CRITICAL CARE NURSES' HAEMODYNAMIC DECISION MAKING

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

Deakin University
October 2003
DEAKIN UNIVERSITY
CANDIDATE DECLARATION

I certify that the thesis entitled Critical Care Nurses' Haemodynamic Decision Making submitted for the degree of Doctor of Philosophy

is the result of my own work and that where reference is made to the work of others, due acknowledgment is given.

I also certify that any material in the thesis which has been accepted for a degree or diploma by any other university or institution is identified in the text.

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Date: October 27, 2003
ABSTRACT

For cardiac surgical patients, the immediate 2-hour recovery period is distinguished by potentially life-threatening haemodynamic instability. To ensure optimum patient outcomes, nurses of varying levels of experience must make rapid and accurate decisions in response to episodes of haemodynamic instability. Decision complexity, nurses' characteristics, and environmental characteristics, have each been found to influence nurses' decision making in some form. However, the effect of the interplay between these influences on decision outcomes has not been investigated. The aim of the research reported in this thesis was to explore variability in critical care nurses' haemodynamic decision making as a function of interplay between haemodynamic decision complexity, nurses' experience, and specific environmental characteristics by applying a naturalistic decision making design.

Thirty-eight nurses were observed recovering patients in the immediate 2-hour period after cardiac surgery. A follow-up semi-structured interview was conducted. A naturalistic decision making approach was used. An organising framework for the goals of therapy related to maintaining haemodynamic stability after cardiac surgery was developed to assist the observation and analysis of practice. The three goals of therapy were the optimisation of cardiovascular performance, the promotion of haemostasis, and the reestablishment of normothermia. The research was conducted in two phases. Phase One explored issues related to observation as method, and identified emergent themes. Phase Two incorporated findings of Phase 1, investigating the variability in nurses' haemodynamic decision making in relation to the three goals of therapy.

The findings showed that patients had a high acuity after cardiac surgery and suffered numerous episodes of haemodynamic instability during the immediate 2-hour recovery period. The quality of nurses' decision making in relation to the three goals of therapy was influenced by the experience of the nurse and social interactions with colleagues. Experienced nurses demonstrated decision making that reflected the ability to recognise subtle changes in haemodynamic cues, integrate complex combinations of cues, and respond rapidly to instability. The quality of inexperienced nurses' decision making varied according to the level and form of decision support as well as the
complexity of the task. When assistance was provided by nursing colleagues during the reception and recovery of patients, the characteristics of team decision making were observed. Team decision making in this context was categorised as either integrated or non-integrated. Team decision making influenced nurses' emotions and actions and decision making practices. Findings revealed nurses' experience affected interactions with other team members and their perceptions of assuming responsibility for complex patients.

Interplay between decision complexity, nurses’ experience, and the environment in which decisions were made influenced the quality of nurses' decision making and created an environment of team decision making, which, in turn, influenced nurses' emotional responses and practice outcomes. The observed variability in haemodynamic decision making has implications for nurse education, nursing practice, and system processes regarding patient allocation and clinical supervision.
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GLOSSARY

Activated clotting time: duration in seconds it takes blood to form a clot
Activated partial thromboplastin time: indicates the degree, in seconds, of anticoagulation due to heparin administration
Acquired valve disease: valve disease which is neither genetic nor present at birth
Adrenaline: synthetic agent of the catecholamine epinephrine. It is administered in an infusion or bolus form to increase heart rate, blood pressure, and myocardial contractility
Afterload: the resistance of the arteries and arterioles against which the heart pumps against in order to eject blood
Aminocaproic acid: haemostatic drug
Anastomosis: connection between blood vessels
Anticoagulation: the process of 'thinning' blood to suppress formation of clots. It is achieved by administering a drug such as Heparin
Aortic valve: valve between the left ventricle and the aorta
Aprotinin: haemostatic drug
Assistant nurse: nurse who provides assistance to the primary nurse during the reception and recovery of a cardiac surgical patient in the critical care unit
Bradycardia: heart rate below 60 beats per minute
Bradykinin: substance in the body released during cardiopulmonary bypass that causes blood vessels to dilate and increased capillary permeability
Capillary permeability: the degree to which fluid and other substances can pass through the smallest vessels arterioles and venules
Cardiac tamponade: compression of the heart due to fluid accumulation in the pericardium
Cardioplegia: the stopping of myocardial contractions through the use of chemical or cold compounds during cardiac surgery
Cardiopulmonary bypass: diversion of the blood circulation from the heart and lungs and the pumping of blood through a heart–lung machine to provide oxygen while the heart is stopped during surgery.
Cardiothoracic: term used synonymously for cardiac surgical (patients or nurses)
Central venous pressure: the pressure of blood in the right atrium
Coagulation: formation of a clot
Coagulopathy: any disorder of blood coagulation
Complement: substance released by the body during cardiopulmonary bypass that cause blood vessels to dilate
Complete observer: also called non-participant observer and precludes the researcher's participation in patient management decisions or activities
Coronary artery bypass graft surgery (CABGS): surgical grafting of blood vessel(s) to bypass obstructions in coronary arteries and improve the supply of arterial blood to the heart.
Coronary artery disease: any disease of the coronary arteries, particularly atherosclerosis, that reduces the flow of blood and hence the oxygen supply to the heart muscle.
Dopamine: synthetic agent of the organic catecholamine dopamine used to increase perfusion to the renal arteries, blood pressure, and myocardial contractions
Dysrhythmia: abnormality in heartbeat, making it beat too fast, too slow or irregularly
Ecological validity: a form of external validity that refers specifically to the extent to which the results of a study may be generalised to a real-world setting
Extubation: removal of the endo-tracheal tube
Failure to capture: failure of the pacemaker cause electrical activity in the heart
Failure to pace: failure of the pacemaker to send electrical activity to the heart
Fibrillation: rapid, uncoordinated quivering of the muscle fibres of the heart instead of beating, so it cannot pump.
Friable: easily crumbled
Gelofusine: colloid fluid of synthetic plasma, used to increase intravascular volume
Glyceryl trinitrate: drug that causes vasodilation
Haemaccel: colloid fluid of synthetic plasma, used to increase intravascular volume
Haemodilution: increase in the fluid content of blood, resulting in a decrease of the concentration of formed elements such as clotting factors and haemoglobin
Haemodynamic: movement of the blood and the forces therein
Haemodynamic monitoring: continuous monitoring of the movement of blood and the pressures being exerted in veins, arteries, and chambers of the heart

Haemostasis: cessation of bleeding through clot formation

Heparin: anticoagulant drug, used to thin blood whilst on cardiopulmonary bypass

Hypokalaemia: low serum level of potassium. May lead to cardiac dysrhythmia

Hypothermia: core temperature of less than, or equal to, 36 ºC

Hypovolaemia: insufficient fluid circulating in the intravascular space

Hypovolaemic: a state of hypovolaemia

Hypoxaemia: deficiency of oxygen in the blood

Injectate: intravenous solution, usually 10 mls of 5% Dextrose, used in measurement of cardiac output via thermodilution method

Inotrope: drug that increases the force of contraction of the myocardium

Inodilator: drug that increases the force of myocardial contraction and dilates peripheral arteries

Intensivist: doctor in charge of critical care

Internal mammary artery: an artery in the chest most commonly used as a conduit in coronary artery bypass grafting, that is, used as a graft

Intra-aortic balloon pump: mechanical device that is inserted in the aorta to lower afterload and increase myocardial contractility

Manifold: plastic tray for holding pressure transducers

Milronone: generic name of a drug with inodilator properties

Mitral valve: valve between the left atrium and the left ventricle.

Myocardial infarction: death of part of the heart muscle deprived of an adequate blood supply by coronary artery blockage (heart attack).

