical patient, I can, say that the patient central venous pressure [CVP] is on the lower side and if you [the doctor] continue fluid removal the patient may crash. We can make suggestions from our experience so that doctors then will assess all factors and according to their conclusions we will intervene (Participant 6, interview).*

> *The doctor is responsible but we need to inform them. Directly we are the ones taking care of the patient about what is happening in every minute (Participant 14A, interview)*

The nurse participants, however, stated that their contribution in the process of decision-making and problem solving can be disrupted by the hierarchical structure that locates nurses and doctors. Communications between nurses and doctors have historically been unequal and the contributions of nurses at times marginalised (Ajeigbe et al., 2013). The Saudi Arabian health care system is dominated by a male doctor culture and a culturally diverse nurse environment characterised by different norms, practices and beliefs functioning in one shared place (Almutairi & Rondney, 2013). In the current research, the nurse participants as expatriates from non-western countries may have accepted the doctor male dominant culture. A lack of shared input or teamwork decisions might, therefore, undermine nurse confidence, autonomy and decision-making skills. Nurses were afraid to speak out in this context. Indeed, internal environmental influences such as the value of teamwork and equal communication have a strong correlation with the level of team member contributions, teamwork quality, decision-making, mutual support, cohesion and autonomy (Ajeigbe et al., 2013).

It has been argued elsewhere that nurses are more likely to work as a team whereas doctors prefer to work independently (Hall, 2005; Kalisch et al., 2007; Reader et al., 2006; Reader, Flin, Mearns, & Cuthbertson, 2009). A study undertaken by Papathanassoglou et al. (2005) demonstrated that intensive care nurses demonstrate moderate autonomy in technical tasks and low decisional autonomy in relation to organisational factors, gender issues, years of ICU experience and educational preparation. In a Saudi Arabian primary healthcare organisation, it was revealed that one-third of nurse participants reported a lack of clinical autonomy due to organisational factors and different work environments (Almalki, 2012). It

appears that the levels of nurse decisional autonomy may differ between countries and working cultures. Social and organisational culture remains an issue for nurses' decisional autonomy which may consequently affect an ability to make independent clinical decisions. This might be the result of limited autonomy or experience on the part of nurses with patients receiving CRRT. For example, one participant failed to link and understand a patient's fluid overload noted:

> *Yes, I asked the doctor why the patient was not receiving any intravenous fluid [IVF] because in the morning I needed to document a positive fluid balance. The* doctors *did not want to give the patient more fluids. There was also no fluid removal in CRRT because the patient was in severe septic acidosis and the level of lactic acid was high so doctors could not remove fluid during the CVVH and the patient was high in inotropes, vasopressin and levophad. Actually, the patient had been receiving intravenous fluid [IVF] but doctors discontinued the fluid. So, I again asked the doctor's opinion whether to restart IVF because the patient was improving. (Participant 22, interview)*

The participants who were developing independence as decision-makers were sometimes slow to control environment interruptions (e.g. complexity of CRRT technology, workload, limited autonomy, caring for different treatments/procedures, patient critical conditions, and distraction by other nurses or doctors calling for help). It was challenging for those nurses to manage critical ill patients and the technical equipment simultaneously. An example was where the nurse participants were helping other nurses, or providing other patient care (i.e. assisting another patient's procedure), rather than closely monitoring and observing a patient's condition. This gave the impression of being unable to completely control or manage patients with AKI on CRRT sometimes due to other demands in the surroundings. As a participant demonstrated:

> At 3:00pm Participant 11 told me: “I will go and help my colleague do the evening care tasks.” At 3:15pm, another intensive care nurse came and checked the CRRT alarm. She read the message on the screen which said “replace the fluid bags” and she changed the replacement bags. (Participant 11, Filed note, 11 November, 2013)

Nurses then need to constantly update the patients' bodily system information in order to identify problems, adjust different therapies and take control over a situation (Alasad, 2002). Nevertheless, Alasad (2002) found that nurses are able to manage technology with experience and that technical activities are considered more stimulating than other nursing practices. Thus, being familiar with technology had the advantage of the technical skills of nurses and achieving better patient outcomes.

Intensive care units are heavily equipped with technical tools which are integral to management of critically ill patients (Wikström et al., 2007). Previous studies have demonstrated that where intensive care nurses are unable to effectively work with advanced technologies the result is anxiety and stress (Crocker & Timmons, 2009; Little, 2000; Tunlind et al., 2014). Providing nursing caring in an environment that uses a lot of technology is very stressful particularly when nurses are inexperienced (McGrath, 2008). Inexperienced intensive care nurses struggle to cope with complex technology and require more support and educational training (McGrath, 2008).

It appears that intensive care nurses’ working knowledge, experience and skills are crucial to provide both technological and human care. Nonetheless, the ICU environment is effected by organisational and social influences that construct nurse clinical decision-making.

5.5 Triggers to Hypothesis Generation, Selection and Nursing Action

In ICUs, alarms act as triggers to which nurses respond by generating hypotheses and selecting decisions that inform actions. Thus, hypotheses were generated as potential explanations for change in a patient's condition. Nurses bring together their knowledge and experience to patient information and clinical deterioration events in relation to identify causes and make decisions to apply quick interventions. According to O'Neill et al, nurses make clinical decisions that result in either satisfactory or unsatisfactory actions (O'Neill et al., 2005). Where an intervention is unsatisfactory nurses will be compelled to revisit causes of a problem and to reassess the patient. Where nurses struggle in making clinical decisions, it may be that technology disrupts nursing care (Alasad, 2002; Almerud, Alapack, Fridlund, & Ekebergh, 2008a; Barnard, 2000; Crocker & Timmons, 2009; Tunlind et al., 2014). Hence, from a nursing perspective, technologies are facilitators and barriers to patient-centered care. It is therefore of interest to consider if CRRT technology was perceived as an aid or hindrance during nursing care and decision-making.

In this research, the nurse participants used pre-encounter information and linked, recognised and identified important cues of patient deterioration or improvement in order to generate relevant hypotheses and determine decisions and actions. The nurses generated hypotheses by identifying clinical indicators or recognising problems, such as linking abnormal potassium levels with cardiac patients who received CRRT, unstable blood pressure with vasoactive therapies, maintaining mean blood pressure with fluid removal, or hypothermia and CRRT's temperature. After identifying problems, nurses may be able to link patient information to apply early interventions. Independent decision-makers efficiently linked factors associated with changing patient conditions, or CRRT problems, with pre-encounter information and acted accordingly. The excerpt below is a reflection on how a

participant drew on previous knowledge and experience to quickly respond to a patient's deterioration:

> *I told you this patient had cardiogenic shock. He has ischaemic heart disease. Usually those cardiac patients should maintain potassium level at least 4mmol to avoid cardiac arrest and forming PVCs [Premature ventricular contractions] which can cause other problems. Already he has the potential for heart failure. If the patient is on CRRT he is creating all waste products through this fluid. Also, all the electrolytes are coming down and so it is better to replace the potassium to keep the levels at least at 4mmol. (Participant 21, interview)*

From the above, it appears that independent clinical decisions involve the prioritisation of important patient information to be followed by rapid decision-making and intervention. This is evident in a further example below:

> *Because the priority is to maintain inotropes and vasopressin drugs otherwise after changing the bags the patient will suffer hypotension and maybe also be coded. My first priority is inotropes. Yes, changing bags can wait, no problem, just the end of timing… within 2 minutes I changed the vasopressin. We are always aware of patient priorities and the first one will be first. (Participant 25, interview)*

Previous studies have noted that good decisions or judgements are influenced by how nurses prioritise and select patient information and use their abilities to respond to salient concerns in clinical or non-clinical situations (Dowding & Thompson, 2003; Johansen & O'Brien, 2015; Pearson, 2013; Tanner, 2006). The use of past experience in clinical decision-making is crucial to good judgement in determining priorities (Cioffi, 2001).

Nonetheless, managing technologies may add a further layer of complexity to nurse clinical decision-making. Management of the technological realms of practice can be time-consuming during, for example, medication administration or other therapies (Poon et al.,

2008) which may lessen the time dedicated to other responsibilities. This might create a situation where nurses struggle to reach appropriate decisions and take successful actions.

There is clear understanding of the challenges for nurses in ICUs in the management of monitors, ventilators, and infusion pumps. This current research contributes to an understanding of the complexities in terms of decision-making and managing CRRT/dialysis technology. The array of technologies requires nurses to have sufficient knowledge and skills to use different equipment and to convert each technology into nursing care. The participants in this research occasionally were, at times not able to independently manage both CRRT technology and critically ill patients. For example, a participant faced difficulties in managing CRRT parameters where there was low blood pressure and high vasoactive therapy support. Thus, managing the function of CRRT with different ICU medications was problematic for nurses. As reflected in the participant's words:

> *If the patient is on really high inotrope dosages, for example, Levophed is 100 mcg/min, we will not start CRRT because at anytime the patient will crash. If the inotrope Levophad dosage is around 50- 60 mcg/min then we can start and manage CRRT but if higher we cannot. (Participant 14, interview)*

It has been argued that the characteristics of nurses, such as age, experience, knowledge, beliefs about technology self-efficacy, fatigue, and sensory inputs all act to moderate and facilitate the use of technology in practice (Powell-Cope, Nelson, & Patterson, 2008). Such characteristics, although not part of the O'Neill et al model, may be worth consideration in ICU practice. One participant responded slowly to a CRRT problem:

> At 3:00pm Participant 5 and another nurse were starting evening care. The CRRT alarm had been on for a while.
> Participant 5 went to the CRRT machine and read the screen which indicated" pre-filter high pressure" (comes from Arterial red line showing -130 to -150).

> The nurse said: “this is maybe a sign of clots”. (Participant 5, Field note, 11 September, 2013).

Poor practice of CRRT management appeared to lead to early filter clotting and delayed patient treatment, such as the above field note illustrates. Where nurses do not understand or identify reasons for CRRT problems, tentative hypotheses are more likely to be formulated. The participant above made an unsafe decision to increase the blood flow rate when the access pressure was low due to hypotension and the filter clotted. The participant explained her decision-making:

> *Initially it was showing low access pressure and so I with the team leader tried to increase the blood flow. Low access pressure means if you increase the blood flow, it may compensate. We hope so but even though the blood flow was around 350 ml/hour it was still it was showing some problems. Maybe according to me, maybe it was touching the walls of the vein that's why this access was showing some and maybe sometimes because of the position so I tried to make the limbs straight even this flushing the lines with normal saline… this system was clotted, we discontinue and restart new circuit again. (Participant 5, interview)*

Where the participants were developing independence as decision-makers, patient clinical changes were more tentatively linked with pre-encounter information. Thus, support was needed to identify causes of problems and to make decisions on the next steps. Two participants noted:

> *We are correcting hypoglycaemia and even if the doctor is not around, but we should ask the team leader herself. (Participant 20, interview)*

> *Let me see and then I will ask the doctor and we can decide. (Participant 29, interview)*

Where dependent decision-makers were unable to recognise patterns they relied heavily on others to assist in generating, evaluating and making appropriate decisions on actions as reflected in the observation below:

> The patient's blood pressure is 73/38 mmHg and he is still on high dose of inotropes (nor-epinephrine).
> I asked Participant 10: "Did you discontinue or gradually reduce inotropes?"
> Participant 10 said: "No, I did not and I will call and ask the doctor if he wants to stop CRRT." (Participant 10, Field note, 5 November, 2013)

> *Because this is my fifth case handling the patient with CRRT. So if I don't know I will ask my colleagues. They know better than me because they are six or seven years of experience while I am just here one year (Participant 6, interview)*

The complexity of decision-making process in CRRT practice means that nurses do rely on others for safe care. In ICU, there is a complex assemblage of individual, social and organisational elements that inform nurse clinical decision-making. Individual factors appear important in shaping the process of nurse clinical decision-making because nurses' contributions to patient outcomes depend on their decision-making skills. Nurses may have internalised beliefs about their own knowledge, skills, and competency which may decrease their self-confidence and make them defer to others as better decision makers (Hagbaghery, Salsali, & Ahmadi, 2004). In addition, a lack of frequent exposure to caring for a patient requiring CRRT and CRRT management and decision-making, can negatively affect a nurse's competence (Graham & Lischer, 2011). Intensive care nurse managers or team-leaders are normally responsible for assigning nurses to patients (Graham & Lischer, 2011). A participant referred to the limited opportunities to engage with CRRT technology:

> *I cannot ask team leaders or managers to assign me to a CRRT patient to learn because they give [CRRT cases] to different nurses each time. So we*

> *have to share the CRRT experience with all staff and I have to consider also my colleagues also need a chance to learn. (Participant 9B, interview)*

The nurse participants demonstrated varying degrees of competence in managing CRRT. A nurse participant, for example, did not modify the CRRT temperature because she did not know it was possible to do so.

> *There is no CRRT Temperature. No, I did not touch it because there is no parameter to change or press. Yes, the patient is still hypothermic, 34.1C. (Participant 26, interview)*

Another participant wrongly thought that when she stopped the CRRT and used the recirculation mode, the circuit or the filter would not clot:

> *Because when I started the nursing care, I moved the patient into a straight position. The patient blood pressure dropped and there was vasoactive therapy support but still the blood pressure was 68/38 mmHg. The patient was already in a very bad condition. Actually, the doctor also planned to discontinue the CRRT if it was clotted. If the blood pressure improves it means I will re-start CRRT again. Because of this, I only put the circuit on recirculation mode to reduce the risk of filter clotting. (Participant 28, interview)*

The above data suggests that nurses have limited understanding about the CRRT machinery in relation to the filter lifespan and the circuit to make competent decision-making. Nursing competence is the through intensive care nurses' abilities to understand and manage the clinical situation (Lindberg, 2006). Inexperience with CRRT means that these nurses are more likely to need support from others because managing the system and patient may induce stress and disrupt their nursing workflow.

At times, intensive care nurses might be unable to recognise equipment failure and may believe that the equipment will always function. Nurses might not be able to early recognise machine malfunction or errors in this complex context. Browne and Cook (2011) argued that experienced intensive care nurses will often be more dependent on monitoring equipment, particularly when that equipment has been used by the nurses for a long time. It may be that using and managing technologies allays concerns about nurse decision-making, workflow and patient outcomes. This is reflected in the excerpt below:

> *I have this dialysis experience. I mean the setting, the concept is still the same. Only the length of time differs. Unlike in the regular dialysis it takes about 3 to 4 hours then we have to terminate the treatment. In CRRT, it's continuous as long as the patient can tolerate it and as long as he is hemodynamically stable. In relation to trouble shooting, only the dialysate fluid we have to troubleshoot, because in dialysis the machine itself is the one to regulate the dialysate. However, with CRRT machinery, we have to manually replace the dialysate replacement and the dialysate fluid removal. But other than that it is still the same, the pressure, the TMP, the heparinization, it is all the same (Participant 12, interview)*

Requiring more support with re-assessing patient conditions, identifying causes of the problems and troubleshooting CRRT to make suitable clinical decisions and to take successful actions was an issue in CRRT practice. Participants struggled during the management of CRRT due to different contextual influences which affected nursing workflow and decision-making processes. Those participants depended on their previous experiences and relied on the team leader in relation to decision-making and problem - solving. Nurses documented the patient's assessment and intervention data on the patient's sheet and nurses' notes even though those nurses did not completely understand and link the patient data. There was no checklist or evaluation of skills.

It has been suggested that early vital sign interpretation, documentation, meaningful communication, and appropriate medical management are crucial aspects on patient earlier prevention of deterioration and intervention (Mitchell et al., 2010). Studies argue that failure in early patient intervention is due to poor documentation of vital signs, inaccurate interpretation of vital signs, and failure of communication between staff (Mitchell & Van Leuvan, 2008; Oakey & Slade, 2006; Smith, Osgood, & Crane, 2002). These factors point to the importance of secure knowledge and professional competence in both ICU and CRRT practice. The responsibilities of nurses who manage CRRT include more than turning off an alarm (Randell, 2004). Thus, the combination of technical skills, knowledge and environmental information is important to direct perceptions and to anticipate future events in making safe decisions in real practice (Dominguez, 1994; Stubbings et al., 2012). In turn, all of these factors will contribute to the shaping of nurses' decisions and actions.

5.6 *Chapter Summary*

This chapter deliberated on the deductive content analysis findings in relation to the existing literature on intensive care nurses' clinical decision-making, AKI care and CRRT practice. This chapter adds understanding to the process of nurses' clinical decision-making and management of advanced technology. The concepts drawn from the O'Neill et al. model formed the analytical framework which informed the development of categories that demonstrated the variations in how intensive care nurses make clinical decisions in CRRT practice. Key analytical points that shaped the process of nurse decision-making in CRRT and ICU practices were three different levels of decision-makers: *independent decision-making, gaining independence as a decision-maker, and dependent decision-making*. Participants demonstrated differing levels of skills in recognition and response, use of clinical patterns, knowing the patient, and control over the environment with or without assistance or

with very minimal support. It appears that the development of different levels of decision-makers created significant difficulties in nursing workflow and decision-making in CRRT practices. These difficulties may jeopardise the patient safety and nursing practice with advanced technologies in the ICU setting. In addition, the contextual factors exacerbated the complexity of CRRT management and nursing decision-making.

The O'Neill et al. clinical decision-making model however cannot be applied in the ICU context without considering contextual factors such as workforce characteristics, management practices, individual factors, socialisation and organisational influences in relation to the nurse's clinical decision-making process. As others have pointed out, a variety of individual, social and organisational factors can enhance or inhibit the effectiveness of nursing decisions (Hagbaghery et al., 2004). These factors seemed to be associated with nurses struggle in the process of decision-making and management of advanced technology. The model for example cannot show the decision-makers' rationales to show in depth the differences among experienced nurses and the contextual influences. This however adds new insights into nursing literature on clinical decision-making and CRRT practice in the ICU setting. This point in addition to the unexplored other influences (e.g. individual, social, technological and organisational) to explain why, in the research setting, variations existed among experienced intensive care nurses in relation to making clinical decisions in CRRT practice. In other words, there is a dearth of knowledge on how managing CRRT technology effect or impact on nursing decision-making and nursing workflow. The following chapter turns to an exploration the ways in which contextual factors have affected the process of nurse decision-making with advanced technologies in the ICU context.

Chapter Six: Complexity of performance
Conceptual Analysis

6 Introduction

This chapter seeks to explain the complexity of performance in the context of intensive care nurse decision-making and practice around CRRT technology. Technology is a part of nursing practice and can be understood as a combination of knowledge, skills and techniques (Bull & FitzGerald, 2006; Sandelowski, 1999). When nurses face multiple uncertainties during the care for a critically ill patient, nursing care with technology become less predictable and more complex (Laerkner, Egerod, & Hansen, 2015). This may be reflected in a nurse's performance with technology and patient care. The process of intensive care nurse clinical decision-making appeared, in this research, complex at a number of levels. An understanding of the decision-making process was critical in determining how and why the intensive care nurse participants made particular decisions and engaged different management techniques to troubleshoot CRRT and clinical deterioration.

In addressing the dimensions of decision-making, this chapter presents an exploration of the three concepts generated in the second phase of data analysis. The chapter explores first, the complexities that surround *negotiating CRRT practices* in the context of the practice setting. The second concept, *normalising CRRT practices*, depicts an interpretation of nurses' perceptions/understandings and acceptance of different practices. Underpinning the decision-making process was the *centrality of technology*, whereby nurses focused on the machine as a priority over patient-centered care. An exploration of these concepts contributes to a broader understanding of the complexity of performance in CRRT nursing practice.

6.1 Negotiating CRRT practices

The concept of negotiating CRRT practices was an important dimension of nurses' clinical decision-making and actions taken in response to deterioration and CRRT troubleshooting. The negotiating process demonstrates how the interactions of nurses shaped responses to clinical problems and clinical decision-making.

The nurse participants worked hard to make clinical decisions and to work within their perceived scope of practice. Scope of practice is "the full range of roles, responsibilities and functions that nurses are educated, competent and authorized to perform." (White et al., 2008, p. 45). While there was no national and legislated nursing scope of practice in Saudi Arabia, at the time of the research, protocols did exist in the research context. Nonetheless, in this research, a tension existed where nurses were expected to be autonomous decision-makers but were constrained by a strongly hierarchical healthcare structure. There was a significant difference in the authority of doctors and nurses in decision-making. Doctors appeared to control all aspects of ICU work and a perceived tension between nurses and doctors may have undermined interaction in relation to decision-making. Where nurses experience difficulty in articulating problems identified around patient care, they may contribute less to decision-making (Hamric & Blackhall, 2007).

Hence, the authority of nurses in the decision-making process of CRRT practice was not only poorly defined but marginalised within inter-professional interactions. The subordination of nursing in the research setting had significant social and cultural origins as has been addressed in different nursing studies and contexts (Ganz, Engelberg, Torres, & Curtis, 2016; Stein-Parbury & Liaschenko, 2007; Tang, Chan, Zhou, & Liaw, 2013). Effective collaboration between nurses and doctors can be undermined because of traditional barriers between the two professions including hierarchical organisational structures, gender

and class differences, and the belief of doctors that they have the final authority over clinical decisions (Stein-Parbury & Liaschenko, 2007).

There are other implications of the void that exists between doctors and nurses. The study by Stein-Parbury and Liaschenko (2007) concluded that a breakdown of collaboration between doctors and nurses occurred where nursing knowledge of a patient was not valued because it was unknown by doctors. Nursing knowledge of the patient, therefore, could be dismissed because it did not fit into the schema of case knowledge or the expectation of doctors that they are the final arbiters of clinical decisions (Stein-Parbury & Liaschenko, 2007). A more recent study concluded that while there was some sharing of information between intensive care nurses and doctors, decisions were rarely made cooperatively (Ganz et al., 2016). Ganz et al. (2016) argued that most ICU clinical decision making continues to occur independently with some sharing of information due to system factors, such as unit culture and interdisciplinary rounds (Ganz et al., 2016). However, these authors did not address the level of autonomy of nurse and nor their input in the decision-making process. Indeed, nurses struggle to be independent decision-makers because of workplace cultures and associated issues of hierarchy and power.

Within the research context, while nursing practice around CRRT appeared to be shaped by individual experience and level of understanding, the practices of nurses were significantly mediated by context. Participants learned how to manage CRRT from their clinical experience in the hospital ICU and were thus dependent upon team leaders to assign nurses to CRRT cases. As has been argued above, it is also difficult to understand the complexity of decision-making process within a technological and medical dominated environment. Opportunities to develop knowledge and skills are required to create a nursing culture where nurses constantly challenge their own practice through decision-making skills. Ongoing negotiation in nursing practice is important because it allows nurses to define and

redefine nurse-patient relationships and thus to improve patient safety (Schluter, Seaton, & Chaboyer, 2011). Thus, of importance are the conditions that explain the ways in which CRRT practices and nurse decision-making were negotiated and how they were shaped by a hierarchical health professional structure, and cumulative nursing knowledge and experience.

A hierarchy in healthcare

A hierarchical workplace was a relevant factor in this research. Intensive care units require nurses to interact and to work with others (e.g. team leaders, doctors or senior nurses) when making decisions. The nurse participants often made decisions within a group, or as a team, and/or relied on others. All can be effective in decision-making and nursing practice if the ICU, in any geographical location, has an environment in which nurses openly communicate and work with others without fear of reprisal, inferiority or embarrassment (Reader, Flin, Mearns, & Cuthbertson, 2007). Indeed, while communication and teamwork skills appear important elements for safety and performance in high-risk settings, poor communication and teamwork are found to often contribute to nursing errors in the ICU (Bion, Abrusci, & Hibbert, 2010; Reader et al., 2006; Reader et al., 2009; Rowan, Brady, Vella, Boyden, & Sexton, 2004). There is evidence of a decrease in adverse event rates in ICUs where nurses work in teams and communicate well with other professionals (Jain, Miller, Belt, King, & Berwick, 2006). As such, team decision-making is influenced by the effectiveness of communication and also by leadership (Reader et al., 2009). The nature of nurse-doctor interactions and decision-making in the research is reflected in the following excerpts:

> *In managing this patient, the ventilator settings were within high parameters...So there was no extra breathing and for that reason the patient was quiet until 4 p.m. I therefore managed the CRRT well. Once the patient was awake and started coughing there were some difficulties with CRRT alarms. The doctors had*

already discontinued the sedation therapy [in order to] to do a brain CT scan. I informed the doctors and they told me to give a fentanyl intravenous dose immediately. The blood pressure was also improving and I am trying to reduce norepinephrine infusion dose. So with the CRRT, I can manage with vasoactive and sedation therapies (Participant 11, interview)

In relation to the CRRT, when we start the dialysis this patient's blood pressure usually drops so it is very low. It was challenging for me to maintain the blood pressure and we gave a lot of fluid and high levels of inotropes…the patient's condition was not good… We could not continue CRRT because of the patient's low blood pressure. We could not, that is why first I consulted the doctor, and then I discontinued CRRT, because without an order from the doctor, I can't do anything. My observation was that the patient's blood pressure was very low and so I informed the doctor and followed his instructions. I discontinued the CRRT.(Participant 10, interview)

The above data suggest that participants delayed action while awaiting doctor authorisation. The nurses normally turned to doctors or team leaders to make decisions and act despite the fact that participants had the authority to give sedation and to discontinue CRRT in accordance with accepted practice. The nurses assumed a position subordinate to doctors and their actions were congruent with the belief that responsibility for decision-making was situated with others. Delayed decision-making, however, risked jeopardising patient safety. Thus, participant roles and responsibilities were defined by interrelationships between power, authority, and the hierarchy of health care workers. The participant comment below is pertinent to the above points:

The doctors are very good at their job and they are better than us. They have much, much more sophisticated clinical and medical knowledge. So, this is why I insist that he does it. But he refused and unfortunately I have to approach another willing doctor. (Participant 5, interview)

Where the contextual factor of collaboration was lacking, as manifested in this research, nurse decision-making around CRRT was overtly less effective. It is widely argued that managing critically ill patients who are connected to advanced technologies such as CRRT or mechanical ventilation is an enhanced nursing role and should be carried out in collaboration with a multidisciplinary team (Alastalo, Salminen, Lakanmaa, & Leino-Kilpi, 2017; Gelsthorpe & Crocker, 2004; Karra, Papathanassoglou, Lemonidou, Sourtzi, & Giannakopoulou, 2014; Rose, Nelson, Johnston, & Presneill, 2007; Villa, Manara, & Palese, 2012). As Coombs and Ersser (2004) have argued, an inconsistency exists where the nursing role is at once marginal and yet vital to medicine in the delivery of health care. Domination by medical knowledge and practice in health care decision-making relies on power and authority (Coombs & Ersser, 2004).

Nurses have limited authority and are dependent on the hospital medical director (i.e. a male-dominated, bureaucratic, and hierarchical system) for financial allocation, autonomy and a level of professional development in the Saudi Arabian health care system (Alshammari, 2014; Tumulty, 2001). As a result, in the research context, the nursing role appeared as both relatively unimportant from a medical perspective and yet essential to patient care. Thus, the nurse participants were required to manage the tensions inherent to their institutional role. There is an expectation that nurses in institutional settings, such as ICUs, will adhere to existing rules whether those rules are set down in writing or are assumed (Baggs et al., 2007). Such rules might undermine the legitimacy of the nursing role.

A study undertaken in Saudi Arabia by Aldossary (2013), found that the domains of physical care, care management, and professional issues shaped the major focus of the nurse role, with no evidence of role legitimacy around the psychosocial and communication dimensions of patient care. The term “diagnosis” was also considered to sit outside the role of

the nurse (Aldossary, 2013). A concern of Aldossary (2013) was that a lack of role legitimacy would affect the future of the nursing profession in Saudi Arabia, as nurses are not decision makers. This is so even though nursing practice with advanced technologies requires nurses to legitimately make clinical decisions (Aitken et al., 2009; Aldossary, 2013; Thompson et al., 2004; Thompson & Dowding, 2009). Such skills in nursing practice also assume a degree of autonomy in judgement and in intervention.

Participants also perceived nursing team leaders as superior in knowledge and hence to be deferred to in relation to CRRT cases. Yet, in Saudi Arabia, younger nurses with bachelor degrees hold managerial positions, with more experienced and less formally educated older nurses assuming subordinate positions (Zakari, Al Khamis, & Hamadi, 2010). As noted above, there is no defined national nursing scope of practice and nor a career trajectory for nurses in Saudi Arabia, which may explain the relationship between years of experience and perceived professionalism (Zakari et al., 2010). The level of perception of nursing professionalism in Saudi Arabia has been judged to be low due to number of factors related to the workplace itself and the personal background of the nurses (Zakari et al., 2010). A multinational nursing workforce with diverse perceptions of nursing positions, authority and power may reinforce the hierarchy of power in healthcare and discourage nurses from confidently making decisions and speaking up. Knowledge, service and autonomy are important keys to nursing professionalism (Spooner-Lane & Patton, 2007; Zakari et al., 2010). Professional autonomy, for instance, is crucial to nurse authority over and accountability in decision-making processes and care activities (Manojlovich & Ketefian, 2002; Zakari et al., 2010). Such autonomy was constrained, in the present research, by hierarchical structures in the Saudi Arabian health care system where decision-making setting appeared to be the domain of higher positions (doctors and/or team leaders or managers). Nurse participants looked to the team leader for assistance with decision-making to troubleshoot CRRT rather

than make direct decisions to solve problems. Team leaders had authority in delegating work, which may have constrained nurses from working through issues independently as reflected in the following excerpts below:

> *I need my team leader's support when troubleshooting because I don't work a lot with CRRT cases. Team leaders allocate CRRT cases equally to everyone. We, therefore, have to spread the experience across all staff so I can't just simply ask to work with this CRRT case. I have to consider my colleagues. They also want to learn. (Participant 9B, interview)*

> *I ask the team leader to help with some machine problems… Sometimes, we can't stop the alarm because of issues and we don't know how to stop these alarms.(Participant 6, interview)*

Nurses continually deferred to team leaders. This situation was exacerbated because the nurses did not have ongoing experience with those patients having CRRT. Yet, team leaders in this research, although with many years of clinical experience, were also lacking in expertise in managing CRRT. A team leader was observed, for example, directing a nurse to continue CRRT even though the filter was clotted which might have posed a risk when the patient's blood was returned, as can be seen in the observational note below:

> At 2:35 PM the CRRT alarm is on and the message on the screen shows "low access pressure".
> Participant 9A checked the filter and did a saline flush. The CRRT alarm was on and off showing "lower access pressure".
> Participant 9 A said: "I will ask the team leader because I don't have much experience with re-priming CRRT."
> At 3:00 PM the team leader came and checked the filter and the lumen chamber.
> She said: "Continue the treatment until it stops."
> However, Participant 9 responded: "The alarm is going off every 10 seconds and so maybe we should stop the treatment and return the blood."

> The team leader replied: “The blood circuit is still going, so leave it until the filter automatically stops or continues alarming, and return the patient’s blood and inform the doctors in their evening round if they want to continue with a new CRRT circuit.” (Participant 9A, Field note, 25 September, 2013)

Team leaders were, also a product of the broader system. Thompson, et al. (2008) argued that increasing years of nurses’ clinical experience does not associate with better quality in clinical judgment because variations in decisions exist and remain an issue. Nurses struggle to interpret and separate a signal of the need for action from clinical noise, recognise the strength of those signals and know the important cues as assessment information (Thompson et al., 2008). For example, when intensive care nurses work under time pressure, nurses’ performances vary and hence their decision-making (Thompson et al., 2008).

In addressing decision-making variability, the study Currey and Botti (2006) argued that the issue was due to the link between the complexity of patients’ haemodynamic management, nurses’ levels of experience, and the level and type of decision support provided by nursing colleagues. The demands of critically ill patient care vary and the ICU environment is characterised by numerous interruptions and multitasking (Kalisch & Lee, 2010). If the sources of variation are not addressed, the variability contributed to nurses' judgment and decisions will also increase (Thompson, Aitken, Doran, & Dowding, 2013).

It has been demonstrated elsewhere that teamwork, leadership, role clarity and continuing education are facilitators of effective nursing practice (Oelke et al., 2008). Conversely, poor communication, ineffective teamwork, high patient acuity, and lack of time are all barriers in working to full scope of practice (Oelke et al., 2008). Furthermore, where role ambiguity exists, so does the likelihood of tension in the workplace between healthcare professionals (White et al., 2008). While the nature of nurse-doctor relationships has improved in recent decades and arguably more so in western countries, progress is still to be

made in developing effective collaboration around decision-making (Morinaga, Ohtsubo, Yamauchi, & Shimada, 2008). Nurses, for example, have been found to consistently feel undervalued in decision-making and are very often reminded of the power differentials in nurse-doctor relationships even though experienced doctors depend upon the knowledge of nurses (Manias et al., 2005; Manias & Street, 2001).

A dependence on teamwork among the nurse participants was also a concern. A higher density of interventions, invasive procedures, and management decisions is needed for critically ill patients than for other patients (Orgeas et al., 2008). Where there are workload issues, nursing shortages and other environmental interruptions, it may be difficult to engage others in order to make decisions. The participant statement below reflects a hectic ICU setting and the difficulties in securing help or support from other nurses:

> *No, I did not do the nursing [evening] care alone. My colleague came and helped me but then she went to check her patient because the patient had removed the ventilated tube (self-extubated). The team leader said a new post-surgery patient admission was coming and if there is anyone free, I would come and help you. I can't care for this patient alone. He is critical which means if anything happens I can't call anyone to help me and I cannot leave the patient alone (Participant 29, interview)*

Issues related to the complexity and workload of ICU settings have been well researched (Manojlovich, 2007; Rothschild et al., 2005). A study conducted by Bucknall (2000), for example, found that intensive care nurses make a clinical judgment or decision every 30 seconds. Given the intensity of ICU nursing work, studies have examined the relationship between workload and teamwork in order to reduce the complexity of ICU practice. Thomas, et al. (2003) argued that effective teamwork can overcome staff shortages to manage errors. Furthermore, intensive care nurses have difficulty discussing errors (Sexton,

Thomas, & Helmreich, 2000). The comment from one participant is pertinent to the issues of workload, tensions and teamwork:

> *We normally face so many problems with doctors because they are very busy, and we do understand. But at least they should follow the protocol, for example, that the first wound dressing should be changed by the surgical team and then teach us. This is why I was insisting that the doctor should do it but she said she is very busy and she needs to leave. We are also busy and this is not our responsibility.(Participant 5, interview)*

Thus, differences in responsibilities, status/authority, autonomy, and the cultures of nurses and doctors can create conflict (Georgiou, Papathanassoglou, & Pavlakis, 2017; Tang et al., 2013; Weller, Barrow, & Gasquoine, 2011). Tang et al. (2013) suggested that inter-professional education was crucial to empower nurses in making clinical decisions and develop policies to resolve workplace issues. In Saudi Arabia hospitals, lack of professional status as perceived by nurses, the work environment, communication, and the level of cooperation.

Developing knowledge on the job

As noted, the nurse participants developed their knowledge of CRRT largely in the workplace. It is therefore crucial to understand how these nurses developed their clinical knowledge through exploring the work conditions and its influences on the process of learning in technological practices. An ideal work place is an environment where learning is encouraged and supported by everyone and each learner is considered an individual (Huggins, 2004). The approach of work-based learning brings together nurses' self-knowledge, expertise at work and formal knowledge (Flanagan, Baldwin, & Clarke, 2000; Williams, 2010). Informal learning can also ensure a flexibility that facilities learning in a variety of spaces within a workplace (Eraut, 2004). Nonetheless, workplace learning occurs

concomitant with the extent to which the workplace affords learning and individual participation in the learning opportunities (Illeris, 2003, 2018). Informal learning is importantly also interactive and a social process part of which is a one to one local transfer of knowledge (Koopmans, Doornbos, & Eekelen, 2006).

Evidence has demonstrated that an emphasis on workplace learning can have a positive and/or negative influence on nurses' knowledge and skills (Huggins, 2004; Price, 2013; Spalding, Ferguson, Garrigan, & Stewart, 1999; Torunn Bjørk, Tøien, & Lene Sørensen, 2013). A study conducted by Spalding, et al. (1999) produced positive outcomes related to individual developments such as confidence building and social cohesion. Indeed, contextual factors have been found to shape the learning of the nurses in the workplace (Davis, White, & Stephenson, 2016; Sibarani, Tjakraatmadja, Putro, & Munir, 2015; Torunn Bjørk et al., 2013). Such, factors include the benefits and limitations of informal learning, levels of authority, workload, leadership, management support, and availability of CRRT cases or continuity of care in CRRT practice. Davis, White and Stephenson (2016) argued that to demonstrate the value in nurses' learning and education, a dual system is required to enable nurses to demonstrate accountability for their own learning with clear organisational and educational systems. Understanding the processes that underlie the decision-making of intensive care nursing in CRRT practice thus seems crucial to understand how nurses develop their knowledge and skills. The following statement reveals one nurse's experience of learning in practice:

> *I learnt to manage the CRRT filter and circuit from my previous experience because I was working in another private hospital here in Saudi Arabia in Jeddah. I learnt to manage and save the filter because it is very expensive to change…We just do the saline flushing. We aspirate the blood clots and, open all the circuit and the filter. You, cannot learn this technique from a book but must do so from experience. We need to do this just to save the circuit…the system will not work anymore so what we are doing, we are aspirating through*

> *the needle to remove the clots…. For vascular access also sometimes the access is not good so there is blocking. We sometimes interchange the venous and arterial lines but I know this one is not good but again just to save the life. Once, the machine is okay and working, we will again restore the lines in the proper way. (Participant 14A, interview)*

From the above, it is clear that contextual influences constructed practice. The result was that the nurses had differing levels of knowledge, experience, and decision-making skills in CRRT practice. As Torunn Bjork, et al. (2015) argued, leadership styles and social relations in a ward create variations in nurses' informal learning processes.