Myocardium: the muscular wall of the heart

Nitric oxide: gas that is inhaled to induce pulmonary vasodilation and therefore reduction of the afterload of the right ventricle

Noradrenaline: synthetic agent of the catecholamine norepinephrine. It is administered in an infusion or bolus form to increase blood pressure by constricting arteries.

Normothermia: a core temperature ranging between 36.6 ºC and 37.5 ºC

Oedema: an abnormal accumulation of fluid in the extracellular spaces of the body

Primary nurse: nurse allocated to recover a postoperative cardiac patient
**Preload:** volume of blood in the right and left ventricles prior to ejection reflected by the central venous pressure and the pulmonary capillary wedge pressure respectively

**Protamine sulphate:** haemostatic agent

**Pulmonary artery catheter:** a catheter inserted in the subclavian or jugular vein that passes through the right atrium and right ventricle and rests in the pulmonary artery. A standard thermodilution pulmonary artery catheter provides for monitoring of central venous pressure, pulmonary artery pressures, cardiac output measurements, and core temperature

**Pulmonary capillary wedge pressure:** pressure in the left atrium which reflects volume of blood in the left ventricle, measured via a pulmonary artery catheter in critical care

**Pump blood:** extraneous blood from the cardiopulmonary bypass circuitry that is pooled and may be reinfused to the patient in the postoperative period

**Relative hypovolaemia:** a decrease of fluid only in the intravascular space rather than an overall loss of fluid in the body as per the case in hypovolaemia

**Renin-angiotensin system:** multi-stage bodily response that results in vasoconstriction and retention of salt and water which leads to increased fluid in the intravascular space

**Resident:** junior medical staff in critical care

**Registrar:** senior medical staff in critical care, subordinate to intensivist

**Sodium nitroprusside:** potent drug that causes arterial vasodilation

**Saphenous vein:** a blood vessel in the leg; not used as often for conduits for coronary artery bypass grafting now that radial artery and internal mammary arteries are used

**Swan or Swan-Ganz catheter:** trade name commonly used by clinical nurses when referring to pulmonary artery catheter

**Systemic vascular resistance:** measurement of afterload of the left ventricle

**Tachycardia:** heart rate greater than 100 beats per minute

**Tension pneumothorax:** accumulation of fluid or gas in the pleural cavity with the additional problem of the air being unable to escape which results in collapse of the lung

**Third spacing:** movement of fluid out of the intravascular space to the interstitial space

**Transducer:** object that converts biophysical event (such as blood pressure) into an electric event which can be displayed on a cardiac monitor

**Tricuspid valve:** valve between the right atrium and the right ventricle

**Vasoactive:** potent drug used to dilate or constrict blood vessels
Vasoconstriction: the state of narrowed blood vessels
Vasoconstrictor: drug that causes constriction (narrowing) of blood vessels
Vasodilator: drug that induces dilation (widening) of blood vessels
Vasodilation: the state of increased diameter of blood vessel
Viscera: large interior organs in any large body cavity
ABBREVIATIONS

AACN: American Association of Critical-Care Nurses
ACLS: advanced cardiac life support
BPM: beats per minute
CABGS: coronary artery bypass graft surgery
CVP: central venous pressure
ECG: electrocardiograph
GTN: glyceryl trinitrate
ICU: intensive care unit
ID: patient identity
MAP: mean arterial pressure
PAC: pulmonary artery catheter
PCWP: pulmonary capillary wedge pressure
SaO₂: arterial oxygen saturation
SpO₂: arterial oxygen saturation via pulse oximetry
SVR: systemic vascular resistance
CHAPTER 1

THE RESEARCH PROBLEM

For cardiac surgical patients, the immediate 2-hour recovery period is marked by potentially life-threatening haemodynamic instability. Within this context of instability, the haemodynamic decision making required of nurses is complex. To optimise patient outcomes, rapid and accurate decision making is required of nurses who have varying levels of experience. In addition, this complex decision making takes place in a clinical environment that has unique features. Decision complexity, nurses' experience, and features of the environment in which decisions are made are hereafter referred to as the multifactorial influences on decision making. These influences have each been found to vary nurses' decision making in some form, but there is a poor understanding of the effects of interplay between decision complexity, nurses' experience, and environmental characteristics on the outcomes of nurses' decision making. It is proposed that this interplay is likely to lead to variability in nurses' assessment and interventional decisions related to patients' haemodynamic status. In addition, the absence of clear practice guidelines about what haemodynamic parameters are salient or what assessments and interventions should be prioritised to improve patient outcomes in this context intensifies the potential for decision making variability. Little is known about the potential implications for patient outcomes of interplay between the multifactorial influences on decision making because methodological issues and limitations associated with previous research have failed to capture such relationships.

Patients in the 2-hour recovery period after cardiac surgery are haemodynamically unstable because of multiple physiological disturbances associated with cardiopulmonary bypass. If nurses do not anticipate, prevent, and alleviate haemodynamic instability through their decision making, adverse patient outcomes may result. Although the clinical sequelae of cardiac surgery for patients are somewhat predictable and the surgery is considered routine because of its frequency, nurses' decision making in the recovery period is complex. In particular, haemodynamic decision making is complex because nurses have to consider numerous alternative
parameters, each with numerous attributes, within a rapid time frame (Payne, 1982). In order to describe the complexity of haemodynamic decision making as well as to provide an organising framework for both the literature review and analysis in this thesis, nurses' haemodynamic decision making in the postoperative period has been classified into three major goals. The three postoperative goals of therapy are the optimisation of cardiovascular performance, the promotion of haemostasis, and the reestablishment of normothermia. Research findings from laboratory-based studies suggest that complex decision tasks can influence decision processes and performances (Orasanu & Connolly, 1993; Payne, 1976). Specifically, individuals have been found to use fewer information cues (Wright, 1974), be more hesitant to make a decision (Lewis, 1997), pay less attention to attributes of a task (Chinburapa et al., 1993) and be less consistent in their decision making (Hughes & Young, 1990) when making complex decisions. A naturalistic study found experienced nurses used goal-directed processes in complex decision making, whereas inexperienced nurses used rule-based processes (Ellis, 1997). Little is known about how nurses' decision making varies as a function of complex haemodynamic decision tasks in the clinical setting. Likewise, how nurse and environmental characteristics interplay with complex decision tasks to influence nurses' decisions about patients' haemodynamic states is poorly understood.

A useful way to explore the role of experience in a complex domain is to describe experience as years of clinical practice and educational preparation. Nurses' level of experience is likely to moderate the difficulty of making complex haemodynamic decisions because knowledge and experience enhances decision making (Devine & Kozlowski, 1995; Payne, 1982). Experience has been shown to enhance nurses’ abilities to make rapid decisions (Baumann & Bourbonnais, 1982), to identify salient cues from non-salient cues, and to recognise and act on patterns of information (Benner, Tanner, & Chesla, 1992). Such concentration on salient cues in a decision task results in less attention being directed towards irrelevant cues (Thomas, Wearing, & Bennett, 1991) and the use of fewer information cues overall (Elstein, Shulman, & Sprafka, 1978). Educational preparation and experience are specific to experts' practice domains (Devine & Kozlowski, 1995). Those research findings suggest that nurses with cardiac surgical intensive care knowledge and experience are likely to make faster and more accurate haemodynamic decisions than their inexperienced colleagues.
making of that kind by experienced nurses has the potential to limit the extent and duration of haemodynamic instability after cardiac surgery. In the clinical setting, inexperienced nurses receive and recover cardiac surgical patients too. Thus, it is important that we understand inexperienced nurses' skills and abilities to make complex decisions for high acuity patients and the factors that enhance or inhibit their ability to do so. At present, there is a dearth of research describing the complex decision making practices of nurses with varying levels of experience in the cardiac surgical context and the potential implications for patient outcomes from those decisions.