It follows that there may be negative outcomes in relation to informal learning processes in workplaces (Ashton, 2004; Dale & Bell, 1999; Fuller & Unwin, 2003). The research conducted by Price (2013) confirmed that nursing staff may see intensive care units as a place of learning; however, personal and contextual issues might affect nurses' motivation or support such as patients and families demands, workload, organisational and team additional demands to avert prioritising nurses' learning process. Dale and Bell (1999) also argued that learners may be proficient in some aspects only of a task, or develop superficial skills that are not transferable. An expectation that learning will be informal may also lead to fewer opportunities for formal education (Fuller & Unwin, 2003).

Other workplace influences on informal learning are also gender, hierarchy of power and authority. In this research, the nurse participants were all female and with limited authority and power to request or participate in workplace learning opportunities. It has been noted that men and individuals in higher positions receive more opportunities for learning than other less empowered staff and particularly female (Colley, Hodkinson, & Malcolm, 2002; Manuti, Pastore, Scardigno, Giancaspro, & Morciano, 2015). Torunn, et al. (2013), for instance, suggested that leadership is imperative in promoting informal learning through building a culture that facilitates and supports learning for all nurses on the ward.

In the research context, participants had limited authority to request management support in relation to ongoing education and training. In the Saudi Arabian setting, the major challenge to the advancement of nursing practice is considered to be the lack of experience among recently qualified expatriate nurses (Alamri, Rasheed, & Alfawzan, 2006). Nurses who are required to teach and supervise novices in clinical units, while still performing their usual tasks, might have limited authority, support, experience and can create an additional workload (Almalki et al., 2011). Almalki, et al. (2011) argued that inexperienced nurses need structured training programs around new technologies because learning on the job for newcomers and/or junior nurses could be risky and particularly with advanced technologies such as CRRT or mechanical ventilation. Senior nurses may also not have enough time to teach effectively (Currey & Botti, 2006). Nurse participants were underprepared to work with complex CRRT technology. Studies have reported that nurses complain about the lack of coordination related to every part of CRRT management, including knowledge of the basics, troubleshooting simulation, and manual training in the management of machines operating at the bedside (Baldwin & Fealy, 2009b; Ricci et al., 2015). As discussed earlier, participants were largely expatriates from different developing countries where specialist renal nurses routinely managed CRRT in the ICU as the following participant points out:

> *I do not have that much experience in CRRT, or professional training, because I have only worked with CRRT since coming to Saudi Arabia (Participant 25, interview)*

Intensive care management was not visibly concerned about nurses' knowledge and experience development around CRRT. It was taken for granted that the daily practice of intensive care nurses involved responsibility for complex interventions and yet participants had no authority to request professional training or education in the Saudi context.

The argument of Hunter et al. (2008) is appropriate in asserting that where new staff receive orientation to a ward, it is orientation into a community of practice. Thus, "orientation of new staff is a multilayered and complex process that requires all staff involved to accommodate varying skill levels, learning styles and personality traits in an ever-changing clinical environment." (Hunter, Spence, McKenna, & Iedema, 2008, p. 663). For example, in intensive care areas, time allocated, even in a busy workday, for learning and reflection is crucial (Hunter et al., 2008). One nurse expressed her struggle to learn and manage CRRT as follow:

> *Actually, working with CRRT means heavy workloads for us and I already have back pain and yes, I always need help. Sometimes we all are busy and we have shortages so we cannot ask for help. We do all the work alone. (Participant 22, interview).*

There was some frustration expressed by participants who perceived management of patients undergoing CRRT a burden in terms of workload. Working conditions can give rise to errors and resultant emotional and professional distress because of limited management support. It is a given that hospitals are responsible for training for nurses to work in a technological environment and improving skills (Bagherian, Sabzevari, Mirzaei, & Ravari, 2017). Yet where newly employed nurses are trained while working shifts and under the supervision of more experienced nurses, this usually reflects a lack of standard courses of training (Bagherian et al., 2017).

The nurse participants may have learned how to operate the CRRT technology through observing others but failed to understand its functions and potential problems. In this research, it was considered important that learning extended to the how and why of the CRRT processes. Studies on individual learning in the work place have concluded that engaging with the work, interacting with others, solving issues, and reflecting on and evaluating work

experiences is valuable in conjunction with formal education (Billett, Smith, & Barker, 2005; Collin & Valleala, 2005; Eraut, 2004; Tynjälä, 2008). The nurse participants, however, confronted a number of issues that undermined their learning and they struggled in decision-making and problem solving due to the complexity of CRRT, the context and working under pressure.

As a result of the lack of a learning environment, the nurse participants lacked confidence that their practice was appropriate and could be recognised as an example for other nurses. Most obviously, there limited opportunities to enhance experience in caring critically ill patients with CRRT as reflected in the participant language below:

> *I work with CRRT occasionally depending on our shift assignments and learnt from senior nurses (Participant 7, interview)*

Nursing are needs to be experienced as connected and coherent for continuity to exist (Haggerty et al., 2003; Van Servellen, Fongwa, & Mockus D'Errico, 2006). The nurse participants did not have cumulative clinical experience needed for the development of skills to care for the patient who received CRRT.

There has been much debate over the continuity of patient care and implications for quality care outcomes (Sparbel & Anderson, 2000; Van Servellen et al., 2006; Waibel, Henao, Aller, Vargas, & Vázquez, 2012). An integrated nursing review of research close to two decades ago concluded that continuity of patient care was a multifactorial concept affected by communication, patient, professional, environmental influences and system factors (Sparbel & Anderson, 2000). It appears that there is a gap in our understanding of continuity of nursing care and decision-making in relation to advanced technologies. Nurses, within context, attempt to make sense of challenging situations, identify problems, and follow nursing activities to problem-solve (Bobay, 2004). However, due to the complexity of

managing CRRT and limited nursing experience with the technology, nursing care around CRRT was not coherent in this research.

6.2 Normalising CRRT practices

The concept of normalising CRRT practices depicts an interpretation of nurse behaviours and associated social and cognitive processes. Within clinical nursing environments, practices do become normalised. Normalisation occurs as the result of routine or repetitive behaviour which nurses come to assume is normal and acceptable practice. It is a long-standing concern of the social sciences to understand the normalisation processes by which practices become routinely embedded in daily life (May & Finch, 2009). Nonetheless, the normalisation of deviance concept was coined by the sociologist Diane Vaughan in the 1990s as a result of her research on the events that led up to the explosion of the Challenger space Shuttle. Vaughen's research described a situation where individuals within an organisation become unresponsive to deviant practice (Vaughan, 1997, 2005). Robinson and Bennett (1995, p.556) considered most deviance negative, defining it as "voluntary behaviour that violates significant organisational norms and in so doing threatens the well-being of the organisation, its members, or both," and developing a typology of deviant workplace behaviours (Robinson & Bennett, 1995). Studies have examined this concept in different contexts including health care (Banja, 2010; McNamara, 2011; Odom-Forren, 2011; Prielipp, Magro, Morell, & Brull, 2010). However, there is limited knowledge of normalisation practices within ICUs.

In this research, the nurse participants routinely engaged in CRRT practices that did not reflect nursing guidelines. A range of strategies, interventions and actions were used every day to manage CRRT with critically ill patients with AKI. Continuous renal replacement therapy practices were normalised, not because nurses had normalised practice

but because they accepted practices as normalised. This finding points to questions on how and why different practices become normalised in the ICU context.

Health care professionals generally do not perform practices with harm or malicious intent. On the contrary, as Banja (2010) points out, practice is justified on the basis of wanting to relieve patient pain or suffering. Yet health professionals, including nurses, engage in practices as routine but that occasionally breach rules or standards.

Newly employed nurses may be encouraged to adapt to prevailing practice even where this diverges from what has been learned. Where divergent practices or behaviours are common they can become normalised around CRRT practice. An example in this research was problem solving filter problems in the ICU in such a way that was potentially unsafe for the patient. An example, where a nurse pressed the air detector alarm to override the alarm and where air or micro clots could have been moved into the patient's blood circulation system is described by one participant;

> *Actually, the team leader pressed the air bubble button that was alarming. She pressed it for a minute and then she tried to reduce the blood flow to see the clot which was further down. We just tried to reduce the blood flow to check whether the clot was going smoothly or obstructing the lumen in the circuit. Anyway, it was obstructed very much and has been running now for maybe an hour. (Participant 4, interview)*

It has been argued that nurses might not have difficulty in changing their practices because practice routines may be entrenched and difficult to change (Banja, 2010; Odom-Forren, 2011; Treweek, 2005). Indeed, it is important for health service managers and policy-makers to understand how new clinical techniques, technologies and other complex interventions become normalised in practice (May, 2006). How these complex interventions can become embedded as routine elements of clinical and organisational work in health care

(May, 2006), and thus normalised can be explained by focusing on the conditions of technology use and the behaviours of everyday nurses.

McNamara (2011) argued that nurses have to constantly evaluate their own practices and appraise areas where nurses may have allowed normalisation to occur (McNamara, 2011). Yet, culture plays a significant role in how a process is institutionalised and thus underpins normalisation practices. The normalisation of deviance or variations in practices are thus constructed by institutionalisation, socialisation, and rationalisation (Banja, 2010).

Institutionalisation

Nurse participant decision-making demonstrated normalised practices in relation to different management techniques and interventions in CRRT practice. Participants responded and acted according to what was clinically acceptable in the ICU setting by ICU doctors, managers and team leaders. Nurses were required to respond to complex clinical situations, including CRRT, where critical thinking was involved. However, the hospital itself was complicit in defining intensive care nurse practices.

Health organisations expose new nurses to deviant and/or normalised behaviours through use of authority to impose behaviours as organisationally normative (Banja, 2010). The nurse participants appeared to use common strategies or techniques that were approved in this ICU to manage CRRT and critically ill patients with AKI. Some techniques were associated with the risk of infection or development of thrombus in the patient blood circulation. One participant explained the process of managing CRRT circuit with the advice of the team leader:

> *Initially it was showing low access pressure so we [the team leader and I] tried to increase the blood flow. Low access pressure means if you increase the blood flow, it may compensate. We hoped so but even though the blood flow was around 350 ml/hour it was still showing some problem…the team leader did the*

saline flushing but the system was alarming and clotted. We then stopped the machine. (Participant 5, interview)

The above is an example of nurses conforming to a higher authority which shaped the nurse's practice and problem-solving. The Saudi Arabian health care system's heavy reliance on expatriates and thus has a transient workforce, may have undermined attempts to improve the legitimacy of different practices. A study undertaken in Saudi Arabia by Aboshaiqah and Baker (2013) argued that nursing staff were not able to freely discuss safety issues or raise concerns related to mistakes or errors (Aboshaiqah & Baker, 2013). Where participants did not communicate well with doctors or senior nurses about management of CRRT, this may have led to unsafe behaviours or normalised practice, including a failure to report events or other potential problems that might affect patient health outcomes. Price and Williams (2015) also argued that individuals cannot do anything to influence the system that has the power to push individuals to deviate in their practices.

There was little discussion in the research context about the choice of strategies or techniques used to solve problems with CRRT and why accepted techniques became everyday or routine practices. For example, pointing out correct practice and encouraging discussion between staff to address any misunderstanding was not observed. Participants did not have the authority, knowledge or clinical experience to argue with staff about clinical decisions, normalised practices or deviant actions. One observation reflected this point:

> At 3:00 PM the team leader came and checked the filter and the lumen tube.
> The team leader said: "continue the treatment until it stops."
> But Participant 9a said: "it keeps alarming every 10 seconds and maybe we should stop the treatment and return the blood."
> The team leader said: "No, the system circuit is still going and so leave it until it stops or the alarm continues a and then ask tell the doctors on their evening round if they want to continue."
> Participant 9A said: "OK". (Participant 9A, Field note, 25 September, 2013)

The decision of the team leader prevailed even though it was not convincing. The authority of the nurse leader controlled the process of decision-making and encouraged the acceptance of a questionable practice in this hospital ICU.

Socialisation

It is important to understand the social mechanisms and decision-making processes with the implementation of technology in nursing practices. Przybyl et al. (2015) suggested that the social systems are important in understanding changes in nurse work behaviour that includes the norms and customs of nurses performing CRRT. The phenomenon of socialisation determines if new nurses will or will not join other nurses in adopting normalised practices (Banja, 2010). Individuals may normalise practices that do not accord with optimal nursing practice in order to cope with others and the system (Price & Williams, 2015).

As noted above, observational episodes in this research captured examples of variations in the clinical decision-making of nurses and in techniques and interventions in troubleshooting CRRT. For instance, the nurse participants were observed physically disconnecting the patients from CRRT to prevent technical problems (e.g. kinked lines or clotting) and to provide nursing care such as changing the patient's position. Observed was a patient being disconnected from the circuit for periods of 30 minutes or longer although the patient was still in the ICU. It appeared that disconnection was routine practice and had become normal practice in this ICU. One observation of a participant was as follows:

> At 3:00 pm Participant 5 started to flush the circulation with normal saline while it was connected to the patient and with the help of another nurse. She then discontinued the CRRT while she was doing the evening cares.
> I asked her: "why did you do that?"
> She said: "to prevent an incidence of clotting while turning the patient when we do evening care."

> 3:30pm after she finished her evening care she reconnected the CRRT and continued the treatment." (Participant 5, Field note, 11 September, 2013)

In the observation above, there was no apparent reason for disconnecting the patient from the CRRT other than to reposition the patient. Participants seemed using the disconnection technique frequently during nursing care.

There is no evidence in the literature on nursing management of CRRT and (Kidney Disease: Improving Global Guidelines (KDIGO) Acute Kidney Injury Work Group, 2012) that supports disconnecting a patient from CRRT during nursing care or patient positioning. The only reasons for CRRT disconnection are to return the extracorporeal circuit blood as a part of an end treatment, for recirculation, or for sending a patient for a medical/radiology procedure outside the ICU (Baldwin & Fealy, 2009a, 2009b). Baldwin and Fealy (2009b) suggested that when nurses transfer a patient from the chair to a bed (using a 'slide board' or similar device), they need to stop fluid exchange and to slow the blood pump speed to 100 ml/min in order to prevent high circuit pressures and alarm events from stopping the blood pump during the transfer procedure. The recommendation is that nurses use techniques to avoid kinking of the access catheter during patient positioning or transferring without disconnecting the patient from the CRRT circuit (Baldwin & Fealy, 2009a, 2009b).

It has been noted that infections in the ICU represent a major threat for haemodialysis catheters (Canaud, Desmeules, Klouche, Leray-Moragués, & Béraud, 2004; Rewa et al., 2015; Vinsonneau et al., 2015). Thus, it is strongly recommended that catheter management and care should comply with best practice guidelines and should be part of a continuous quality improvement programme in order to reduce catheter-related morbidity (Canaud et al., 2004; Rewa et al., 2015; Vinsonneau et al., 2015). Disconnecting the patient regularly from the circuit for unnecessary situations, it might highly increase the risk of infection and develop further catheter-related issues in critically ill patients.

Where nurses repeatedly move away from an acceptable standard of practice, that move becomes the new norm or standard. Being adequately treated for inadequate renal function is important for patient outcomes; however, intensive care nurses need to apply underpinning knowledge (physiology, pathophysiology, and CRRT) in the care for a patient and to simultaneously manage the technology. The literature demonstrates internal influences on standard care and internal factors such as individual attitudes, perceptions, and knowledge (Abrahamson, Fox, & Doebbeling, 2012; Ebben et al., 2013; Jun, Kovner, & Stimpfel, 2016; McCluskey, Vratsistas-Curto, & Schurr, 2013). There are also external factors including arrangement and usability of clinical practice guidelines, leadership, resources and organisational culture that influence the use of clinical guidelines (Abrahamson et al., 2012; Ebben et al., 2013; Jun et al., 2016; McCluskey et al., 2013).

Nursing activities with CRRT appeared as normal routine, if at times complex, among participants. Newcomers may be convinced by others in an organisation that deviant normalised practices are not only legitimate but necessary (Banja, 2010). The nurse participants posed different rationalisations for the ways in which decisions were made and CRRT was managed. The nurse participants for instance assumed that some CRRT alarms were false alarms and did not take action. This is referred to as 'normalcy bias' which is one of many human factors contributing to deviance normalisation and breakdown of safe practices (Prielipp et al., 2010). The following statement from one participant illustrates this point:

> At 3:00PM the CRRT alarm was on. Participant 18 went to check. I asked her "what is happening?"
> She said: "Nothing happened, I just pressed the fluid balance system on, it was off." Again, at 3:15 PM the CRRT alarm sounded.
> Participant18 checked the screen and it read: "Low access pressure and balance system" but the alarm was turned off, and she did not do anything.

> She said: “maybe it is because of the vascular access or because the blood pressure is not high or because of the patient positioning.” (Participant 18, Field note, 10 December, 2013)

This nurse participant did not undertake a patient assessment to determine the cause of the intermittent alarms. This example indicates that, over the years, nurses may have developed used deviant normalised practices or heuristics (i.e. short-cuts mental strategies) to simplify information and to provide faster and easier health care. The nurse used heuristic strategies to estimate the probability of identifying and solving the problems through a rapid assessment that gave rise to a quick or premature judgement. The participant either believed there was nothing wrong with the machine, or it was a false alarm, or she over trusted the machine and in all cases no action was indicated. Kahneman and Tversky (1973, 1974, 1982) argued that ‘subjective probability judgements’ (heuristics) are relied upon in uncertain decision-making situations (Kahneman & Tversky, 1973, 1982; Tversky & Kahneman, 1974). The nurse in the above situation describe cues that invited her attention in association with CRRT but did not completely assess and identify each possible cause of the problem and make appropriate decisions. Thus, there is some degree of indeterminacy or uncertainty of all causes and decision outcomes.

Heuristics can lead to errors because individuals do not give equal consideration to all given information due to its enormity and complexity (Cioffi, 1997; Cioffi, 2012; Cioffi, Conway, Everist, Scott, & Senior, 2010; Muoni, 2012). Cioffi, et al. (2010) noted that nursing assessment is underpinned by the objective of identifying ‘changes of concern’ that point to potential early clinical deterioration in patients which can provide more complete clinical information for best practice decisions. Where nurses engage in normalised practices, the consequences are not so clear simply because it is taken for granted practice.

In this research, the nurse participants had several years of experience working in the ICU although exposure to CRRT was not a frequent (or everyday) occurrence. Limited exposure on a regular basis may have led nurses to rely on the equipment and assume that as long as it was connected to the patient it would be safe.

6.3 Centrality of technology

The final concept underpinning nurses' decision-making in the intensive care situation was the *centrality of technology*. The growing complexities associated with technology in health care can be difficult for nurses to manage. One implication is that nurses may be preoccupied with the management of machines rather than assume a holistic approach to patient care. In the current research, intensive care technologies, such as CRRT, appeared at the centre of nurses' attention, and the technology significantly mediated patient care and decision-making.

As has been argued elsewhere, equipment, science, values and culture are interrelated elements that constitute technology in nursing practice (Barnard, 1999; Bennett, 2010; Bull & FitzGerald, 2006). Bennett (2010) reported that nursing management and environment were important factors to determine the quality of dialysis nursing care. There is an imperative, on the part of the nurses, to be seen as technologically proficient (Bull & FitzGerald, 2006). It has been argued that nurses are technical functionaries who implement and enforce its requirements through the authoritative performance of specialised clinical activities such as dialysis (Bevan, 2000). Yet, the authors also found that underpinning technological activities was an ethical commitment to caring for vulnerable patients (Bennett, 2010; Bull & FitzGerald, 2006). As such, technology and nursing care are not discrete concepts. There is consensus that technology and nursing are considered of high value in caring for a patient and

are integrated in practice (Almerud, Alapack, Fridlund, & Ekebergh, 2008b; Bevan, 1998; Tranter, Donoghue, & Baker, 2009).

Nurses work every day with different technologies and are required to interpret diagnostic and physiological factors in clinical decision-making where there is patient deterioration. Nurses, therefore, use technologies as nursing care to inform, direct, interpret, evaluate, and understand patient conditions (O'Keefe-McCarthy, 2009). In the research ICU hospital, however, a hierarchy of care was evident where CRRT technology assumed primacy. The physical link between patient and the machine was observed but the cognitive linkage to problem solving appeared limited.

Where technology is perceived and used as a physical entity it may have a disrupting effect on communication (Price, 2013; Wikström et al., 2007). It may also depersonalise care (Almerud et al., 2008b; Rinard, 1996) and inhibit nurse-patient interaction (Bennett, 2010; Jakimowicz & Perry, 2015; Tranter et al., 2009; Tunlind et al., 2014). Bennett (2010) argued that the nursing role can humanise renal replacement therapy, through negotiation care, in order to respond to the patient experiences of illness and therapy. It has also been argued that increased time pressure, nurse-patient communication, and the nurse-patient relationship are still barriers in implementing a process of advance care planning in hemodialysis units (Moran, 2018). This argument brings focus to an understanding of the process of intensive care nursing decision-making and performance.

The concept of mediating technology, as the medium between patients and nurses is applicable to the current research. The nurse-patient relationship, within context, socially constructs the ethical base of nursing practice (Peter & Morgan, 2001). Nurses are required to view technology and the use of technology as a way to guarantee and enhance moral nursing practice. The social space wherein nurse/patient relationships form, however, is also altered by technology. Technologies, such as CRRT, are powerful in drawing nursing care away

from the patient and disrupting the development of strong interrelationships between the technology and the patient. Technology proficiency, authority and power and social interactions among other contextual mediators, shaped the behaviours of the participants in their use of CRRT technology. There was the appearance of epistemic authority and a hierarchy of power in relation to the CRRT.

O'Keefe-McCarthy (2009) refers to the mediating effect of technology on the nurse-patient encounter. In contextualising the current research situation, the question becomes one of how mediating technology, such as CRRT, supports or influences that relationship and decision-making. The social and mechanical functions of technology situate nurses in positions whereby technology's unquestioned authority may disrupt a nurse's capacity to advocate for a patient. Indeed, the nurse participants' routine care was interrupted by the presence of technologies which brought attention to factors that impeded the capacity of nurses to act as decision-makers in the interests for patients. The actions of nurse participants in responding to machinery alarms and revealed some hidden mediating factors that reflected the centrality of technology.

It is expected that intensive care nurses will monitor the whole picture, the patient condition with AKI, CRRT technology and other therapies, in order to make safe clinical decisions and to act on those decisions. This assumes that the nurses were knowledgeable. Yet there was a lack of technological proficiency and hence nurse participants, when wanting to solve any problems, often remained focused on the machine rather than the patient. An example was where the access or return pressure was abnormal and nurses used flushing techniques as a first solution. This practice can harm patients if clots move into the blood circulation. The focus was often on addressing the machine rather than patient conditions or associated risks (Polaschek, 2003; Tranter et al., 2009). Thus, nurse participants struggled to

simultaneously manage the complexity of CRRT machinery and patient assessment. The following was observed in a field note:

> At 4:35pm, CRRT alarm is on. Participant 4 turns it off and does flushing. As she explained: “I do flushing hourly to reduce clotting”. The CRRT alarm continues, TMP [transmembrane pressure] and access pressure are low and return pressure is high.
> I asked her: “What do you think the problem is?
> She said: “The filter clotted”. The team leader came and helped to flush the same circuit without changing it.
> I asked participant 4: “What happened? Did the alarm turn off? The Team leader said: “This saline flushing will help to keep the continue the CRRT going for another hour.” (Participant 4, Field note, 10 September, 2013)

The above data suggests that, as a priority, nurses may over use the saline flushing technique to deactivate an alarm. The ICU nurses, including team leaders, did not appear to understand the appropriate saline flushing technique or when this technique might carry risks. Nurses might respond to technological issues with what Koopman and Hoffman (2003) referred to as "work-arounds" which are temporary and pragmatic fixes to technological issues. Studies have identified workaround practices in nursing as deviations or violations, which may propose wrongdoing or bad behaviours (Berlinger, 2017; Halbesleben, Savage, Wakefield, & Wakefield, 2010; Koopman & Hoffman, 2003; Koppel, Wetterneck, Telles, & Karsh, 2008). In the above instance, the nurse complied with the decision and actions of the team leader, which may be because the latter had more power in the decision-making process and because compliance was the expectation.

The assumption underlying the actions of research participants appeared to be that the use of workarounds was appropriate because patients benefited from faster responses to care in complex settings. There are inconsistency in nursing evidence about the conceptualisation of workarounds, some have argued that working around the rules and policies may be for the

benefit of the patient (Baker, 1997; Furber & Thomson, 2006), while others consider workarounds as problematic and an act that leads to potential errors (Ali, Cornford, & Klecun, 2010; Espin, Lingard, Baker, & Regehr, 2006), or prevents organisational learning because it hides actual practice (McAlearney et al., 2007; Tucker, 2004). Thus, it is contended that workarounds can be both subversive and increase patient safety (Debono et al., 2013). In the research context, however, the workaround practices that nurses adopted in relation to CRRT were being normalised. In some cases, for example, where the circuit or the filter was clotted due to a habitual, if incorrect CRRT practice (e.g. disconnecting the patient from CRRT to do nursing care), patient outcome was compromised.

It has also been argued that, when seeking to master technology, the amount of time nurses spend on indirect care usually increases (Bevan, 1998; Cornell, Riordan, & Herrin-Griffith, 2010; Heidegger, 1977). The result is a shift of the focus of the nurse from patient to machine. It might be argued that, in the long term, more time spent the management of technology might result in time saving. In the interim, however, there are increased opportunities for error. Where nurses over rely on technology this may lead to complacency and a failure to recognise equipment malfunctions (Browne & Cook, 2011).

For the nurse participants, insecurity or lack of confidence with technology may have been due to limited management support, technological work environment demands (responding to alarms including false alarms), and reliance on a higher authority to support their decision-making or performance. False alarms, for instance, often occur in ICUs. False or non-actionable alarms risk desensitising intensive care nurse responses which can result in missed fatal alarms (Sowan, Tarriela, Gomez, Reed, & Rapp, 2015). This might explain why nurse participants ineffectively deactivated alarms. Sowan et al, (2015) argued that nurses' attitudes and practices related to clinical alarms are the key to design sensitive contextual initiatives to fight alarm fatigue. False alarms and alarm fatigue undermine management of

clinical alarms (Alsaad et al., 2017; Cho, Kim, Lee, & Cho, 2016; Ruskin & Hueske-Kraus, 2015; Sowan et al., 2015). Intensive care nurses also face difficulties in differentiating between and responding to the alarms of different medical devices, which leads to clinical alarm hazard and jeopardises patient safety. The issue was the response of nurses to CRRT problems and how their cognitive thinking about patients was mediated by the context.

The integration of patient-centered care and technology in nurse workflows appears complex when addressing factors that affect the selection of strategies to make decisions about CRRT machines. Other research agrees and reports that intensive care nurses do not always link monitored parameters with other patient observations or miss important patient information because of a reliance on technology (Alastalo et al., 2017; Häggström, Asplund, & Kristiansen, 2013; Papathanassoglou et al., 2005)**.** These previous findings generate insights into the mediating factors that construct the centrality of technology in nursing care. An example of observation demonstrated a participant who was unable to act on patient information about blood pressure:

> The patient's blood pressure has dropped 73/38 mmHg and he is still on high dose of nor-epinephrine (inotropes/vasoactive therapy).
> I asked the participant "Did you discontinue or gradually reduce inotropes?"
> Participant 10 said: "No, I did not. I will call and ask the doctor if he wants to stop CRRT." (Participant 10, Field note, 5 November, 2013)

Konngsuwan and Locsin (2011) argued that nurses' insecurity relates to not knowing a technology and thus, a nurse's primary focus shifts from patient to technology. Nurses also fear that the use of unfamiliar technology might jeopardise patient safety (Kongsuwan & Locsin, 2011). Participants appeared unaware of their scope of practice in terms of what is shared with other professionals and what is unique to nursing practice.

Using technology does not mean to replace individual-to-individual interaction or social interaction in different ways, which is important for nurse-patient encounter. In this

research context, the nurse participants were uncomfortable with CRRT machinery and handling technology was difficult as reflected in one participant's expression:

> *My colleague came to help me with CRRT machine but then she went to see her patient because the patient did self-extubating. I cannot help anyone, because my patient is critical, and deterioration could happen anytime. So, I can't call anyone I can't leave the patient or the room. (Participant 29, interview)*

The above findings suggest that there is demand for nursing workforce and/or staffing interaction that is able to work in the context of advanced technologies and patient-focused care in order to meet the needs of the intensive care units and the needs of the organisation. Nursing workforce has proven challenging for nursing leaders in relation to differences in attitudes, beliefs, expectations and work habits (Sherman, 2006). Where a large number of nurses work together with different levels of clinical experience and limited training resources in the workforce, it may create considerable pressure for the organisation in ensuring every nurse is sufficiently trained. To maintain and build a high-value nursing workforce require strategies to produce a sufficient supply of qualified nurses and clinical resources in order to create work environments that support nurses practice, and organise their skills efficiently (Rother & Lavizzo-Mourey, 2009).

It has been argued above that technology and patient care are essentially interconnected. Others have asserted that nursing and technology are incompatible entities there is a tendency for nurses to work against technology in seeking separation from dehumanising care (McGrath, 2008; Sandelowski, 2000). Intensive care nurses, however, are required to nurse patient and technology at the same time.

Previous studies have investigated the effects of technology in care giving and focused on nurses' experiences of technology within the ICU (Alasad, 2002; Barnard, 2000;

Kiekkas et al., 2006; Tunlind et al., 2014; Wikström et al., 2007) or with the dialysis machine (Bennett, 2010; Polaschek, 2003; Tranter et al., 2009). The technology can dehumanise patient care in which caring for technology can interrupt nursing care to meet the patient's needs (Granberg, Engberg, & Lundberg, 1999) and technology limits nurses' independence in taking action (Barnard, 2000; Wikström et al., 2007). The main finding of Barnard's (2000) work, for instance, was alteration to the free will of nurses, which explained that nurses' daily practices were altered by the demands of machinery. Limited technological experience, workload, and unable to develop adequate nurse-patient relationship were factors that mediated the centrality of technology and complicated nursing decision-making processes (Barnard, 2000). Similarly, in this research, the nurse participants struggled with the CRRT machine due to its complicating practice, distraction from other nursing care, and workload. These nurses therefore made inappropriate clinical decisions, were slow or unable to recognise and respond to solve CRRT problems, or relied on other senior nurses to support them in managing the CRRT due to not knowing the patient and/or the CRRT machinery and the complexity of CRRT technology. It seemed that some nursing care was interrupted by CRRT alarms or other nursing care, and the nurse participants could not take control over CRRT practice and patient clinical deterioration at the same time. Thus, most of those findings shared similar mediator factors that led to the centrality of technology.

The above debate demonstrates the effects of using technology as either positive or negative in nursing care. When nurses focus on technology and ignore the patient care, a breakdown of ethics of care may occur. An exposed of ethical dilemma to nurses who use high-technological procedures and equipment to maintain the patient life might happen, but not inevitably quality of life and patients' dignity (Bunch, 2002; Wikström et al., 2007). It appears that technology may have potential to change how nurses conceptualise and act with ethics or moral in nursing care and decision-making. Although technological equipment has

challenged the meaning of nursing care and its position in nursing, it has changed professional and public values of caring (Sabzevari, Mirzaei, Bagherian, & Iranpour, 2015). More focus is needed on examining the mediating factors that construct the relations between technology, nurse and patient.

6.4 *Chapter Summary*

This chapter demonstrated the complexity of intensive care nurses' performance with CRRT machines and critically ill patients with AKI. The dimensions of decision-making explored in this chapter were: *negotiating CRRT practices*, *normalising CRRT practices and centrality of technology*. The concepts explain how nursing care practice is constructed around CRRT technology in the ICU context.

The first concept, *negotiating CRRT practices*, the influences of hierarchical boundaries and unequal participation in decision-making where the role of nurses was marginalised, and their contribution to patient-centered information ignored. This concept also demonstrated influences such as nurses' learning on the job, which had different contextual constraints. The concept of *negotiating CRRT practices* showed that the management of CRRT technology was very demanding and challenging, that nurses could not effectively make clinical decisions without collegial support or team decisions and did not have authority. This complexity of performance with CRRT machines put the patient care at risk and brought intensive care nursing practice into question. As intensive care nursing, more authority and power are required in nursing decision-making and a clear scope of practice. The scope of nursing practice may need more attention in relation to nursing decision-making and using technology. Unit management support and interactions with other professionals played a dynamic role in ensuring safe nursing practice with advanced technologies.

Complex healthcare such as ICUs are inherently hazardous wherein exists a range of technologies, practices and expertise which may engender inadequate nursing practices. Thus, secondly, the notion of normalisation of deviant behaviours has existed over years due to nurses being increasingly challenged to "do more with less" and/or take "short cuts". The literature on patient safety and normalisation of deviance suggests focusing on fixing the system rather than trying to make individuals perfect, which could be more effective in preventing errors. A shift of thinking is required to focus on the system of care in ICUs to value and prioritise the work needed to fix the processes, equipment and work flows that set up the deviations or human errors with machinery. When one normalised behaviour or deviation is entrenched in the system, it could be challenging to root it out.

The last concept *centrality of technology*, was examined in relation to the process of nurses' clinical decision-making. In this research, nurses' management of CRRT technology and its effects on critically ill patients with AKI was limited and questionable. Humanising the technological environment and patient experience of technology is important to nursing care (Ashworth, 1994; O'Keefe-McCarthy, 2009). Yet, the participant nurses appeared focused on technological care rather than patient care due to mediating factors such as the hierarchy of authority and power and social interactions which made difficult the simultaneous management of complex technology and complicated patient care. In addition, false alarms and alarm fatigue presented as other obstacles to care in the ICU context. This may be a key reason that nurses engaged in workaround behaviours in CRRT practice. These issues reflected a lack of effective policy on the management of alarm systems and a multi-method approach including technical, organisational and educational interventions that could decrease nuisance alarms and improve alarm system safety. The knowledge, skills and competence needed in CRRT nursing care was also not obviously recognised as equivalent to highly specialised intensive care nursing work. Where nurses lack confidence in their

skills they may 'hide' behind technology and use it as self-protection (Slatore et al., 2012) rather than assume control over clinical decisions and problem solving. The findings of this research suggest that technology is a medium whereby nurses change the ways in which they interpret their responsibilities in making decisions for critically ill patients. The centrality of technological care, in turn, is a product of social and organisational mediating factors. The final chapter poses some concluding propositions about the context in which the nurse participants cared for patients with AKI and undergoing CRRT and implications. The chapter also addresses some potential limitations of the research and proposes recommendations for future research.

Chapter Seven: Concluding Discussion

7 Introduction

The research reported upon in this thesis explored intensive care nurses' clinical decision-making when providing care for patients with AKI and undergoing CRRT in a Saudi Arabian ICU. The research findings give insight into how and why experienced nurses make clinical decisions when engaging with advanced technologies in the ICU context.

The O'Neill et al. CDMM provided the framework for the deductive content analysis and development of subcategories with the findings presented in Chapter Five. The two studies central to the development of O'Neill et al. CDMM drew on computer scenarios and focus groups (Chin et al., 2006; O'Neill et al., 2006), hence, these original studies did not explore clinical decision-making in the real world of nursing practice; this is the first research to do so.

Three further key concepts were generated from a second conceptual analysis of the data that contributed to a broad understanding of the complexity of performance in CRRT nursing practice. These concepts were: *negotiating CRRT practices*, *normalising CRRT practices* and *the centrality of technology*. These latter concepts gave focus to a limitation of the O'Neill et al. CDMM which does not address the influence of contextual or external factors on the process of nursing decision-making.

In this, the final chapter for the thesis, the findings of the research further considered in light of contextual issues and the implications discussed at the organisational and nurse professional levels. Hence, the discussion focuses on the importance of context in understanding intensive care nursing clinical decision-making and CRRT practice. In extending this argument, the chapter frames intensive care nurses' clinical decision-making in CRRT practice within the context of organisational, social and technological boundaries that

constructed intensive nursing care for patients receiving CRRT in the research context. It is also argued that nursing practices within the research situation invite questions on the need for change in response to rapid technological and other developments in ICUs in Saudi Arabia. Finally, the chapter considers the broader implications of these research findings and poses recommendations that relate to nursing care for patients with AKI and CRRT, to future research and to policy considerations.

7.1 Reconsidering the O'Neill et al. CDMM

O'Neill et al.'s CDMM was developed in response to concern about how nurses make clinical decisions. The theoretical underpinnings of O'Neill et al. work involved information processing theory and pattern recognition to explain nurses' decision-making processes. These cognitive processes assisted in explaining the differences among intensive care nurses' practice and the work consequently identified three levels of decision-makers. While the key concepts in O'Neill et al. CDM model shed much light on nurses' thinking processes in practice and the development of nurses' clinical reasoning skills, the model does not account for contextual influences. The model refers to nurses' levels of clinical knowledge and experience, recognition of cue salience, generating and activating hypotheses and clustering cues specifically in CRRT practice. However, in the current research, there were broader contextual influences of organisational and social boundaries that shaped the process of nurses' clinical decision-making and nursing performance with technologies.

As others have argued, nurses draw on skills that are shaped by both cognitive and social influences in achieving safe and effective practice (Lewis et al., 2012; Mitchell & Flin, 2008). Such skills include teamwork, leadership, communication and cognitive skills such as situation awareness, decision-making and task management (Lewis et al., 2012; Reader et al., 2006). With regard to the conceptual analytical findings, the application of O'Neill et al.

CDMM allowed some degree of understanding of how nurses make decisions and take action in real practice. Indeed, the O'Neill et al. CDM model is likely to be applicable to nursing decision-making in the full range of clinical contexts although, following the findings of this research, some modifications and consideration of potential contextual influences are required. Understanding nurse decision-making processes requires movement beyond cognitive process and reasoning skills as the context in which decisions are made is a critical influence.

Organisational factors

As argued above, the research suggests the need for the expansion of the O'Neill et al. model to include a strong contextual dimension that gives emphasis to the importance of organisational factors in constructing nursing work. Contextual factors in this research included multicultural workforce characteristics, management and leadership support, communication processes, a hierarchy of authority and power, and level of autonomy in relation to nurses' participation in clinical decision-making processes. These factors influenced how and why nurses made choices on decisions and interventions. In other words, a consideration of contextual factors within O'Neill et al. theoretical framework broadens our knowledge of the process of intensive care nurse clinical decision-making in complex practice situations. Thus, of interest are the structural imperatives that acted as facilitators or barriers to effective nursing practice.