In addition to the role played by decision complexity and nurses' experience, variability of decision making may arise from environmental characteristics (Beach, 1990). While recovering cardiac surgical patients, the environmental characteristics of the social context, clinical nursing colleagues, and the geographical layout of the critical care unit are likely to influence nurses' decisions about patients' haemodynamic states. Despite the one nurse to one patient ratio in critical care, two nurses commonly receive, and begin to recover, cardiac surgical patients. Assistance provided by experienced clinical colleagues during the recovery period may benefit inexperienced nurses particularly. In the absence of guidelines for certain aspects of complex haemodynamic decision making, inexperienced nurses are likely to seek assistance from their experienced colleagues (Benner, 1984). The social context of decision making, in terms of nurses' roles and communication patterns, has been found to assist all nurses to solve problems encountered in clinical practice (Chase, 1995). Group decision making may eventuate in critical care because of collegial interactions; but, it may not be a positive experience for the nurses involved (Jenks, 1993). There has been insufficient research describing what type of collegial assistance is provided to inexperienced nurses, how it plays out in clinical practice, and whether it contributes positively to patient outcomes.

Yet, the ways that nursing colleagues interact with nurses of varying levels of experience and knowledge are important to understand. Interactions of that kind have the potential to shape inexperienced nurses' behaviours as well as their current and future decision making.

Interplay between complex haemodynamic decisions, nurses' experience, and environmental characteristics is likely to produce variability in nurses' decision making about cardiac surgical patients' haemodynamic states. Decision making variability is
defined as differences in the haemodynamic data assessed and the therapeutic interventions made by nurses. Decision making variability also refers to differences in the processes used to make those haemodynamic assessment and intervention decisions; for example, whether the decision is made autonomously or in consultation with peers. It is argued that variability of decision making per se is neither to be encouraged nor discouraged; but, rather, that few studies have explored the extent, sources, and implications for patient outcomes of decision making variability as a consequence of the multifactorial influences on decision making. The significance of understanding variability of nurses' decision making lies in the potential implications of that variability for patient outcomes in adverse ways. Identifying the sources of variability in nurses' decision making and its potential for patient outcomes has implications for the ways that the discipline of nursing informs critical care education programs and staff development programs.

The effects of interplay between decision complexity, nurses' experience, and environmental characteristics on nurses' decision making are poorly understood. Accordingly, there are gaps in the literature regarding the potential implications for patient outcomes from interplay between multifactorial influences on nurses' haemodynamic decision making. Such gaps exist in the literature because most previous methodological approaches to the study of decision making have neglected at least one of the multifactorial issues in the research design. Aside from a few notable studies (Aitken, 2000; Bucknall, 2000; Chase, 1995; Ellis, 1997), simulation-based methods have been used to research critical care nurses' decision making. Due to domination of simulation-based studies that may lack ecological validity and may have limited external validity, we have little understanding of real-world decision making (Thomas, Doyle, & Browning, 1990). In light of the research problem and limitations of previous methodological approaches, the logical way to investigate the problem was to gain direct access to real-world haemodynamic decision making of critical care nurses. To do so, an innovative and unique approach was required.

Naturalistic decision making was chosen as the research framework because it is the study of how people use their experience to make complex decisions in natural settings (Zsambok, 1997). A study based on naturalistic decision making provides an exploration of the potential multifactorial relationships between haemodynamic decision
complexity, nurses' experience, and environmental characteristics. Within the naturalistic decision making framework, neither the complexity of haemodynamic decisions nor the environment was controlled by the researcher. Only nurses' experience was controlled by the researcher. A unique feature of this research is that it explores the effects of interplay between multifactorial influences on nurses' real-world haemodynamic decision making in the context of nurses receiving and recovering cardiac surgical patients within critical care.

1.1 Thesis Structure

The purpose of Chapter Two is to review literature related to the multifactorial influences on nurses' decision making in order to discuss the potential variability in nurses' decision making. Discussion focuses on current evidence that supports the proposition that interplay between the multifactorial influences on decision making has the potential to influence the outcomes of nurses' decision making. The chapter is divided into three sections: the complexity of nurses' decision making after cardiac surgery, the postoperative haemodynamic goals of therapy, and the influences on haemodynamic decision making.

The purpose of the first section is to set the scene for, and describe the complexity of, nurses' haemodynamic decision making in the 2-hour recovery period. Physiological disturbances associated with cardiopulmonary bypass place the patient at risk of life-threatening haemodynamic instability. The complexity of haemodynamic decision making arises from issues of high patient acuity, haemodynamic technologies, numerous data sources, and the need for rapid and accurate responses.

In the second section, three postoperative goals of therapy, the optimisation of cardiovascular performance, the promotion of haemostasis, and the reestablishment of normothermia, are introduced as the organising framework to review current evidence concerning nurses' assessment and interventional decision making.

The purpose of the third section of Chapter Two is to present evidence regarding the influences on decision making. First, a review of the literature related to decision performances in complex tasks explores the potential for variability in nurses' haemodynamic decision making. Second, evidence that experience and knowledge
derived from years of clinical experience and educational preparation is likely to vary
nurses' decision making, particularly in complex tasks, is presented. In the context of
managing acute, unstable patients, decision making is likely to vary both within and
between nurses. Literature related to the acquisition of expertise, and the educational
preparation of nurses provides expectations about the variability and commonality of
experienced and inexperienced nurses' haemodynamic decision making in the 2-hour
recovery period. An exploration of experienced and inexperienced nurses' decision
making in the clinical domain, particularly in relation to making complex decisions such
as those concerning patients' haemodynamic status, has not been undertaken. Third,
characteristics of the critical care environment where nurses' haemodynamic decision
making takes place are presented. Environmental characteristics include the notions of
the social context, nursing colleagues, and the geographical layout of the critical care
unit. Haemodynamic decision making variability is likely to result from the influence of
those environmental characteristics because nursing colleagues usually assist nurses to
receive patients. The ways that such assistance plays out in the clinical domain however,
is poorly understood. There are methodological implications for the study of nurses'
haemodynamic decision making from the expected interplay between decision
complexity, nurses' experience, and environmental characteristics. Many possible
relationships may exist between environmental characteristics, nurses' experience, and
decision complexity. These relationships are not well understood, particularly in terms
of their effects on the outcomes of critical care nurses' haemodynamic decision making
in the cardiac surgical context.

The purpose of Chapter Three is to discuss the methodological issues related to
understanding relationships between multifactorial influences on nurses' decision
making in real-world settings. It is argued that naturalistic decision making is an
innovative methodological approach to the study of decision making that addresses the
key methodological limitations of previous research in terms of external validity and
ecological validity.

The findings of the study are presented in Chapters Four, Five, Six, and Seven.
In Chapter Four, the ways that postoperative cardiac patients present in terms of their
haemodynamic data and their haemodynamic progress over the initial 2-hour recovery
period is described. The findings regarding the variability of nurses' haemodynamic
decisions in relation to the optimisation of cardiovascular performance, the promotion of haemostasis, and the reestablishment of normothermia are presented in Chapter Five. In Chapter Six, the findings concerning the variability of nurses' haemodynamic decisions as a consequence of the social context of decision making are presented. Nurses' perceptions and perspectives of receiving and recovering postoperative cardiac patients are reported in Chapter Seven. The findings are drawn together and discussed in Chapter Eight.
CHAPTER 2

NURSES' HAEMODYNAMIC DECISION MAKING AFTER CARDIAC SURGERY

Research evidence suggests that the influences on decision making are decision complexity, characteristics of the decision maker, and characteristics of the environment in which decision making takes place. Evidence spanning various disciplines suggests that individually, these influences can result in variability in decision processes or decision performance. Similar findings have been reported in nursing, however, no attempts have been made to understand the effects on the outcomes of nurses' decision making from interplay between the influences on decision making.