7.2 Working across organisational, social and technological boundaries:

The healthcare system is a situation wherein nurses experience considerable pressure to perform. It is thus important to understand the ways in which nurses act collectively at the organisational, social, and technological levels. Organisations can be viewed as human

systems where people engage in activities and actions which reinforce standard practices and generate value for key stakeholders that ensure the longevity of an organisation (Scahill, 2012). Thus, the characteristics of organisational behaviour and attitudes is a lens through which to understand the culture of a workplace (Braithwaite, Herkes, Ludlow, Lamprell, & Testa, 2016). In this research, the exploration of nurses' interactions and relationships with complex technology, such as CRRT, brought focus to decision-making processes, management support, and a hierarchy of authority that impacted upon clinical decisions. While much existing research in this area has focused on intensive care nursing practice with CRRT machinery (Graham & Lischer, 2011; Kocjan & Brunet, 2010; Langford et al., 2008; Murphy & Byrne, 2010), different contextual boundaries and constraints exist in work environments. Professional working boundaries, for example, were not clearly drawn in the Saudi Arabian setting. A consequence was that the nursing scope of practice was ill defined in relation to clinical decision-making and responding to critically ill patient needs. The complexity of intensive nursing practice environments points to key issues in relation to the organisational, social and technological realms.

7.2.1 *Organisational and system boundaries*

The characteristics of an organisation are influential in shaping the life world, that is the activities and interactions of its members, of an organisation (Carney, 2011; Saffold, 1988). Thus, organisational or institutional theory has developed to explain both individual and organisational actions (Dacin, Goodstein, & Scott, 2002). Organisational theory is the study of " how organisations function and how they affect and are affected by the environment in which they operate (Jones, 2013, p. 8). Other authors have defined organisational theory as " management insight that can help explain or describe organisational behaviours, designs, or structures" (Sarkis, Zhu, & Lai, 2011, p. 2).

Organisational structure and culture control people's motivations and capacities to achieve organisational goals which, in turn, shape people and organisational behaviours (Jones, 2013). Organisational culture is a complex concept and it is can be difficult to analyse how culture shapes and constrains structure and behaviours and how organisational culture constantly changes (Whelan, 2016). Organisational theories would suggest that poor CRRT management is not an individual problem but a system failure where, for example, a culture exists that is not oriented to the improvement of care and teamwork (Grol & Grimshaw, 2003).

Where there is new technology or technological innovation, an organisational context requires an environment that supports the comprehension and sharing of new knowledge (Storey, 2013). In the current research, it appeared that the organisation had limited capacity in technology adoption and diffusion and hence in understanding factors that inhibited or facilitated the process of adoption and use of CRRT among intensive care nurses. There appeared an absence of understating of the relationship between technology adoption and organisational growth as supported by culture (Balthazard, Cooke, & Potter, 2006; Chatman & Jehn, 1994). Others have pointed to, in the Saudi Arabian healthcare context, the lack of organisational systems or behaviours necessary for the implementation of new technology into practice (Alkraiji, Jackson, & Murray, 2013). One example is the problematic assumption that technologies designed in Western countries readily translate to Saudi Arabia. As argued by (Al-Mabrouk & Soar, 2009; Pawson & Hulse, 2011), the use of technology designed in one country and used in another inevitably is shaped by different work practices, culture, and beliefs that construct encounters with technology.

Level of supporting nursing professionalism and/or status

Organisational structures, or the lack there of, that influence ICU nursing practice and decision-making in the Saudi Arabian extend to the professional status of nursing and the degree of definition of nursing scopes of practice. In terms of the characteristics of a profession, over a century ago, Flexner (1910) identified professionals as individuals concerned with a specific career, who have moved beyond a basic education. For Flexner (1910), professionals demonstrate a high level of intellectual functioning, a scientific-based area of specialised knowledge, a sense of responsibility, self-governance, and altruistic views (Flexner, 1910). Thus, through a socialisation process that begins with formal, entry-level education to obtain knowledge and skills, a professional is a person who continues to develop (Wynd, 2003).

In this research, the complexity of nursing practice in relation to CRRT and the constraints on independent clinical decision-making reflected a tension between the day to day requirements of nurses in practice and the effects of the social positioning of nursing in Saudi Arabia. The interplay between a hierarchical imposition of authority, limited managerial support and lack of clarity around the role of nurses was clearly manifest in the current research.

Where nurses practice in a space that values their authority and accountability for decisions and activities, professional autonomy prevails (Manojlovich & Ketefian, 2002). However, the essential features of professionalism were not evident in the current research. The fact that all participating nurses were expatriates may have been a contributing factor because those nurses had limited power in the work setting and they had to deal with and local senior staff who typically did not revere nursing as a profession.

Recently Aboshaiqah (2016) argued that several areas in nursing need to be addressed in Saudi Arabia including nurse education, healthcare delivery systems, the image of nursing,

and policies and regulations (Aboshaiqah, 2016). Because of poor working conditions, nurses across Saudi Arabia have been subject to increased workloads, nurse shortages, low pay, lack of social equity, lack of recognition and appreciation and limited support and opportunities (Lamadah & Sayed, 2014; Mohammad, 2017). It has been found that in, at least, some Saudi Arabian hospitals, nursing and hospital administrators tend not to listen to nursing staff concerns (Gazzaz, 2009) and that negative portrayal of nurses as subservient to the rule of doctors reproduced (Almutairi & McCarthy, 2012). Both national and international nursing literature has, however, argued the importance, in the delivery of quality health care, of nurses to be seen as highly knowledgeable, skilled and autonomous professionals (Aboshaiqah, 2016; Alghamdi & Urden, 2016; Almalki et al., 2011; Almutairi & McCarthy, 2012; Hoeve, Jansen, & Roodbol, 2014; Price & McGillis Hall, 2014). A often posed view is that an improvement in status of Saudi Arabian nursing can only occur when collaboration between nursing organisations in that country and government departments and the media occurs (Aboshaiqah, 2016).

Professionalism for nurses sits largely within the realm of the responsibility of nursing administrators and managers in the organisations (Spooner-Lane & Patton, 2007). Indeed, the structure of an organisation including the top level of management needs to understand that the nursing professional ought to direct nursing practice which includes decision-making. In the research setting, professional support was poor because the autocratic structure of decision-making situated nurses as the recipients of decisions made by others. Furthermore, the diversity of nationalities that constituted the Saudi nursing workforce meant a variety of educational and social backgrounds, and for some, a fear of challenging superiors which also contributes to the perpetuation of the status quo. The challenge for intensive care nurses in becoming independent decision-makers is, therefore, multilayered.

Saudi Arabia scope of nursing practice

Scope of practice has been broadly defined as the full range of roles, responsibilities and functions that nurses perform when they are educated, competent and authorised (American Nurses Association, 2015; White et al., 2008). Thus, nurses are expected to understand and function within a full scope of practice. In this research, intensive care nurses lacked the guidance of nursing standards, or role legitimacy, to manage CRRT or advanced technology, and faced different many contextual barriers to work to their full scope of practice.

The issue of scope of practice is generally comes under the governance of national professional nursing bodies. In Saudi Arabia, however, a strong professional nursing body with regulatory authority does not exist. Although in 2002, under the authority of the Saudi Commission for Health Specialties (SCFHS), a Scientific Nursing Board (SNB) was formed (Abu-Zinadah, 2005; Aldossary, 2013; Alghamdi & Urden, 2016), the SCFHS limited the role and influence of Scientific Nursing Board. The official role of the SNB role was as registration authority or a licensing board (Alghamdi & Urden, 2016). The SNB was charged with formulating professional practice criteria, establishing accountability systems and credentialing processes, developing educational and practical competency standards, and evaluating hospitals and health centres for the purpose of educating nurses (Abu-Zinadah, 2006; Aldossary, 2013; Alghamdi & Urden, 2016). A national scope of nursing practice, however, has not yet been produced.

The outcomes from this research have raised issues around organisational nursing practice standards and expectations of decision-making in the context of work environments laden with technologies. The above findings suggest that the research organisation did not evaluate intensive care nurses CRRT practice, did not provide a clear scope of practice for

working with CRRT technology CRRT, and as such did not give legitimacy to nursing role of monitoring the CRRT.

7.2.2 *Sociotechnical and social boundaries*

In this research, social boundaries around nursing responsibilities in relation to managing CRRT technology were unclear. The medical profession had authority over subordinate nursing staff and effectively marginalised their decision-making. The decision-making process in CRRT practice reflected the assumption that intensive care nurses would be obliged to conform to the medical higher authority and power. Decision makers (most often men in positions of power) imposed decisions which was perceived to be socially appropriate and acceptable in the broader social Saudi Arabian context (Mellahi & Wbod, 2001).

The social construction of intensive care nursing practice in relation to CRRT in this research was also defined by the centrality of technology; nurses practiced technology-centred care. Barnard and Sandelowski (2001) suggest an additional understanding of technology as socially constructed in relation to nursing practices (Barnard & Sandelowski, 2001). Nurses in this research made, at times, inappropriate decisions and engaged in ineffective actions which reflected technology-centred care. As Klein (2014) argued, technology influences the behaviour of people just as people influence the working of technology. Furthermore, human contact and communication have altered into a multi-method process because of technology changes the boundaries between the social and the technical (Casella, Mills, & Usher, 2014). In the 1960s, researchers developed a sociotechnical theory that asserted that "workers were more motivated and productive if there was a good balance between the social and technical aspects of their work" (Casella et al., 2014, p. 121). The concept of sociotechnical also indicates that technology and people in a

work context are interdependent (Klein, 2014). From this perspective, nursing performance is constructed in terms of the balance between the social and technical dimensions of nursing work. This research has uncovered some of the relationships between the actions of nurses, their interactions with others, and the use of technology in relation to CRRT practice.

The actions of the nurses around CRRT technology were also produced and reproduced at the level of social interaction. In the context of the research, the social boundaries of work constructed nursing care, decision-making, and the everyday management of technologies. Nurses turned to doctors and senior nurses based on the assumption of their superior knowledge, experience and decision-making with CRRT. Approval from colleagues provides assurances of shared ownership of decisions and strengthens a sense of personal competence (Hn Tjora, 2000) and that relationships at work are connected with nursing performance (Al-Ahmadi, 2009). Yet collegial approval may have assumed the guise of conforming to the rules of the social setting of the ICU where the ICU nurses turned to others, rather than make autonomous decisions, as the preferred approach to decision-making in managing CRRT technology.

As noted throughout this thesis, the complexity of engagement with technology was established in response to what was considered a failure to provide patient-centred care. A lack of social support was evident in the limited decision-making and technological skills, where nurses had not sufficient authority to request further training or education. A hierarchy of decision-making was evident as the nurses themselves were of the view that the important decision-making power within the hospital was concentrated around the higher positions of the organisation. Furthermore, power was exercised in an autocratic manner on the part of doctors and nurses. It appears that disagreement with those in higher authority roles was not optional in this ICU practice due to the subordination of nursing.

The participant nurses did not have the requisite ability and power to independently manage the complexity of CRRT machinery and critically ill patients nor understand the purpose and function of the machine. Nurses had adequate length of ICU clinical experience but they still struggled in managing CRRT. According to Orlikowski (2000), individual use of technology becomes structured through the user's knowledge, experiences, habits, norms, and the technological artifacts at hand. Thus, when an entrenched and taken for granted structure exists with a specific set of rules in place, it is assumed that individuals will continue to interact with the technology in a way that is compatible with those rules (Orlikowski, 2000). By contrast, the participant nurses appeared to struggle in managing CRRT because of the absence of clear practice standards, roles and professional development. Rules do not ensure good nursing practice. For this reason, the practice of nurses in the context of advanced technologies will vary depending upon the many dimensions that construct technologies-in-practice within overlapping social systems (Orlikowski, 2000). It is, therefore, crucial to understand how and why nurses deal with technology and take particular actions in the context of an organisation.

Understanding how different environments influence the use of and practice with advanced technologies would give insight into the limits of individual decision-making. In the research, nurses often asked senior nurses CRRT to troubleshootalthough several authors point out that intensive care nurses need to be rigorously trained and systematically evaluated in the use of CRRT technology due to the clinical complications associated with its use (Asanuma et al., 2010; Przybyl et al., 2015; Tillman, 2009). Nevertheless, it might be argued that nurses cannot necessarily receive training for every device they use in a high-intensity setting such as intensive care units (Ricci et al., 2015). The CRRT machine has become a part of routine ICU equipment (Richardson & Whatmore, 2014), and a well-trained nurse ought to be able to manage every aspect of a CRRT treatment (e.g. connection, priming, circuit

maintenance, troubleshooting, and modification of settings based on prescribed dose; (Baldwin & Fealy, 2009b; Ricci et al., 2015). Thus, when nurses engage with CRRT, easy access to educational resources is required.

Barriers to nurses' decision-making for patients with AKI receiving CRRT in this research were individual, social, and organisational in nature and in have not been previously reported in relation to the research situation. The social (workplace) environment influence is crucial in the process of adoption and implementation of CRRT. This research found that this type of technology did not simply support the traditional process of intensive care nursing care and that technical skill alone did not lead to improvement in CRRT nursing practice. Gough et al., (2014) argues that research has seen technology as enhancing and legitimising the professionalisation of nursing although this was not the situation in this research. The Saudi Arabian organisational structure did not support to use complex CRRT technology as an essential part of their practice. It could be that crucial barriers for support nurses within Saudi Arabian health care organisations: the insufficiency of infrastructure support to reinforce health technology, and the lack of foundational support for the implementation of advanced technology.

The central argument of the thesis is hence that individual, social, technological, and organisational contextual factors shaped the complexity of intensive care nursing practice and decision-making in relation to CRRT machinery. In the Saudi Arabian health care organisation, the process of technological implementation was complex and shaped by integrated contextual forces, such as social, political and cultural. Where there is poor understanding of organisational, social, and technological factors, this may inhibit nursing improvement and therefore lead to failure in achieving safe and quality nursing care that is patient-centred care.

Some organisational strategies and theories might not be applicable in Saudi Arabia due to different social and organisational cultures. For example, Saudi Arabia, as with other Arab countries, expect that leaders will separate themselves from the group and issue complete and specific guidelines to be adopted by subordinate staff (Al-Adaileh & Al-Atawi, 2011). Thus, organisational change might be required at three levels: individual, team or unit, and the organisation (Cawsey et al., 2016). Resistance to change can appear in the individual level and consequently the group level because groups or teams consist of a number of individuals, all of whom have their own collection of beliefs, values and ways of thinking (Burke, 2017). Changes to an organisational system, to improve intensive care nursing performance in CRRT practice, depends upon the capacity of nursing leaders to inform policy decisions and address the change requirements. In this research, the question was to what extent these resources and processes were effectively used in the ICU nursing practice. It is important that changes and improvements to aspects of intensive care nursing practices, polices and outcomes should be introduced over time to avoid disrupting the sustainability of the organisation.

A study undertaken by Alhazemi, Rees, and Hossain (2013), in Saudi Arabia, revealed that the factors of leadership, culture, training and education were crucial in the strategic change management process operating within the organisation. The findings revealed that there was resistance to change manifested itself in different ways, for instance, an unwillingness to adopt modern work systems, strict adherence to very old Arab traditions continued, and the lack of readiness on the part of the senior management to pay attention to the suggestions and preferences of the working staff (Alhazemi, Rees, & Hossain, 2013). It has been reported that although many Arab countries have a strong financial capacity, technological transfer has been relatively slow (Al-Mabrouk & Soar, 2009). In this research context, it is concluded that social, intensive care unit practices and organisational influences

negatively impacted the acceptance, management and implementation of new or complex technologies and nursing practices. Nurses therefore developed workarounds and normalised those practices that might be considered a site of resistance in response to lack of support in the ICU. It was evident in the current research that the management of CRRT machinery and decision-making processes were managerial driven. The assumption of organisational management was that nurses would follow the decisions of managers, doctors or senior nurses in the workplace. The argument here is that if ICU nurses become integral to decision-making processes, they can become a part of a change process to move towards improved intensive care nursing performance with CRRT and hence better patient outcomes.

Briefly, the findings of this research were connected to previous nursing research in relation to intensive care nurses' clinical decision-making processes and management of critically ill patients with advanced technology such as CRRT. There were some similarities, differences and challenges in the Saudi Arabian ICU nursing context. The findings for instance demonstrated how intensive care nurses made decisions by depending on their previous nursing experiences and the ability to function as part of a team similar to studies by Alswat et al., (2017) and Gazarian, Henneman, and Chandler (2010). However, it was challenging for those nurses to independently assess the patient, know the patient, receive adequate education and deal with different environmental factors such as equipment in order to recognise and manage patient deterioration with technologies. Nurses struggled in decision-making and problem solving due to the complexity of CRRT and the context. The findings therefore built its own recommendations from different previous studies. For example, a study by Massey, Chaboyer and Anderson (2016) who suggested that system modifications and educational development are required in the workplace to improve the ability of nurses' recognition and management of patient deterioration. In addition, nurses were not autonomously decision-makers because they were constrained by a strongly

hierarchical healthcare structure and limited management support. The subordination of nursing has been addressed in different nursing studies and contexts (Ganz et al., 2016; Stein-Parbury & Liaschenko, 2007; Tang et al., 2013). It was a challenge to understand the complexity of decision-making process within a technological and medical dominated environment.

To connect or build on the concept of normalising CRRT practices with previous nursing studies was challenging due to limited knowledge of normalisation practices within ICUs. The Saudi Arabian health care system's heavily depends on expatriates which they are not able to freely discuss safety issues or raise concerns in practices (Aboshaiqah & Baker, 2013). Similarly, this research demonstrated poor communication between nurses and doctors about management of CRRT, which led to unsafe behaviours or normalised practice. The challenge here in the Saudi Arabian ICU context is that the health care system has the power to push individuals to deviate in their practices because of limited support and individuals alone cannot do anything. As has been argued above, studies have reported that technologies can be powerful in drawing nursing care away from the patient (Bennett, 2010; Jakimowicz & Perry, 2015; Tranter et al., 2009; Tunlind et al., 2014). The findings of this research demonstrated the challenges in CRRT nursing practice were: technology proficiency, authority and power, unclear nursing role, different contextual barriers to work to nursing full scope of practice, and social interactions among other contextual mediators that shaped the behaviours of nurses in their use of CRRT technology. Thus, organisational and social changes are required in the Saudi Arabian health care system.

7.3 Strengths and limitations

A strength of the research is that it was informed by an existing theoretical framework of clinical decision-making (O'Neill et al. clinical decision-making theory) which is concerned

with information processing theory and pattern recognition. In the current research, the framework allowed for an explanation of the different clinical decision-making processes of intensive care nurses and the identification of three types of decision-makers. Importantly, the concepts that underpinned O'Neill et al. CDMM also helped in generating subcategories as discussed in Chapters Five and Seven, which broadened the explanation of the phenomena of interest.

A second strength was that the interpretation of findings were embedded in data. The research findings support the use of O'Neill et al. CDMM to examine nurses' decision-making during practice. Of importance, the research also extends the model to add the contextual influences on decision-making (see Chapter Three section 3.3.4 and Chapter Seven, 7.1).

Third, the use of complimentary methods of data generation enhanced the transferability of finding. Recruitment of nurses across genders, ages, and experiences over a six-month period increased the research credibility and captured the range of nurse clinical decision-making processes. The trustworthiness of the findings was assured by providing examples from both observation field notes and interviews. Checking the data of the research with the researcher's supervisors ensured rigor and confirmability of the findings. Finally, the findings of this research address the gap in the intensive care nursing literature and bring attention to the significance of organisational, social and technological influences on nurse decision-making and performance with advanced technologies in the Saudi Arabian context.

There are number of limitations in this research. The research was conducted in one hospital (Adult ICU) in Jeddah, Saudi Arabia and as such the findings cannot be generalised to all intensive care nurses' clinical decision-making in CRRT practice. Participants were expatriate nurses, which may or may not limit the transferability to other intensive care nurses internationally. However, the nurses in this research bring a mix of experiences that

can strengthen this research. Recruitment was limited due to the number of patients receiving CRRT during the time-constraints in conducting this research. The sample may not represent all intensive care nurses who provide care for patients with AKI on CRRT.

A further limitation was the effect of language barriers: for the participants and the researcher. English was a second language for all participants which may have reduced their ability to comprehend questions and respond during interviews. Intensive care nurses may also have felt unable to freely comment during the interviews due to the complex ICU environment (i.e. unstable patient conditions, staff shortages). The presence of the researcher may have also altered participant behaviours during observations but some strategies were used to avoid this limitation (see Chapter Four, section 4.6).

7.4 Recommendation, Implications and Conclusion

7.4.1 *Recommendations*

The findings from this research make a significant contribution to knowledge on intensive care nursing clinical decision-making and technological care in the Saudi Arabian context. There are several implications for nursing education, practice and future research arising from this research.

7.4.2 *Implications for nursing education*

The research findings support an increase in the education of intensive care nurses about AKI and CRRT to improve skills in early recognition and rapid response to solve problems related to CRRT. Nursing schools and departments could implement and enhance continuing education workshops. This would be helpful in preparing new graduates or novice nurses to work effectively with patients and technology to ensure patient-centred care and safe practice.

The heavy reliance on expatiates in Saudi Arabia suggests the need for pre-service and ongoing in-service educational sessions or programs about AKI and CRRT management for new intensive care nursing staff. This education may take the form of simulation-based programs to improve nurse competency with CRRT (Mottes et al., 2013). A related recommendation is the development of a clinical instructor position to manage and maintain the ongoing educational program and CRRT competency evaluation. When intensive care nurses have adequate knowledge and experience, they do and will practice as independent decision-makers and highly competent users of technology. Finally, specific postgraduate intensive care nursing courses to develop and extend specialty nursing knowledge and practice should be supported. Nursing staff could research these courses locally in Saudi Arabia or elsewhere.

7.4.3 *Implications for practice*

Intensive care nurses are responsible for managing CRRT technology in Saudi Arabia. In other countries, such as the Philippines and India, which provide a significant proportion of the expatriate nursing workforce for Saudi Arabia, registered nurses do not manage CRRT technology. There is an urgent need for professional development in the area (see above). The key question is, about how to make nurses also interested in and motivated for continuous education and nursing development. The unit manager and/or head nurse, in this study, were expatriates and may not have been empowered enough to support formal education or training and to request educational or training resources.

Intensive care nurses as stakeholders also should be involved in organisational planning and implementation of advanced technologies to reduce possible boundaries, to facilitate communication, and to improve understanding and acceptance of new technologies.

The above noted issues point to the requirement for policies and structures in health care organisations that support individuals in ongoing professional development and integrate individual experiences with others as shared knowledge across an organisation (Lammintakanen & Kivinen, 2012). This research clearly revealed a lack of organisational policy around nurse decision-making in relation to technology and in this case CRRT. For nurses to be at the centre of practice in ICU, Saudi Arabian health care will have to address issues of limited authority, power, and autonomy and advance of equality and engagement in the process of decision-making. If nurses have responsibility for care they must be able to autonomously make decisions.

Further training and development of nursing staff, particularly in leadership and management is needed in Saudi Arabian hospital administration to reduce the challenges and complexities nurses face in ICU. Leadership style, communication systems and supervisor involvement are crucial examples of where intensive care nursing practice needs to modernise.

7.4.4 Implications for future research

Research to explore education programs or strategies to facilitate intensive care nurses' clinical decision-making skills

The current research findings suggest a need for further research on the knowledge levels of intensive care nurses, in Saudi Arabia and elsewhere, on AKI and CRRT technology. Having a better understanding of knowledge levels would inform teaching and learning strategies crucial for novice/inexperienced nurses.

Research that explores the impact of intensive care nurses' clinical decision-making on patient care and outcomes

Future research is required to examine patients with AKI outcomes in relation to CRRT nursing practice and clinical decision-making. Research could focus on patient-centred care, CRRT technology and the impact of organisational, technological and social factors on intensive care nurse' clinical decision-making in different countries. It would be worthwhile knowing the extent these factors influence intensive care nursing practice. In relation to the Saudi Arabian context, there is a need to determine the influences of a range of unexplored or unaddressed contextual factors.

Research related to the development of CRRT competency tool

More research is required on whether and how CRRT competency tools improve knowledge. A follow-up research could then examine the effect on intensive care nurses' clinical decision-making during CRRT practice. This research would be of importance in Saudi Arabia where competence is not routinely assessed.

7.5 Conclusion

The purpose of this research was to examine intensive care nurses' clinical decision-making when they provided care for patients with AKI who were receiving CRRT. To achieve the research purpose, an interpretive theoretical design was used to attain a better understanding of the phenomena of interest. Patient care with technology can be compromised where there is an imbalance of experienced and inexperienced nurses (Ball & McElligot, 2003). The challenge here, therefore, was to explore the social processes that underpinned the ways in which nurses focused on technological care more than the patient care and what were the contextual influences on their actions. This research adds new insights and extends knowledge into the nursing literature on CRRT nursing practice, AKI

care and clinical decision-making. It can be concluded from the above, therefore, that the complexity of nursing performance and decision-making with advanced technology such as CRRT, as the focus of this research, would appear to have been constrained with shared social, technological and organisational boundaries and the absence of any investigation of the advanced technological practice in the Saudi Arabian health care nursing. The research revealed an important understanding of the issues that emerged around the complexity of nursing performance and decision-making with CRRT machinery. The consequent discussion demonstrated the urgent need for organisational and social changes in the Saudi Arabian context to improve intensive care nursing practice with advanced technologies and give nurses adequate autonomy as decision-makers.

The significance of this research was that intensive care nurses lacked power in discussing with leaders and managers about their limited technological proficiency and participation in decision-making processes in relation to change management and improve practice due to nurses being subordinate, female and expatriates. The Saudi Arabian management processes are characterised by a hierarchy of power and authorisation, and a masculine culture which can be an explanation for limited communication channels. Thus, the way CRRT technology was dealt by nurses in this research was according to the meanings and decision-making of the managerial team rather than through collaboration. It appears that nursing leadership may be one significant influence on nurses' interactions with technology. A leader should create an organisational culture which enables groups to work together and to provide high-quality services. Effective nursing leadership in intensive care areas is important as ICUs face mounting challenges with advanced technologies.

In the Saudi Arabian health care system, staff relations are doctor centred and more authoritative. Doctors, therefore, have the power to influence nurse managers on how the latter should implement their managerial strategies. The challenge for nurse leaders is thus to

either conform to the higher authority of the medical profession in reinforcing the existing hierarchy or to work towards greater autonomy, better teamwork and essential resources for nursing. A further challenge is the multicultural workforce found in Saudi Arabia. To ensure autonomous clinical decision-making in relation to technology nurse managers have to negotiate the complexities of a hierarchy of authority and an international workforce.

Technology-centred care resulted in this research due to marginalising nurses from the decision-making process and created challenges in CRRT practice. The change process and improvement of nursing technological practice are needed and require positive, supportive and equivalent inter-professional relationships in the organisational culture. A fundamental restructure of the organisational and social support in Saudi Arabian hospitals particularly in the ICU is needed.

Hence, the lack of management support for the development of nursing technological skills to a professional level was evident due to limited access to ongoing education and training. This and other findings clearly reveal the need to review key aspects of education, training and clinical experience for nurses placed in the complex and challenging environment of ICU, dealing with critically ill, technologically dependent patients.

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Appendices

Appendix A: Conference Representation

EXAMINING INTENSIVE CARE NURSES' CLINICAL DECISION-MAKING ASSOCIATED WITH ACUTE KIDNEY INJURY AND CONTINUOUS RENAL REPLACEMENT THERAPY

Miss Hajar Ali Alasmari[1]
Professor Fiona Coyer[1,2]
Professor Ann Bonner [1,3]

[1] **School of Nursing, Queensland University of Technology, QLD, Australia**
[2] **Department of Intensive Care Medicine, Royal Brisbane and Women's Hospital, QLD, Australia**
[3] **Kidney Health Service, Royal Brisbane and Women's Hospital, QLD, Australia**

Introduction
Acute kidney injury (AKI) is a complex disorder which impacts upon patient morbidity and mortality, especially among critically ill adults. The increasing numbers of AKI patients in intensive care unit (ICU) settings and the complex treatment creates a greater need for nurses to make timely and safe clinical decisions. To date there have been no studies examining ICU nurses' clinical decision-making when providing continuous renal replacement therapy (CRRT).

Study Objectives
To understand how ICU nurses make clinical decisions that inform their actions when managing AKI patients and CRRT.

Method
A single explanatory case-study design was used. Over a six month period, 29 nurses working in ICU were observed while caring for patients who were receiving CRRT. Observations were followed by individual semi-structured interviews. Data were analysed thematically.

Results
One of the four themes identified involved complexity of performance with CRRT technology. This theme showed how ICU nurses make clinical decisions, and take action, in answer to AKI patient deterioration and CRRT issues. Two sub-themes emerged: recognising and responding to critically ill AKI patient conditions and CRRT problems. ICU nurses' performance varied between working rapidly, slowly and incompetently to identify and act on CRRT problems.

Conclusion
A high level of professional competence is crucial for ICU nurses to manage the complexity of critically ill AKI patients and CRRT technology. This study suggests that there is a need for ongoing education, competency development and training evaluations with CRRT technology and the deteriorating AKI patient.

Dear Hajar

Thank you for submitting an abstract for an oral presentation for consideration for the ANZICS/ACCCN 2015 ASM. The Reviewers have now completed their reviews. The standard of submissions this year was very high and we are delighted to advise your submission has been successful. Congratulations!

Could you kindly action the following:

- Confirm your intention to present by emailing selina@w4u.co.nz by Monday 31 August 2015
- Submit your PowerPoint (PPT) by Friday 25 September 2015. This will be forwarded to both the AV suppliers and the reviewers (as appropriate).

As a presenter at ANZICS/ACCCN 2015 ASM you are required to register and pay the appropriate fees. Please visit http://www.intensivecare.org.nz/registration for all costs, information and terms and conditions and to register online.
For your reference, please find your submission record at the below:

Submission ID: 39
Submission Title: EXAMINING INTENSIVE CARE NURSES' CLINICAL DECISION-MAKING ASSOCIATED WITH ACUTE KIDNEY INJURY AND CONTINUOUS RENAL REPLACEMENT THERAPY
Name: Hajar Alasmari
Presentation Type: Oral

Please do contact us if you have any questions. We look forward to seeing you at SkyCity Convention Centre, Auckland in October.

Kind Regards,
Donna Clapham
Workz4U Conference Management

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Appendix B: KAAUH Intensive Care Unit's CRRT Protocol Examples

❖ Follow up sheet	Day 1			Day 2			Day 3			Day 4		
	0 hr	12 hr	24 hr									
HR/SBP/ MAP/CVP	/ / /	/ / /	/ / /	/ / /			/ / /			/ / /		
★NGAL(serum/ urine)	/		/	/			/					
Cystatine-c												
Lactate												
SVO2												
Urine analysis:												
Protein												
Glucose												
WBC												
RBC												
Casts												
U&E												
Na												
K												
Cl												
Urea												
Creatinine												
Urine creatinine												
Urine Na												
Urine culture												
Bilirubin (serum)												
Blood gases												
PH												
PCO2/PO2	/	/	/	/			/			/		
HCO3												
Na/Cl	/	/	/	/			/			/		
Albumin												
CBC												
Hb												
RBC/Hct	/	/	/	/			/			/		
Platelets/WBC	/	/	/	/			/			/		
Vasoactive therapy(total)	0 hr	12 hr	24 hr	0	12	24	0	12	24	0	12	24
1												
2-												
3-												
4-												
CRRT (Yes/ No)												
BIPAP (Yes/ No)												
Scores:												
RIFLE												
SOFA												
APACHE II												
TISS 28 score												

❖ *Follow up sheet*

	Day 1			Day 2			Day 3			Day 4		
	0 hr	*12 hr*	*24 hr*									
HR/SBP/ MAP/CVP	/ / /	/ / /	/ / /	/ / /			/ / /			/ / /		
★**NGAL**(serum/ urine)	/		/	/			/					
Cystatin-c												
Lactate												
SVO2												
Urine analysis:												
Protein												
Glucose												
WBC												
RBC												
Casts												
U&E												
Na												
K												
Cl												
Urea												
Creatinine												
Urine creatinine												
Urine Na												
Urine culture												
Bilirubin (serum)												
Blood gases												
PH												
PCO2/PO2	/	/	/	/			/			/		
HCO3												
Na/Cl	/	/	/	/			/			/		
Albumin												
CBC												
Hb												
RBC/Hct	/	/	/	/			/			/		
Platelets/WBC	/	/	/	/			/			/		
Vasoactive therapy(total)	0 hr	12 hr	24 hr	0	12	24	0	12	24	0	12	24
1												
2-												
3-												
4-												
CRRT (Yes/ No)												
BIPAP (Yes/ No)												
Scores:												
RIFLE												
SOFA												
APACHE II												
TISS 28 score												

MRN.....
Serial no .....

Patient's name: ..... Age: ..... Gender: ..... Wt: ..... Ht: .....

Admission Dx:

.....

Discharge Dx:

.....

❖ *Inclusion criteria:*

	Yes *	Reading	No
>18 years old			
SBP <90 mmHg			
MAP <65 mmHg			
Vasoactive therapy			
Sepsis "not an absolute in. criteria"			

(*) Yes is the answer for inclusion

❖ *Vasoactive therapy:*

Name	Dose	Date/Start time	Date/ End time
1-			
2-			
3			

❖ *"In case of sepsis" what is/are the isolated organisms?*

.....

.....

❖ *Exclusion criteria:*

	Yes	No *
Creatinine > 200		
Obstructive Uropathy		
ERSD		
Pregnancy		

(*) No is the answer for inclusion

❖ *Notes:*

.....

.....

★
- The specimen will be in red top tube(plain tube)
- Sample to be send only Saturday, Sunday, and Monday up to 4PM(c/o Mr. Abdulsalam/ Al Diladi)
- The patient's selection should be from Sat/ Sun, and Monday.

KING ABDULAZIZ UNIVERSITY HOSPITAL
INTENSIVE CARE UNIT
DIALYSIS ORDER SHEET

Name of the Patient: _____ Age: _____ Sex: _____ Date: _____

File Number: _____ Wt: _____ Height: _____ BSA. _____

CRRT	Conventional Dialysis
SCUF ( ) CVVH ( ) CVVHDF ( )	☐ Conv. Dialysis.
1. Blood flow	☐ Filter Size. 12. 14. 16. 19.
Filter Size: 12. 14. 16. 19.	☐ Blood Flow
2. Dailysate type – ( )	☐ Daily Set Type
3. Dailysate Flow Rate. L/HR	K0 K1 K2
Add KCL to each liter of dailysate (meq/L)	☐ UFV (L)
IV. Replacement Solution	☐ Dialysis Duration
Type of Fluid	**Anti Coagulation**
PRE ( ) Post ( )	☐ Heparin Free:
Rate of Replacement ( )	☐ Systemic heparinization: (u/h)
V. Fluid Loss.	☐ Heparin bolus :
Initial Volume Loss ( ) Hourly Loss ( )	

VI. Other Order:

Physician Name: _____ Sign: _____

Appendix C: Ethics forms, introductory letter and Participant Information Sheet

- **Ethical Approval from Queensland University of Technology**

Queensland University of Technology Brisbane Australia	University Human Research Ethics Committee (UHREC) **Standard Conditions of Approval – Human Research**

All ethical approvals are granted subject to the following standard conditions of approval. These are also available online at:
www.research.qut.edu.au/ethics/humans/stdconditions.jsp
General Conditions
The research team must:
Conduct the project in accordance with your UHREC approved protocol.
Conduct the project in accordance with QUT policy, NHMRC / AVCC guidelines and regulations, and the provisions of any relevant State / Territory or Commonwealth regulations or legislation.
Respond to the requests and instructions of the University Human Research Ethics Committee (UHREC).
Ensure all research participants are provided with the current Participant Information Sheet and Consent Form, unless otherwise approved by the Committee.
Report on the progress of the approved project at least annually, and at the completion of the project.
(Where the research is publicly or privately funded) publish the results of the project is such a way to permit scrutiny and contribute to public knowledge.
Ensure, wherever possible, that the results of the research are made available to the participants.
Concerns, Complaints, Adverse Events and Unexpected Outcomes
Follow Section 5.5.3 of the National Statement which states that: 'Researchers have a significant responsibility in monitoring approved research as they are in the best position to observe any adverse events or unexpected outcomes. They should report such events or outcomes promptly to the relevant institution/s and ethical review body/ies and take prompt steps to deal with any unexpected risk'.
As such, the research team must, via the **Concerns, Complaints and Adverse Events form**:
Immediately advise the Research Ethics Coordinator, if any complaints are made, or expressions of concern are raised, in relation to the project.
Suspend or modify the project if the risks to participants are found to be disproportionate to the benefits, and immediately advise the Research Ethics Coordinator of this action.
Stop any involvement of any participant if continuation of the research may be harmful to that person, and immediately advise the Research Ethics Coordinator of this action.
Advise the Research Ethics Coordinator of any unforeseen development or events that might affect the continued ethical acceptability of the project.
Modifying your Ethical Clearance
The research team must:
Convey proposed changes to the Research Ethics Unit for appropriate review and approval, prior to implementation of any proposed change.
Submit requests for variations via the Variation Request Form; minor changes will be assessed on a case by case basis.