The focus of this chapter is the complexity of haemodynamic decision making faced by critical care nurses in the 2-hour recovery period after cardiac surgery. The roles of decision complexity, nurses' experience, and the surrounding environment on nurses' decision making processes and performances are discussed. There are three main sections to this chapter. In the first section, the typical cardiac surgical patient is described to set the scene for nurses' decision making. The complexity of haemodynamic decision making is attributed to issues of high patient acuity, haemodynamic monitoring technologies, numerous data sources, and the need for rapid responses.

In the second section, the complexity of haemodynamic tasks is explored. A useful way to explore the potential for decision making variability in complex decision tasks is to use an organising framework. A framework based on the clinical sequellae of surgery that involves three haemodynamic postoperative goals of therapy was developed by the author. The goals of therapy are the optimisation of cardiovascular performance, the promotion of haemostasis, and the reestablishment of normothermia. Assessment

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1 Elements of this chapter have been published in:

and interventional haemodynamic decisions concerning the goals of therapy are used to illustrate the potential variability in nurses' haemodynamic decision making.

In the third section, the influences on decision making are explored. A review of studies that have explored how decision processes and performances can vary as a function of task complexity begins this section. This is followed by a review of the role of experience and knowledge on nurses' haemodynamic decision making in order to illustrate the potential variability and commonality of nurses' haemodynamic decision making as a function of cardiac surgical intensive care experience. A useful way to explore the role of experience in a complex domain is to conceptualise experience as years of clinical practice and educational preparation. Clinical experience in the forms of receiving and recovering cardiac surgical patients, familiarity with typical patients' trajectories, and practical haemodynamic monitoring skills are likely to enhance nurses' abilities to make complex haemodynamic decisions. Likewise, nurses with knowledge of the principles of haemodynamic monitoring and clinical sequelae of cardiopulmonary bypass are likely to display enhanced abilities to make complex haemodynamic decisions. Finally, the environmental characteristics of the critical care unit are discussed in terms of their potential influence on nurses' haemodynamic decision making in the 2-hour recovery period. In this thesis, the defining characteristics of the critical care environment are the social context, nursing colleagues, and the geographical layout. Social interactions are likely to take place during the reception of patients because of the usual practice of nurses assisting each other at this time. Such interactions provide beginning understandings of how decision task complexity, nurses' experience, and environmental characteristics interplay to vary nurses' decision making. The influence of environmental characteristics also raises methodological issues. In order to study the interplay between the multifactorial influences on nurses' haemodynamic decision making, an innovative methodological approach is required so that all three factors can be studied as an integrated whole. The chapter concludes by discussing the likely interplay between complex haemodynamic decisions, nurses' experience, and environmental characteristics and the potential effects of such interplay on the outcomes of nurses' haemodynamic decision making.
2.1 The Complexity of Haemodynamic Decision Making

To set the scene for, and understand the complexity of, nurses' haemodynamic decision making, the distinctive features of cardiac surgical patients are described in this section. In particular, issues associated with high risk patients, the unique surgical approach, and the subsequent clinical sequelae are discussed. In addition to issues of high patient acuity, the numerous parameters generated from haemodynamic monitoring technologies and the need for rapid and accurate responses by nurses contribute to the complexity of haemodynamic decision making.

2.1.1 Cardiac Surgical Intensive Care Patients

Cardiac surgery can be considered routine by health professionals in this area because of its high frequency. However, the clinical sequelae of cardiopulmonary bypass and the technologies used to monitor patients' haemodynamic status create unique circumstances for both postoperative patients and critical care nurses. Despite the routine nature of cardiac surgery, many patients who presently undergo surgery are high risk. High risk patients are in danger of developing more postoperative complications and have a higher mortality than other patients, contributing to the complexity of haemodynamic decision making required of nurses.

Heart disease remains one of the leading causes of morbidity and mortality in our society. In Australia during 1998, 29% of deaths were caused by heart disease, primarily coronary artery disease and acquired valvular disease (Davies & Senes, 2001). In 1998, over 25,000 patients underwent coronary artery bypass graft surgery (CABGS) (21,402) or valve surgery (4170) (Davies & Senes, 2001). The cardiac surgical rate in Australia during 1998 was 1,188 per million people and the associated 30-day mortality rate was 2.6% (Davies & Senes, 2001).

In 1998, approximately 17,448 patients undertook CABGS which involved an average of three grafts and an associated mortality rate of 2.1% (Davies & Senes, 2001). Reoperations for coronary artery disease made up 5.9% of those patients. In the current climate, patients who present for surgery are more acute and complex than in previous years. High risk patients are those with factors known to increase operative mortality such as poor left ventricular function, older age, renal dysfunction, diabetes, chronic
obstructive airways disease, and female gender (Higgins, Yared, & Ryan, 1996). Hence, people who present to critical care following cardiac surgery, particularly in tertiary referral hospitals, are characteristically older in age, have comorbidities such as diabetes, undergo multiple procedures such as a valve replacement and CABGS, or are recipients of a reoperation (Higgins et al., 1996). Associated mortality for patients undergoing CABGS for the second time increases to 5.3%, more than twice that of CABGS overall (Davies & Senes, 2001). High risk patients can potentially increase the complexity of nurses' decision making. In addition to patient related variables, other factors that influence the complexity of these patients are related to the surgical approach used, the subsequent clinical sequelae, and haemodynamic monitoring technologies.

2.1.2 Surgical Approach

To facilitate CABGS and valve replacement surgery, patients are placed on cardiopulmonary bypass and receive myocardial protection measures. Cardiopulmonary bypass involves the diversion of blood that normally circulates through the heart and lungs to an artificial heart-lung machine. Cardiopulmonary bypass allows for oxygenation of blood, removal of carbon dioxide, control of blood temperature, and circulation of blood while the heart is stopped during surgery. The combination of cardiopulmonary bypass and myocardial protection measures provides a bloodless, motionless heart for surgery, a lowered metabolic rate to reduce oxygen consumption, and appropriate myocardial cellular conditions.

The physiologic principles of cardiopulmonary bypass are anticoagulation, haemodilution, and systemic hypothermia (Weiland & Walker, 1986). Anticoagulation is necessary to prevent massive clotting when patients' blood contacts the synthetic surfaces of cardiopulmonary bypass tubing. Anticoagulation is achieved by administering heparin to achieve an activated clotting time that is at least four times normal (Seifert, 2002). Systemic heparinisation prevents blood clots forming in the cardiopulmonary bypass circuitry and enhances blood flow through capillary beds. Haemodilution occurs when the cardiopulmonary bypass circuitry is primed with intravenous isotonic crystalloid solution and a colloid solution. The effects of haemodilution are to reduce blood viscosity (which is raised by hypothermia), increase
capillary permeability, and decrease coagulation factors (through dilution) (Weiland & Walker, 1986).

Systemic hypothermia is needed to decrease metabolic and oxygen requirements of the myocardium and other tissues during surgery. For every 1 °C reduction in core body temperature, oxygen consumption decreases by 7% (Adolph, 1956; Young et al., 1959). Hypothermia also reduces blood clotting by depressing liver function; causes peripheral vasoconstriction; and increases catecholamine release, which, in turn, increases blood glucose, serum potassium, and myocardial irritability. Despite the maintenance of body core temperature between 28 °C to 30 °C, and therefore the reduction of myocardial oxygen consumption by at least 50%, myocardial ischaemic injury remains a risk and further measures to protect the myocardium are required.