Note that major changes, depending upon the nature of the request, may require submission of a new application.
NOTE: **The UHREC may apply additional specific conditions to your approval. You will be notified of these in your approval email and certificate. You must ensure all research team members also understand and comply with any specific conditions of approval.**

From: QUT Research Ethics Unit <ethicscontact@qut.edu.au>
Date: 19 July 2013 11:23:04 am AEST
To: Hajar Ali M Alasmari <hajar.alasmari@student.qut.edu.au>, Ann Bonner <ann.bonner@qut.edu.au>, Fiona Coyer <f.coyer@qut.edu.au>
Cc: Janette Lamb <jd.lamb@qut.edu.au>
Subject: Ethics Application Approval -- 1300000339

Dear Ms Hajar Ali M Alasmari
Project Title: Examining intensive care nurses' clinical decision-making associated with acute kidney injury and continuous renal replacement therapy in Saudi Arabia

Ethics Category: **Human - Low Risk**
Approval Number: **1300000339**
Approved Until: **19/07/2016** (subject to receipt of satisfactory progress reports)

We are pleased to advise that your application has been reviewed by the Chair, University Human Research Ethics Committee (UHREC) and confirmed as meeting the requirements of the National Statement on Ethical Conduct in Human Research (2007).

I can therefore confirm that your application is APPROVED. If you require a formal approval certificate please respond via reply email and one will be issued.

CONDITIONS OF APPROVAL
Please ensure you and all other team members read through and understand all UHREC conditions of approval prior to commencing any data collection:
Standard: Please see attached or go to www.research.qut.edu.au/ethics/humans/stdconditions.jsp
Specific: None apply

Decisions related to low risk ethical review are subject to ratification at the next available UHREC meeting. You will only be contacted again in relation to this matter if UHREC raises any additional questions or concerns.

Whilst the data collection of your project has received QUT ethical clearance, the decision to commence and authority to commence may be dependent on factors beyond the remit of the QUT ethics review process. For example, your research may need ethics clearance from other organisations or permissions from other organisations to access staff. Therefore the proposed data collection should not commence until you have satisfied these requirements.

Please don't hesitate to contact us if you have any queries.

We wish you all the best with your research.

Kind regards
Janette Lamb on behalf of the Chair UHREC
Research Ethics Unit | Office of Research | Level 4 88 Musk Avenue, Kelvin Grove | Queensland University of Technology
p: +61 7 3138 5123 | e: ethicscontact@qut.edu.au | w: www.research.qut.edu.au/ethics

- **Ethical Approval from KAAUH**

KINGDOM OF SAUDI ARABIA
Ministry of Higher Education
KING ABDULAZIZ UNIVERSITY
Faculty of Medicine

المملكة العربية السعودية
وزارة التعليم العالي
جامعة الملك عبد العزيز
كلية الطب

Ref. : ..... الرقم : .....
Date : / / التاريخ : / / ١٤٣هـ
Encl. : ..... المرفقات: .....

UNIT OF
BIOMEDICAL ETHICS
Research Committee

TO :Principal Investigator: **Ms. Hajar Ali Alasmari** (Nursing Phd Candidate) From : Professor. Hasan Alzahrani
Supervisor : Prof. Ann Bonner co-supervisor : Dr. Fiona Coyer

Date: Wednesday, May 29, 2013 CC : Vice-Dean, University /Hospital Director& File & Expedite approval File
RE: "Examining Intensive Care Nurses' Clinical Decision-Making Associated with Acute Kidney Injury and Continuous Renal Replacement Therapy in Saudi Arabia." (Reference No 1159-13)

The above titled research/study proposal has been examined with the following enclosures:

- The study protocol
- Consent form

The REC recommended granting permission of approval to conduct the project along the following terms:

1. Any amendments to the approved protocol or any element of the submitted documents should NOT be undertaken without prior re-submission to, and approval of the REC for prior approval.
2. Monitoring: the project may be subject to an audit or any other form of monitoring by the REC.
3. The PI is responsible for the storage and retention of original data of the study for a minimum period of five years.

The Organization & operating procedure of the KAU. Faculty of Medicine - Research Ethics Committee(REC) are based on the Good Clinical Practice (GCP) Guidelines.

PLEASE NOTE THAT THIS APPROVAL IS VALID FOR ONE YEAR COMMENCING FROM THE DATE OF THIS LETTER.

Professor Hasan Alzahrani
Chairman of the Research Ethics Committee

(HA-02-J-008) No of Registration At National Committee of Bio.& Med. Ethics.

Mohammed al searee (Reference No 1159-13)

ص.ب ٨٠٢٠٥ جـــــــدة ٢١٥٨٩ فاكس ٦٤٠٠٨٥٥ ٦٩٥٢٠٦٣ / ٦٩٥٢٤٤١ :☎
P.O. Box 80205 Jeddah 21589 Fax : 6400855 ☎ : 6952063 /6952446

- **Introductory Letter**

Introduction letter

Dear Intensive Care Unit Nursing Staff,

The purpose of this letter is to invite you to participate in the project conducted by Miss Hajar Alasmari, a PhD student at Queensland University of Technology, Australia.

This research seeks to understand how Intensive Care Unit (ICU) nurses make clinical decisions that inform their nursing actions when managing adult patients with Acute Kidney Injury (AKI) who receive Continuous Renal Replacement Therapy (CRRT). CRRT involves advanced technology and management techniques that create a greater need for nurses to make timely decisions for complex patient care. This requires nurses to have sufficient knowledge and understanding to provide appropriate and safe nursing care in critical care environments. This research will explore how these decisions are made in practice.

I will observe and subsequently interview you when you make your clinical decisions about AKI patients who receive CRRT. You may fear that your performance will be assessed and reported to your supervisors. I therefore will inform each participant that the purpose of the observation is not to evaluate their work but to observe the current nursing clinical practice. I will provide you with more information about the project and invite you to participate. If you are willing to participate, you can contact Miss Hajar Alasmari (**+966557623023** or **hajar.alasmri@student.qut.edu.au**) and you will be required to voluntary sign consent.

Your participation will contribute towards a greater understanding of ICU nurses' clinical decision-making associated with AKI and CRRT in Saudi Arabia. I look forward to explaining more about this project at your next nursing meeting or ward based in-service.

Yours sincerely

Hajar Alasmari, RN, PhD candidate

Principal Researcher

- **Participant Information Sheet for Intensive Care Nurses**

Queensland University of Technology
Brisbane Australia

King Abdul-Aziz University Hospital (KAUH), Jeddah, Saudi Arabia

PARTICIPANT INFORMATION FOR QUT RESEARCH PROJECT
– Observation and Interview for ICU nurses –

Examining Intensive Care Nurses' Clinical Decision-Making Associated with Acute Kidney Injury and Continuous Renal Replacement Therapy in Saudi Arabia

QUT Ethics Approval Number 1300000339

RESEARCH TEAM

Principal Researcher: Hajar Alasmari, PhD student, QUT

Associate Researcher: Principal Supervisor, Professor Ann Bonner and Co-supervisor, Associate/ Professor Fiona Coyer, QUT

DESCRIPTION

The purpose of this project is to understand how intensive care unit (ICU) nurses make clinical decisions that inform their nursing actions when managing acute kidney injury (AKI) patients and continuous renal replacement therapy (CRRT). This project is being undertaken as part of a PhD research project by Hajar Alasmari. You are invited to participate in this project because you are an intensive care unit nurse who provides care for acute kidney injury patients who receive continuous renal replacement therapy.

PARTICIPATION

If you agree to take part in this project and sign a consent form, you will be observed on 2-4 occasions whilst you undertake nursing care for an AKI patient who is receiving CRRT. There will be up to 5 hours of observations. The researcher will take field notes during this time for subsequent analysis. After each observation an interview will be conducted in the privacy of an office and at a time which is convenient to you. The interview will last for no longer than 30-60 minutes and will be audio-taped. The first interview will collect your demographic characteristics (e.g. gender, age, education level, length of work experience in the nursing profession, and length of work experience in ICU and clinical experience with AKI patients and CRRT). In the interviews questions such as 'I noticed that you did … could you tell me why you did that?' or 'did you do this because of …?' will be asked.

Your participation in this project is entirely voluntary. If you do agree to participate you can withdraw from the project without comment or penalty. If you withdraw, on request any identifiable information already obtained from you will be destroyed. Your decision to participate or not participate will in no way impact upon your current or future relationship with your workplace or QUT.

EXPECTED BENEFITS

There are no direct benefits for you in participating in this research. Your participation will contribute towards a greater understanding of ICU nurses' clinical decision-making associated with AKI and CRRT in Saudi Arabia. This study will add to the existing literature on ICU nurses' clinical decision-making when providing care to AKI patients on CRRT. An increased understanding of ICU nurses' decision-making practices will be useful to inform the postgraduate education of nurses. It may also help to develop a standard tool to improve and evaluate ICU nurses' performance with CRRT in the future.

RISKS

Participating in this project that uses observation and interview methods may cause some emotional discomfort. Participants may fear that their performance will be assessed and reported to their supervisors. The researcher therefore will inform each participant that the purpose of the observation is not to evaluate their work but to observe current nursing clinical practice. If you experience any discomfort or distress from being observed or answering the questions, observation or interviewing will immediately cease. If you are distressed from this project please contact the staff psychologist within the hospital for confidential counselling. The psychologist has been informed of this study.

PRIVACY AND CONFIDENTIALITY

The collected data from observations and interviews will remain confidential and following transcription, anonymous. Your privacy is assured. All information will be stored securely in a locked filing cabinet in the Principal Investigator's office at Queensland University of Technology (QUT) and no supervisor or manager in your workplace or elsewhere will have access to your data.

Non-identifiable data collected by the audio recording in this project may be used as comparative data in future projects or stored on an open access database for secondary analysis. The information will also be entered onto a computer file held on a password protected computer to assist with analysis. Data will be stored for seven (7) years. Once the project is completed and the data analysed, all hard copy documents identifying you will be destroyed by shredding.

CONSENT TO PARTICIPATE

We would like to ask you to sign a written consent form (enclosed) to confirm your agreement to participate.

QUESTIONS / FURTHER INFORMATION ABOUT THE PROJECT

If you have any questions or require further information please contact one of the research team members below.

Hajar Alasmari Name – PhD Candidate
School of Nursing
Faculty of Health/ Queensland University of Technology (QUT)
+966557623023
hajar.alasmri@student.qut.edu.au

Professor Ann Bonner
School of Nursing
Faculty of Health/ Queensland University of Technology (QUT)
+61731380823
ann.bonner@qut.edu.au

A/Professor Fiona Coyer
School of Nursing
+61731383895
f.coyer@qut.edu.au

CONCERNS / COMPLAINTS REGARDING THE CONDUCT OF THE PROJECT

If you wish to find out more about the research, at King Abdul-Aziz University contact the secretary of the ethics committee on 02-6952000 or the QUT Research Ethics Unit (telephone:0061731385123; email: ethicscontact@qut.edu.au). Any concerns/complaints lodged to the Ethics Committee of KAUH will be also reported to the QUT Research Ethics Unit. Neither the Ethics Committee of King Abdul-Aziz University nor the QUT Research Ethics Unit is connected with the research project nor can both facilitate a resolution to your concern in an impartial manner.

Thank you for helping with this research project. Please keep this sheet for your information.

- **Participant Consent**

Queensland University of Technolog
Brisbane Australia

King Abdul-Aziz University Hospital (KAUH), Jeddah, Saudi Arabia

CONSENT FORM FOR QUT RESEARCH PROJECT
–Observation and Interview for ICU nurses –

Examining Intensive Care Nurses' Clinical Decision-Making Associated with Acute Kidney Injury and Continuous Renal Replacement Therapy in Saudi Arabia

QUT Ethics Approval Number 1300000339

RESEARCH TEAM CONTACTS

Hajar Alasmari Name – PhD Candidate
School of Nursing
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Professor Ann Bonner
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Faculty of Health/ Queensland University of Technology (QUT)
+61731380823
ann.bonner@qut.edu.au

A/Professor Fiona Coyer
School of Nursing
+61731383895
f.coyer@qut.edu.au

STATEMENT OF CONSENT

By signing below, you are indicating that you:

- Have read and understood the information document regarding this project.
- Have had any questions answered to your satisfaction.
- Understand that if you have any additional questions you can contact the research team.
- Understand that you are free to withdraw at any time, without comment or penalty.
- Understand that you can contact the Research Ethics Unit of QUT on +6173138 5123 or email ethicscontact@qut.edu.au or King Abdul-Aziz University contact the secretary at 02-6952000, if you have concerns about the ethical conduct of the project.
- Understand that the project will include observation and an audio recording and the results will be written in papers and published.
- Agree to participate in the project.

Name .....

Signature .....

Date .....

Please return this sheet to the investigator.

- **Withdrawal Consent**

Queensland University of Techno Brisbane Australia King Abdul-Aziz University Hospital (KAUH), Jeddah, Saudi Arabia	**WITHDRAWAL OF CONSENT FOR QUT RESEARCH PROJECT** **– Observation and Interview for ICU nurses –**

Examining Intensive Care Nurses' Clinical Decision-Making Associated with Acute Kidney Injury and Continuous Renal Replacement Therapy in Saudi Arabia

QUT Ethics Approval Number 1300000339

- **RESEARCH TEAM CONTACTS**

Hajar Alasmari Name – PhD Candidate School of Nursing Faculty of Health/ Queensland University of Technology (QUT) **+966557623023** **hajar.alasmri@student.qut.edu.au**	Professor Ann Bonner School of Nursing Faculty of Health/ Queensland University of Technology (QUT) **+61731380823** **ann.bonner@qut.edu.au**	A/Professor Fiona Coyer School of Nursing **+61731383895** **f.coyer@qut.edu.au**

I hereby wish to WITHDRAW my consent to participate in the research project named above.

I understand that this withdrawal WILL NOT jeopardise my relationship with my workplace King Abdul-Aziz University Hospital (KAUH) and Queensland University of Technology (QUT).

Name .....

Signature .....

Date .....

- **Participant Information Sheet for other health professionals**

Queensland University of Technolog
Brisbane Australia

King Abdul-Aziz University Hospital (KAUH), Jeddah, Saudi Arabia

PARTICIPANT INFORMATION FOR QUT RESEARCH PROJECT
– Observation for other Health professionals –

Examining Intensive Care Nurses' Clinical Decision-Making Associated with Acute Kidney Injury and Continuous Renal Replacement Therapy in Saudi Arabia

QUT Ethics Approval Number 1300000339

RESEARCH TEAM

Principal Researcher: Hajar Alasmari, PhD student, QUT

Associate Researcher: Principal Supervisor, Professor Ann Bonner and Co-supervisor, Associate/ Professor Fiona Coyer, QUT

DESCRIPTION

The purpose of this project is to understand how intensive care unit (ICU) nurses use patient objective and subjective data and their working knowledge to make clinical decisions that inform their nursing actions when managing acute kidney injury (AKI) patients and continuous renal replacement therapy (CRRT). This project is being undertaken as part of PhD research by Hajar Alasmari. You are being advised of this study and being asked to consent to indirect participation because you are a health professional who ICU nurses interact/communicate with when they make their clinical decisions with respect to your mutual patients.

PARTICIPATION

You will not directly participate in this research; the researcher will observe ICU nurses' clinical decision-making when they interact/communicate with you.Your participation in this project is entirely voluntary. If you do agree to participate you can withdraw from the project without comment or penalty. If you withdraw, on request any identifiable information already obtained from you will be destroyed. Your decision to participate or not participate will in no way impact upon your current or future relationship with your workplace or QUT.

EXPECTED BENEFITS

There are no direct benefits for you in participating in this research. Your participation will contribute towards a greater understanding of ICU nurses' clinical decision-making associated with AKI and CRRT in Saudi Arabia.

RISKS

The researcher will observe ICU nurses when they interact with you in order to make their decisions with AKI patients and CRRT. It may cause some emotional discomfort. If you experience any discomfort or distress from being observed with ICU nurses, observations will immediately cease. If you are distressed from this project help will be offered by the psychologist within the hospital for confidential counseling.

PRIVACY AND CONFIDENTIALITY

Confidentiality will be maintained as no identifying information will be collected about you. The researcher will not collect information from you. However, the researcher might collect some information when ICU nurses interact/ communicate with you in order to make decisions about AKI patient with CRRT. This information is confidential and your privacy is assured. Any information will be stored securely in a locked filing cabinet in the researcher's office, and will only be available to the research team. Once the project is completed and the data analysed, all hard copy documents will be destroyed by shredding.

CONSENT TO PARTICIPATE

We would like to ask you to sign a written consent form (enclosed) to confirm your agreement to participate.

QUESTIONS / FURTHER INFORMATION ABOUT THE PROJECT

If have any questions or require further information please contact one of the research team members below.

Hajar Alasmari Name – PhD Candidate
School of Nursing
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Professor Ann Bonner
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+61731380823

ann.bonner@qut.edu.au

A/Professor Fiona Coyer
School of Nursing
+61731383895

f.coyer@qut.edu.au

CONCERNS / COMPLAINTS REGARDING THE CONDUCT OF THE PROJECT

If you wish to find out more about the research ethics committee, at King Abdul-Aziz University contact the secretary on 02-6952000 or the QUT Research Ethics Unit (telephone: 0061731385123; email: ethicscontact@qut.edu.au). Any concerns/complaints lodged to the Ethics Committee of KAUH will be also reported to the QUT Research Ethics Unit. Neither the Ethics Committee of King Abdul-Aziz University nor the QUT Research Ethics Unit is connected with the research project nor can both facilitate a resolution to your concern in an impartial manner.

Thank you for helping with this research project. Please keep this sheet for your information.

- **Participant Consent for other health professionals**

Queensland University of Technology
Brisbane Australia

King Abdul-Aziz University Hospital (KAUH), Jeddah, Saudi Arabia

CONSENT FORM FOR QUT RESEARCH PROJECT
– Observation for other Health professionals –

Examining Intensive Care Nurses' Clinical Decision-Making Associated with Acute Kidney Injury and Continuous Renal Replacement Therapy in Saudi Arabia

QUT Ethics Approval Number 1300000339

RESEARCH TEAM CONTACTS

Hajar Alasmari Name – PhD Candidate	Professor Ann Bonner	A/Professor Fiona Coyer
School of Nursing Faculty of Health/ Queensland University of Technology (QUT)	School of Nursing Faculty of Health/ QUT	School of Nursing Faculty of Health/QUT
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hajar.alasmri@student.qut.edu.au	**ann.bonner@qut.edu.au**	**f.coyer@qut.edu.au**

STATEMENT OF CONSENT

By signing below, you are indicating that you:

- Have read and understood the information document regarding this project.
- Have had any questions answered to your satisfaction.
- Understand that if you have any additional questions you can contact the research team.
- Understand that you are free to withdraw at any time, without comment or penalty.
- Understand that you can contact the Research Ethics Unit of QUT on +6173138 5123 or email ethicscontact@qut.edu.au or King Abdul-Aziz University through the secretary on 02-6952000, if you have concerns about the ethical conduct of the project.
- Understand that the project will include observation.
- Understand that any information or personal details gathered in the course of this research about me are confidential, and that neither my name nor any other identifying information will be collected.
- Agree to participate in the project.

Name .....

Signature .....

Date .....

Please return this sheet to the investigator.