The primary myocardial protection measure is the administration of cardioplegia. Cardioplegia is a cold, potassium rich electrolyte solution that induces and maintains hypothermic cardiac arrest without causing ventricular fibrillation. Cardioplegia also provides essential substrates to myocardial cells and removes accumulated acid wastes (Seifert, 2002). Other myocardial protection measures include topical hypothermia and aortic cross clamping. During aortic cross clamping, the aorta is clamped above the position where the coronary arteries originate to prevent cardiopulmonary bypass blood entering the left ventricle or coronary arteries during surgery.

All of these intraoperative measures, however, have implications for haemodynamic instability after surgery. Indeed, as patients emerge from a transient abnormal state during the first few hours after surgery, they are at risk of the most potent life-threatening problems (Finkelmeier, 2000). As a result of the unique nature of cardiac surgery, nurses closely monitor and manage the haemodynamic status of patients with advanced monitoring technologies.

2.1.3 Haemodynamic Monitoring and Decision Making

To manage high acuity cardiac surgical patients, highly invasive and technologically driven haemodynamic monitoring is used. Haemodynamic monitoring typically involves the application of 5-lead cardiac monitoring and the insertion of an arterial line, standard pulmonary artery catheter (PAC), and urinary catheter. Numerous data are provided by these invasive and non-invasive haemodynamic monitoring
devices. Additionally, data are derived through nurses' physical assessment of patients. For simplicity, the most commonly measured haemodynamic data for typical cardiac surgical patients are shown in Table 2.1.

It is apparent that nurses are confronted with multiple haemodynamic cues when managing cardiac surgical patients. Due to the unique nature of cardiac surgery, haemodynamic decision making in the immediate 2-hour postoperative period requires a thorough understanding of the principles and potential complications of cardiopulmonary bypass, myocardial protection measures, cardiac surgery, and haemodynamic monitoring. Specialised knowledge and experience associated with these areas is subsequently referred to as cardiac surgical intensive care knowledge and experience.

After surgery, patients are admitted to critical care and the general anaesthetic is not reversed, giving rise to the unique situation where the anaesthetists deliver patients to critical care and provide a handover to nurses. The usual procedures carried out by nurses when they receive postoperative patients is described in the next section in order to illustrate some of the important circumstances surrounding nurses' initial decision making in the 2-hour recovery period.

The reception of patients in critical care signals the onset of haemodynamic decision making responsibility by critical care nurses. Nurses accept decision making responsibility for the following: 1) assessing haemodynamic data; 2) interpreting complex and often ambiguous data; 3) formulating and implementing appropriate therapeutic responses, often in consultation with medical staff; and 4) evaluating the effectiveness of those interventions in terms of patients' responses.

Following surgery, one clinical nurse is typically allocated by the Associate Charge Nurse to receive and recover the patient. Invariably, a nursing colleague assists the allocated nurse to receive and recover the patient. In this thesis, for clarity and to distinguish the role of each nurse, the nurse allocated to receive and recover the patient is termed the primary nurse. The nurse who assists the primary nurse is termed the assistant nurse. The term primary nurse does not relate to the broader model of nursing care delivery.
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The usual procedures and processes that occur while nurses receive patients into critical care are shown in Table 2.2. These procedures are driven by the priorities of primary nurses to identify all catheters and pacing equipment, reestablish haemodynamic monitoring capabilities and chest tube suction, confirm haemodynamic stability, and reestablish mechanical ventilation (Finkelmeier, 2000). The primary nurse cannot complete all the procedures simultaneously and that is the reason why an assistant nurse helps the primary nurse. Although not all critical care units have such a formalised means of support, such arrangements are fairly commonplace in cardiac surgical intensive care nursing and have been reported elsewhere (Chase, 1995; Finkelmeier, 2000).

There are advantages if all nurses are familiar with the decision making priorities and procedures associated with receiving patients. For instance, confusion is minimised (Daily & Schroeder, 1994); patients are settled quickly; sudden problems are responded to promptly (Finkelmeier, 2000); and patients' haemodynamic states can immediately be assessed, which, in turn, allows for prompt interventions. Immediate assessments of haemodynamic parameters can be used to direct patient management and evaluate patients' clinical trends over the next few hours (Finkelmeier, 2000). Changes in patients' data over time are referred to as ipsative changes. Ipsative changes are important for nurses to detect because they signify haemodynamic deterioration or improvement specific to individual patients.

A core process that occurs during this time is a verbal handover by the anaesthetist to the primary nurse. The concerns of primary nurses and anaesthetists are similar (Chase, 1995). The content of an anaesthetist's handover is outlined in Table 2.3 and includes information about the patient's history, surgery, and overall haemodynamic state. During handover, particular emphasis is placed on grasping trends in haemodynamic parameters and patients' responses to therapeutic interventions (Daily & Schroeder, 1994; Finkelmeier, 2000). Familiarity with the content of a typical handover enables an experienced nurse to prompt the anaesthetist for missing information so that a thorough handover is received.
<table>
<thead>
<tr>
<th>Clinical issue</th>
<th>Primary nurse</th>
<th>Assistant nurse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haemodynamic status</td>
<td>Transfer cardiac, pressure, and pulse oximetry</td>
<td>Remove transport equipment used for cardiac and pressure monitoring</td>
</tr>
<tr>
<td></td>
<td>monitoring to critical care equipment</td>
<td>Apply rewarming measures as directed by primary nurse</td>
</tr>
<tr>
<td></td>
<td>Check pacemaker settings</td>
<td>Other actions as directed by primary nurse</td>
</tr>
<tr>
<td></td>
<td>Level air-fluid interface of pressure transducers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Zero pressure transducers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Set alarm limits for all monitored parameters</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Connect temperature and cardiac output cables from monitor to pulmonary artery</td>
<td></td>
</tr>
<tr>
<td></td>
<td>catheter</td>
<td></td>
</tr>
<tr>
<td>Chest drainage system and chest tubes</td>
<td></td>
<td>Connect to suction and check integrity of chest drain system</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ensure chest tubes are patent</td>
</tr>
<tr>
<td>Renal status</td>
<td></td>
<td>Empty urinary catheter collection bag</td>
</tr>
<tr>
<td>Other</td>
<td>Check all intravenous drug and fluid infusions</td>
<td>Obtain intravenous drug and fluid infusions as directed by primary nurse</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Arrange chest x-ray and electrocardiogram as directed by primary nurse</td>
</tr>
<tr>
<td>Respiratory</td>
<td></td>
<td>Connect to mechanical ventilation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Remove transport equipment used for artificial ventilation during transport</td>
</tr>
<tr>
<td>Overall patient status and history</td>
<td>Receive handover from anaesthetian</td>
<td>Receive handover from anaesthetian</td>
</tr>
<tr>
<td>Patient status</td>
<td>Parameters</td>
<td></td>
</tr>
<tr>
<td>---------------</td>
<td>------------</td>
<td></td>
</tr>
</tbody>
</table>
| History       | Duration of coronary artery or valvular heart disease  
                Previous procedural or surgical interventions  
                Incidence of myocardial infarction(s)  
                Assessments of left ventricular function such as visual classification  
                by the surgeon, ejection fraction  
                Presence of comorbidities such as diabetes, renal failure |
| Surgery       | Type of surgery performed  
                Complications with surgery such as haemorrhage, associated  
                therapeutic interventions, and patient responses |
| Cardiovascular| Values of key haemodynamic parameters  
                Vasoactive infusions commenced, their doses, and patient responses  
                Cardiac rhythm of patient when weaned from cardiopulmonary  
                bypass and subsequent pacing requirements  
                Bleeding, blood products, clotting profile, and instructions for  
                retesting haematological status |
| Respiratory   | Ventilation requirements during surgery and any specific  
                postoperative requirements  
                Problems encountered, if any |
| Neurological  | Preoperative state with particular mention of any deficits present  
                prior to surgery |
In the next section, the clinical sequelae of surgery are discussed as a source of decision making complexity. In particular, the discussion focuses on the haemodynamic instability and potential postoperative complications associated with cardiac surgery and the implications for nurses' decision making.

2.1.4 Clinical Sequelae of Surgery

At the completion of surgery, measures are taken to reverse the anticoagulation and hypothermia associated with cardiopulmonary bypass. Anticoagulation is reversed pharmacologically. Hypothermia is reversed by gradually rewarming patients' blood via the cardiopulmonary bypass machine. Haemodilution caused by priming the cardiopulmonary bypass circuit, however, is not able to be reversed. Nurses' haemodynamic decision making while recovering patients is centred on reducing the haemodynamic instability and potential for postoperative complications associated with cardiopulmonary bypass. These potential complications include haemorrhage, residual hypothermia, and cardiovascular instability.

Although bleeding is a potential postoperative complication for all surgical patients, cardiac patients undergo full systemic anticoagulation during surgery. Anticoagulation associated with cardiopulmonary bypass is reversed in the operating theatre by administering protamine sulfate, however, patients invariably bleed to some degree in the postoperative recovery period. The rate of actual postoperative haemorrhage has been reported to be between 2% and 12% of cardiac patients (Hall et al., 2001).

Postoperative haemorrhage can be classified as either medical or surgical (Finkelmeier, 2000; Weiland & Walker, 1986). Coagulation disorders, or coagulopathies, due to the effects of cardiopulmonary bypass place patients at risk of medical bleeds in the 2-hour postoperative recovery period (Higgins et al., 1996). A surgical bleed is one that can usually be traced to surgical techniques or mechanical events in the operating room such as a leaking anastomosis site in a vein or artery (Finkelmeier, 2000; Weiland & Walker, 1986) and is usually detected by assessing chest drainage. Most surgical bleeds are evident within the first 4 hours of the recovery period and accordingly, urgent surgical reexploration occurs within this time frame (Michelson, Torosian, Morganroth, & MacVaugh, 1980). Blood losses greater than 300 ml in the first
postoperative hour, 250 ml in the second hour, and 150 ml/hour thereafter are usually indicative of the need for surgical reexploration and have been correlated with surgically correctable bleeding (Michelson et al., 1980). However, if clots accumulate in the chest tubes, measured blood loss may be less than actual blood loss (Daily & Schroeder, 1994).

Surgical bleeding may also cause a cardiac tamponade which, in terms of blood loss, is characterised by an abrupt decrease in chest drainage or a slowing in the rate of blood loss. Suspicion of cardiac tamponade should also be raised when patients show signs of haemodynamic instability refractory to fluid and inotropic therapies (Higgins et al., 1996). Cardiac tamponade occurs in less than 1% of patients, but can be life threatening (Loop et al., 1990). Skilled nursing assessments, assimilation of numerous haemodynamic data, and reflection on the overall status of patients are required to detect cardiac tamponade. In addition to haemorrhage, residual hypothermia also poses a risk to haemodynamic stability and postoperative recovery of cardiac patients.

Hypothermia is defined as a core temperature of less than, or equal to, 36 °C (Morley-Forster, 1986; Vaughan, Vaughan, & Cork, 1981), however, in the cardiac surgical context, mild hypothermia is commonly defined by a core temperature between 34 °C and 36.5 °C (Phillips & Skov, 1988). While the surgeon places chest drains in the surgical field, the patient is rewarmed to 37 °C through the cardiopulmonary bypass circuit to reverse systemic hypothermia. Despite achieving normothermia, that is, 36.6 °C to 37.5 °C (Phillips & Skov, 1988), the exposure of mediastinal viscera to room air in the operating suite while chest drains are inserted, as well as the administration of unwarmed intravenous fluids and blood products, means that core temperature invariably drops after separation from cardiopulmonary bypass (Whitman, 1991). Certain forms of general anaesthesia administered during cardiac surgery may also reduce core temperature by interfering with the body's ability to control its thermoregulatory centre (Morley-Forster, 1986; Whitman, 1991).

By the time patients are received in critical care, their core temperatures are often about 35.5 °C to 36.5 °C and have been reported as low as 34 °C (Whitman, 1991). This unintentional reduction in core temperature following surgery is referred to as afterdrop (Moors, Pickett, Woolman, Bethune, & Duthie, 1994; Whitman, 1991) and is attributed to the body core losing heat to the larger body shell following separation from
cardiopulmonary bypass (Moors et al., 1994). In the initial 45 to 90 minute recovery period, afterdrop continues because peripheral vessels dilate and release cooled blood into the central circulation as a consequence of rewarming (Whitman, 1991).

The electrophysiological properties of the heart can be affected by hypothermia and cardioplegia, resulting in dysrhythmias. Hypothermia may affect cardiovascular performance through peripheral vasoconstriction, cardiac dysrhythmias, and shivering; haemostasis through alterations in haematological function and impaired coagulation; and respiratory and neurological function through delayed drug clearance (Burns, 2001; Haskell, Boruta, Rotondo, & Frankel, 1997; Higgins et al., 1996).

Shivering, in particular, is a common and potentially deleterious complication for cardiac patients in the initial 2 hour recovery period (Guffin, Girard, & Kaplan, 1987; Spaniol, Bond, Brengelmann, Savage, & Pozos, 1994). The physiological changes that occur during shivering cause haemodynamic instability in the forms of hypotension and tachycardia. Moreover, the increased oxygen consumption associated with shivering has the potential to induce myocardial ischaemia. It is apparent that the risks associated with residual hypothermia may affect patient outcomes in the short and long term. Perhaps the most clinically significant risks to patient outcomes in the long term, however, relates to cardiovascular instability.

Patients' cardiovascular states are fragile and labile in the first few hours after surgery despite the reversal of anticoagulation and hypothermia and the reestablishment of normotension and a pulsatile blood flow (Higgins et al., 1996). Haemodilution associated with cardiopulmonary bypass is not reversed; but, the body naturally corrects haemodilution over the following 2 to 3 days. In the meantime, the effects of haemodilution are an overall increase in total body fluid and an increased capillary permeability. Physiological disturbances of that kind result in a phenomenon known as 'third spacing' which is movement of fluid out of the intravascular space to the interstitial space. The reduction in intravascular volume, or hypovolaemia, is reflected in a low preload. Hypotension also results from hypovolaemia, potentially compromising cardiac output. Haemodilution also places patients at risk of serum electrolyte disturbances such as hypokalaemia which may induce cardiac dysrhythmias. Hence, the cardiovascular system, in terms of preload, perfusion pressure, and cardiac output can be profoundly affected by a reduction in intravascular volume due to haemodilution.
In addition to the clinical sequelae of haemodilution, patients are at risk of cardiovascular instability from the actual surgery and other aspects of cardiopulmonary bypass. A low cardiac output in the 2 hour recovery period can be due to inadequate myocardial protection during surgery, an intraoperative event such as a myocardial infarction, or postoperative hypovolaemia (Higgins et al., 1997; Morris & St Claire, 1999). In turn, postoperative hypovolaemia can result from bleeding or vasodilation induced by rewarming or drugs. Additionally, a low cardiac output can result from increased circulating catecholamines and hypothermia induced peripheral vasoconstriction (Higgins et al., 1997; Morris & St Claire, 1999). Clearly, cardiovascular instability can present in many forms and there may be many causes for each form of presentation.