- **Participant Consent for Patient's Family member**

Queensland University of Technology Brisbane Australia King Abdul-Aziz University Hospital (KAUH), Jeddah, Saudi Arabia	**PARTICIPANT INFORMATION FOR QUT RESEARCH PROJECT** **– Observation for Patient's Family member–**
Examining Intensive Care Nurses' Clinical Decision-Making Associated with Acute Kidney Injury and Continuous Renal Replacement Therapy in Saudi Arabia **QUT Ethics Approval Number 1300000339**	

RESEARCH TEAM

Principal Researcher: Hajar Alasmari, PhD student, QUT

Associate Researcher: Principal Supervisor, Professor Ann Bonner and Co-supervisor Associate/ Professor Fiona Coyer, QUT

DESCRIPTION

The purpose of this project is to understand how intensive care unit (ICU) nurses use patient objective and subjective data and their working knowledge to make clinical decisions that inform their nursing actions when managing acute kidney injury (AKI) patients and continuous renal replacement therapy (CRRT). This project is being undertaken as part of PhD research by Hajar Alasmari. You are a relative/family member of an acute kidney injury patient who is receiving continuous renal replacement therapy in an adult intensive care unit and unable to sign consent to participate in this project.

PARTICIPATION

Your relative will not directly participate in this research; the researcher will observe ICU nurses practices when they provide care for your relative. The researcher will be observing the nurse as she/he monitors your relative clinical signs and symptoms and the kidney treatment (called continuous renal replacement therapy). Your relative participation in this project is entirely voluntary. If you on behalf of your relative do agree to participate your relative can withdraw from the project without comment or penalty. If your relative withdraws, on request any identifiable information already obtained from your relative will be destroyed. Your decision on behalf of your relative to participate or not participate will in no way impact upon your relative current or future relationship with your relative workplace or QUT.

EXPECTED BENEFITS

There are no direct benefits for your relative in participating in this research. Your relative participation will contribute towards a greater understanding of ICU nurses' clinical decision-making associated with AKI and CRRT in Saudi Arabia.

RISKS

There will be no anticipated risks involved in observing ICU nurses provide care for your relative. If your relative experiences any discomfort or distress from being observed, observations will immediately cease. If your relative are distressed from this project help will be offered by the psychologist within the hospital for confidential counseling.

PRIVACY AND CONFIDENTIALITY

Confidentiality will be maintained as no identifying information will be collected about your relative.

The researcher will not collect information from your relative medical file. However, the researcher might collect some information when ICU nurses make decisions about your relative clinical conditions with CRRT. This information is confidential and your relative privacy is assured. Any information will be stored securely in a locked filing cabinet in the researcher's office and will only be available to the research team. Once the project is completed and the data analysed, all hard copy documents will be destroyed by shredding.

CONSENT TO PARTICIPATE

We would like to ask you to sign a written consent form (enclosed) to confirm your agreement on behalf of your relative to participate.

QUESTIONS / FURTHER INFORMATION ABOUT THE PROJECT

If you have any questions or require further information please contact one of the research team members below.

Hajar Alasmari Name – PhD Candidate
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A/Professor Fiona Coyer
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f.coyer@qut.edu.au

CONCERNS / COMPLAINTS REGARDING THE CONDUCT OF THE PROJECT

If you wish to find out more about the research ethics committee at King Abdul-Aziz University contact the secretary at 02-6952000 or the QUT Research Ethics Unit (telephone:0061731385123; email: ethicscontact@qut.edu.au). Any concerns/complaints lodged to the Ethics Committee of KAUH will be also reported to the QUT Research Ethics Unit. Neither the Ethics Committee of King Abdul-Aziz University nor the QUT Research Ethics Unit is connected with the research project nor can both facilitate a resolution to your concern in an impartial manner.

Thank you for helping with this research project. Please keep this sheet for your information

Appendix D: Short Tool of Demographic Characteristics of Intensive Care Nurses

A descriptive qualitative Study Design
Short tool

Demographic characteristics of ICU nurses:

What is the participant gender? Female Male

How old are you? .....years

What is your highest level of education?

Diploma Bachelor degree Post-graduate

How long have you been working as a registered nurse?

Years …… Months …….

How long have you been working in the intensive care unit?

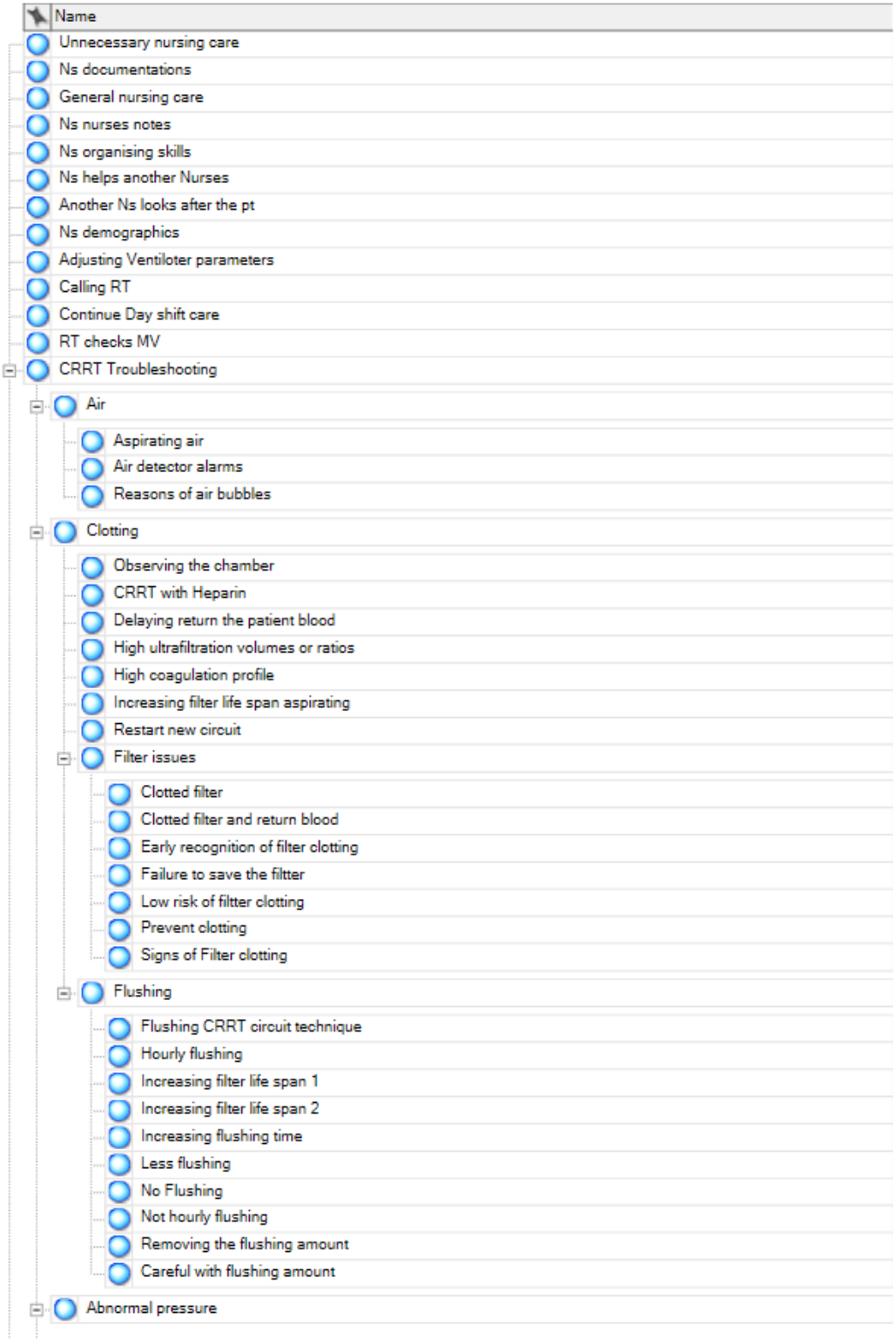
Years …… Months …….

How long have you been working with AKI patient and CRRT?

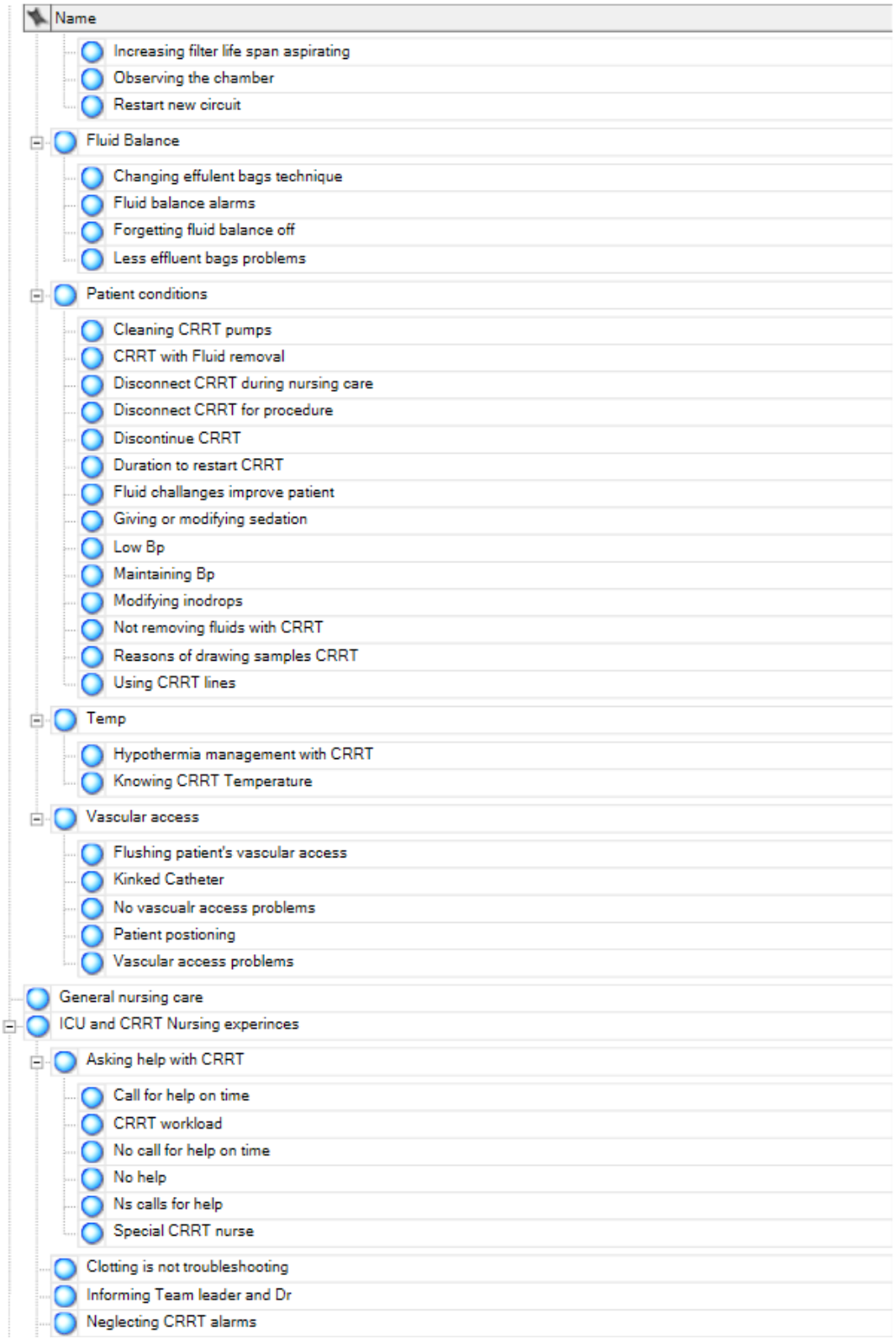
Years ……. Months…….

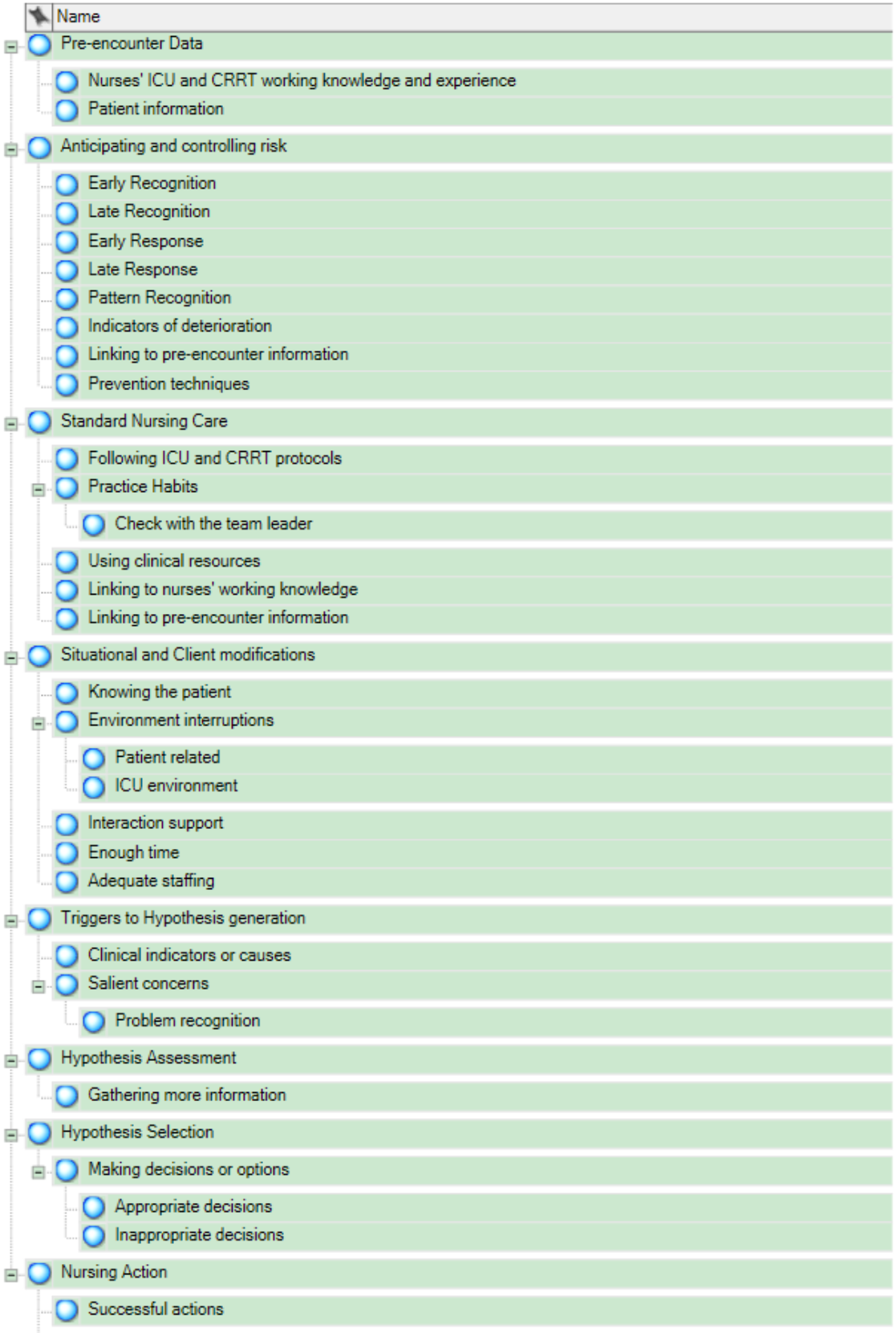
Appendix E: Data Management, Coding Process through NVivo10 Software

Nodes



Nodes


Name
Increasing filter life span aspirating
Observing the chamber
Restart new circuit
Fluid Balance
Changing effulent bags technique
Fluid balance alarms
Forgetting fluid balance off
Less effluent bags problems
Patient conditions
Cleaning CRRT pumps
CRRT with Fluid removal
Disconnect CRRT during nursing care
Disconnect CRRT for procedure
Discontinue CRRT
Duration to restart CRRT
Fluid challanges improve patient
Giving or modifying sedation
Low Bp
Maintaining Bp
Modifying inodrops
Not removing fluids with CRRT
Reasons of drawing samples CRRT
Using CRRT lines
Temp
Hypothermia management with CRRT
Knowing CRRT Temperature
Vascular access
Flushing patient's vascular access
Kinked Catheter
No vascualr access problems
Patient postioning
Vascular access problems
General nursing care
ICU and CRRT Nursing experinces
Asking help with CRRT
Call for help on time
CRRT workload
No call for help on time
No help
Ns calls for help
Special CRRT nurse
Clotting is not troubleshooting
Informing Team leader and Dr
Neglecting CRRT alarms


Name
Pre-encounter Data
Nurses' ICU and CRRT working knowledge and experience
Patient information
Anticipating and controlling risk
Early Recognition
Late Recognition
Early Response
Late Response
Pattern Recognition
Indicators of deterioration
Linking to pre-encounter information
Prevention techniques
Standard Nursing Care
Following ICU and CRRT protocols
Practice Habits
Check with the team leader
Using clinical resources
Linking to nurses' working knowledge
Linking to pre-encounter information
Situational and Client modifications
Knowing the patient
Environment interruptions
Patient related
ICU environment
Interaction support
Enough time
Adequate staffing
Triggers to Hypothesis generation
Clinical indicators or causes
Salient concerns
Problem recognition
Hypothesis Assessment
Gathering more information
Hypothesis Selection
Making decisions or options
Appropriate decisions
Inappropriate decisions
Nursing Action
Successful actions

Nodes

Name	Sources	References	Created On
Attributes shaping nurses' CDM	85	227	5/11/2014 7:14 PM
Complexity of Performance	104	653	14/05/2014 12:11 PM
Negotiating CRRT practices	0	0	28/04/2018 10:00 PM
A hierarchy in Healthcare	0	0	28/04/2018 10:00 PM
Needing Written infromation	42	54	10/09/2014 1:13 PM
Following clinical practice g	16	17	10/04/2014 1:41 PM
Following doctors order	12	14	6/04/2014 3:59 PM
Following ICU correction rou	9	10	23/04/2014 2:57 PM
Not following clinical practic	12	13	3/04/2014 2:42 PM
Developing knowledge on the job	0	0	28/04/2018 10:01 PM
Understanding information fro	106	396	11/11/2014 1:06 PM
Normalising CRRT practices	0	0	28/04/2018 10:02 PM
Institutionalisation	0	0	28/04/2018 10:02 PM
Rationalisation	0	0	28/04/2018 10:03 PM
Linking patient information	86	247	24/09/2014 2:47 PM
Limited linking patient infor	70	184	9/04/2014 12:16 PM
Linking patient information	42	63	3/04/2014 11:47 AM
Socialisation	0	0	28/04/2018 10:02 PM
Interacting with other professio	49	116	14/05/2014 3:27 PM
Shared opinions	49	116	10/09/2014 1:15 PM
Informing Team leader a	8	9	23/04/2014 2:58 PM
Ns and doctor interactio	37	62	2/04/2014 6:50 PM
Ns's suggestion to docto	5	5	7/04/2014 11:55 AM
Requiring doctors clarific	3	4	3/04/2014 2:16 PM
Team leader and Ns inte	14	19	14/04/2014 1:04 PM
Updating doctors	15	17	2/04/2014 6:51 PM
The centrality of technology	0	0	28/04/2018 10:03 PM
Mediating technology	0	0	28/04/2018 10:04 PM
Nursing alarm fatique	0	0	28/04/2018 10:04 PM
Troubleshooting CRRT (complex practi	104	653	13/05/2014 7:15 PM