In sum, the unique physiological circumstances surrounding cardiac surgical patients infers that nurses need to be readily versed in the clinical sequelae of cardiopulmonary bypass in order to detect, and respond to, various forms of haemodynamic instability and postoperative complications. Moreover, although cardiac surgery may be considered commonplace and haemodynamic instability somewhat predictable, the signs of instability often present as subtle combinations of cues rather than overt cues. As a consequence, nurses need to be deeply reflective in order to uncover the causes of postoperative instability. A failure by nurses to detect and respond to patients’ haemodynamic instability appropriately may place patients' lives at risk.

2.1.5 Summary

In the previous sections, the unique processes associated with cardiac surgery and cardiopulmonary bypass were outlined. In the immediate recovery period, the clinical sequelae of surgery places patients at high risk of haemorrhage, residual hypothermia, and cardiovascular instability. Nurses use advanced haemodynamic technologies to assess and monitor the progress of patients in order to prevent and detect haemodynamic complications that can present in unique and subtle ways. The scene for nurses' clinical decision making in the recovery period was described as a series of complex assessment and interventional decisions in haemodynamically unstable patients. In the next section, an orienting framework for understanding complex
haemodynamic decision making by nurses is described in terms of three major goals of therapy in the context of cardiac surgery.

2.2 Goals of Therapy

The discussion so far, has described how decision making by nurses in the 2-hour recovery period is driven by the complexity of haemodynamic decision tasks, haemodynamic technologies, and high patient acuity. Nurses' decision priorities are further determined by the clinical sequelae of cardiopulmonary bypass. At first glance, particularly during the reception of patients, decision making can appear to be a series of independent and separate tasks rather than an integrated approach designed to achieve specific goals. The reality of nurses' decision making during this time is that many decisions are cross-networked and logical relationships exist between cues and decisions. In order to understand how cues and decisions fit together, an orienting framework is needed. The orienting framework needs to facilitate observations of nurses' decision making and encompass haemodynamic task complexity in terms of the numerous data sources, advanced technologies, and high patient acuity in the initial recovery period after surgery. Additionally, the framework needs to accommodate surrounding issues such as evidence-based practice and policy guidelines. In view of these considerations, nurses' haemodynamic decision making in the 2-hour recovery period has been divided into three major goals of therapy. The three goals of therapy for cardiac patients are the optimisation of cardiovascular performance, the promotion of haemostasis, and the reestablishment of normothermia.

There are several advantages in exploring practice using goals of therapy as a framework. First it acknowledges the importance of nurses' decision making as working toward particular outcomes rather than being task orientated. The theoretical significance of using goals of therapy as an organising framework relates to whether nurses' haemodynamic decision making is goal orientated in order to achieve optimal outcomes for patients. Second, the organising framework can be used to identify variability in nurses' decision making that matters. Decision making practices that matter are those that have the potential for adverse patient outcomes and that can be identified for improvement. Through the use of the goals of therapy as an organising framework,
variability of nurses' decision making that has clinical significance can be identified. In sum, this framework appears a useful way of conceptualising the complexity of nurses' decision making for cardiac surgical patients in the 2-hour recovery period.

The salient parameters concerning each goal of therapy are identified in the following sections. Additionally, issues surrounding frequency and accuracy of assessment are discussed. Ultimately, the actual parameters assessed, the frequency of parameter assessment, and the accuracy with which those parameters are assessed constitute the three key areas in which nurses' decision making concerning assessments of patient data can vary. Nurses' decision making in terms of frequency and accuracy of assessment and techniques of management will be discussed for each goal of therapy in order to set the scene for analysis of data in this study.

2.2.1 Optimisation of Cardiovascular Performance

The optimisation of cardiovascular performance involves the management of the cardiac and circulatory systems in order to ensure adequate perfusion to vital organs and tissues. In the clinical environment, nurses are confronted with a myriad of technologically-derived haemodynamic parameters to assess, all of which may seem equally important to assess in order to meet the goal of optimising cardiovascular performance. The scope of technologically-derived haemodynamic data used in nurses' decision making related to the optimisation of cardiovascular performance needed to be narrowed for the purposes of this study in order to provide meaningful information about nurses' decision making. Hence, this study will focus on cues deemed salient according to literature and expert opinion.

Traditionally, there has been a strong emphasis on cardiac index and mean arterial pressure (MAP) as the most important haemodynamic parameters to optimise (Ahrens, 1998) in relation to cardiovascular performance. In support of Ahrens' (1998) view, a recent study confirmed that experienced nurses assessed and prioritised the MAP, cardiac index, and preload when nursing cardiac surgical patients. Aitken (1997; 2000) explored 8 experienced nurses’ use of pulmonary artery pressure monitoring by employing a combination of two methods: asking nurses to ‘think aloud’ during actual clinical practice and conducting interviews. The nurses had an average of 4.7 years cardiac surgical intensive care experience. The researcher was present during the 'think
aloud' period which lasted two hours and was conducted within the first two postoperative days. The concepts of preload, cardiac output, and MAP dominated their haemodynamic decision making. Given that Aitken (1997) conducted her study in the clinical area and each patient had a standard PAC insitu, these findings provide important information about what haemodynamic parameters are prioritised and considered salient by experienced critical care nurses in the postoperative cardiac context.

In a paper designed to provide an orderly and concise approach to the management of haemodynamically unstable cardiac surgical patients, Gorman, Gorman, Milas & Acker (2000) suggested seven salient parameters. The seven parameters were based on the principle that the ultimate aim of haemodynamic decision making in relation to cardiovascular performance is to adequately oxygenate the body's tissues and organs. Hence, the salient parameters are those that determine oxygen delivery. The parameters are heart rate, heart rhythm, pulmonary capillary wedge pressure (PCWP), central venous pressure (CVP), afterload in the form of systemic vascular resistance (SVR), myocardial contractility in the form of cardiac index, and arterial oxygen saturation. As this view is supported by the literature and current practice, the seven technologically-derived parameters and the values considered appropriate for cardiac surgical patients in the 2-hour recovery period are illustrated in Table 2.4. In addition to these parameters, cues related to physical assessment and pacemakers will be included as they provide critical information about, and are used by nurses to assess, cardiovascular performance. The optimisation of cardiovascular performance is achieved through fluid, pharmacological, and nursing interventions as well as manipulations of pacemaker settings.

Aside from decision variability concerning what parameters to assess, variability in the frequency with which nurses' assess haemodynamic parameters has the potential to affect patient outcomes. Indeed, nurses' assessment and interventional decisions regarding certain parameters in the recovery period are critical to patient outcomes (Doering, Esmailian, Imperial-Perez, & Monsein, 2001; Miller, 1998). Although there are few clear guidelines for assessment frequency, it is common practice for nurses to perform a comprehensive assessment of all patient parameters on admission (Bucknall, 1996) and subsequently assess and document patient data hourly. Thereafter, nurses tend
to decide assessment frequency based on the rationale for performing a particular assessment and unit protocols. The patient's level of haemodynamic stability is also likely to influence assessment frequency where nurses are likely to assess data more frequently in unstable patients.

Table 2.4
Technologically-derived Parameters Deemed Salient for the Optimisation of Cardiovascular Performance

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart rate and rhythm (heart rate 70 - 100 bpm, no dysrhythmia)</td>
<td></td>
</tr>
<tr>
<td>Mean arterial pressure &gt; 70 mmHg and &lt; 95 mmHg</td>
<td></td>
</tr>
<tr>
<td>Pulmonary capillary wedge pressure 10 - 15 mmHg</td>
<td></td>
</tr>
<tr>
<td>Central venous pressure 8 - 12 mmHg</td>
<td></td>
</tr>
<tr>
<td>Cardiac index &gt; 2.2 L·min⁻¹·m⁻²</td>
<td></td>
</tr>
<tr>
<td>Systemic vascular resistance &gt; 750 dynes·sec·cm⁻⁵ and &lt; 1200 dynes·sec·cm⁻⁵</td>
<td></td>
</tr>
<tr>
<td>Arterial oxygen saturation &gt; 95%</td>
<td></td>
</tr>
</tbody>
</table>

Note: > = greater than. < = less than.

Variability in optimising cardiovascular performance may also be evident in the accuracy with which nurses use haemodynamic monitoring technologies. Haemodynamic data are assessed by nurses to determine patients' current status as well as to inform and evaluate therapeutic interventions. Patient outcomes may be adversely affected if inaccurate data are used to select or evaluate interventional decisions. Indeed, unless haemodynamic data are measured accurately and repetitively, data may be unreliable (Goldman, 1990). Attention to evidence-based practices associated with haemodynamic monitoring and assessment of data are vital to ensure haemodynamic parameters derived from technological sources are accurate.

In the next section, the complex nature of decision making concerning the optimisation of cardiovascular performance will be presented. Discussion will focus on the clinical issues surrounding heart rate and rhythm, perfusion pressure, preload, afterload, and contractility (see Table 2.5). For each of the five aforementioned parameters, the potential variability arising from how each is measured; the techniques
of management, including different levels of evidence for best practice; and the accuracy and frequency with which nurses use the available technology will be discussed.

2.2.1.1 Cardiac Rate and Rhythm

Electrophysiologically, the myocardium requires a certain cellular environment for optimal function. That cellular environment is disturbed by processes associated with cardiopulmonary bypass. Therefore, temporary pacing wires are commonly inserted prior to the completion of surgery to support cardiac rhythm. Temporary cardiac pacing has been reported to be required in up to 47% of postoperative cardiac patients (Vitello Cicciu et al., 1987). As illustrated in Table 2.5, for cardiac rate and rhythm, nurses’ decision making can vary in relation to setting alarms, assessing pacemaker function, taking an electrocardiograph (ECG), and monitoring serum biochemistry.

To determine if the goal of sinus rhythm is being maintained, continuous cardiac monitoring is established. To ensure continuous assessment of the heart rate and rhythm, alarm facilities in the cardiac monitor are set to appropriate ranges and then activated. Alarmed cardiac monitoring is considered mandatory because dysrhythmias are common in the recovery period as a result of the adverse effects of cardiopulmonary bypass.

Best practice in relation to the maintenance of an appropriate cardiac rate and rhythm requires pacemaker settings to be checked for safety and operation (Finkelmeier, 2000). When patients are received, nurses check the pacemaker's settings and ensure that the safety features are in place. To do so, the pacemaker's rate, sensitivity, and output settings are noted; the battery is replaced if necessary; and the keypad is locked so that the current settings are not inadvertently changed. Inspection of the rhythm on the cardiac monitor determines whether the cardiac rhythm corresponds with the pacemaker settings. Later, as time and the patient's condition allows, a second assessment that involves full checks of the pacemaker's settings and function are performed. These checks include determination of the stimulation and sensing thresholds; checks for improper function such as failure to capture, failure to sense, and failure to pace (Hickey & Baas, 1991); and determination of an underlying rhythm. During either the first or second assessment, nurses make changes to the pacemaker's current settings to optimise the cardiac rate or rhythm. Pacemakers are usually set at 90 to 100 bpm to optimise cardiovascular performance. If the patient has an intact conduction system, atrial pacing
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Clinical issues in 2-hour recovery period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac rate and rhythm</td>
<td></td>
</tr>
<tr>
<td>5-lead cardiac monitoring</td>
<td>Continuous monitoring</td>
</tr>
<tr>
<td></td>
<td>Set alarms</td>
</tr>
<tr>
<td>12-lead electrocardiograph</td>
<td>Perform to assess for ischaemia</td>
</tr>
<tr>
<td>Pacemaker</td>
<td>Safety check on receiving patient</td>
</tr>
<tr>
<td></td>
<td>Complete check of settings and function</td>
</tr>
<tr>
<td>Serum potassium and magnesium</td>
<td>Assess at least once</td>
</tr>
<tr>
<td>Arterial blood acid/base status</td>
<td>Analyse at least once</td>
</tr>
<tr>
<td>Perfusion pressure</td>
<td></td>
</tr>
<tr>
<td>Mean arterial blood pressure</td>
<td>Continuous monitoring</td>
</tr>
<tr>
<td></td>
<td>Set alarms</td>
</tr>
<tr>
<td>Neurovascular limb observations</td>
<td></td>
</tr>
<tr>
<td>Mentation</td>
<td>Perform at least once</td>
</tr>
<tr>
<td>Urine output</td>
<td>Perform at least once</td>
</tr>
<tr>
<td></td>
<td>Hourly measurements</td>
</tr>
<tr>
<td>Preload</td>
<td></td>
</tr>
<tr>
<td>Pulmonary capillary wedge pressure</td>
<td>Perform at least three times</td>
</tr>
<tr>
<td>Central venous pressure</td>
<td>Continuous monitoring</td>
</tr>
<tr>
<td></td>
<td>Adhere to evidence-based guidelines to obtain accurate values</td>
</tr>
<tr>
<td>Myocardial contractility</td>
<td></td>
</tr>
<tr>
<td>Cardiac index</td>
<td>Perform cardiac output at least twice</td>
</tr>
<tr>
<td></td>
<td>Adhere to evidence-based guidelines to obtain accurate values</td>
</tr>
<tr>
<td>Afterload</td>
<td></td>
</tr>
<tr>
<td>Systemic vascular resistance</td>
<td>Assess at least twice</td>
</tr>
<tr>
<td>Arterial oxygen saturation</td>
<td></td>
</tr>
<tr>
<td>Pulse oximetry</td>
<td>Continuous monitoring</td>
</tr>
<tr>
<td>Arterial blood gases</td>
<td>Analyse at least once</td>
</tr>
</tbody>
</table>
is preferred. Atrioventricular pacing is usually reserved for patients with an underlying rhythm of asystole or profound bradycardia. At times, the surgeon only inserts ventricular wires. In those instances, ventricular pacing is used as a backup. That is, the pacemaker only activates ventricular pacing when the sinus and atrioventricular conduction systems fail. Ventricular pacing is less useful in optimising cardiovascular performance as it precludes the contribution of atrial systole to the cardiac output. Atrial systole can account for as much as 25% of cardiac output (Finkelmeier, 2000). Nevertheless, the insertion of only ventricular pacing wires is appropriate for patients permanently in atrial fibrillation because atrial wires are ineffective in the presence of atrial fibrillation.

A 12-lead ECG is almost always recorded postoperatively. If the patient is atrioventricular paced, the ECG may not be performed. Alterations in ventricular depolarisation as a consequence of atrioventricular pacing impedes detection of an intraoperative myocardial infarction or ischaemia. However, the ECG may still be taken to gain a clearer or broader picture of the electrical activity of the heart than offered by cardiac monitoring.

In addition to optimising pacing settings, nurses monitor the patient's oxygenation, acid/base status, and electrolyte levels. Those data are assessed and corrected where necessary to promote an optimal cellular environment. Whether patients are paced or in their own intrinsic rhythm, the maintenance of a normal cellular environment is crucial for cardiac rate and rhythm.

2.2.1.2 Perfusion Pressure

To optimise cardiovascular performance, it is essential that postoperative patients have adequate perfusion to the brain; kidneys; coronary arteries, including recently established bypass grafts; and other vital organs. Perfusion pressure is primarily measured through the MAP. Non-invasive measurements of perfusion pressure include assessments of mentation, urine output, and neurovascular circulation. There are many causes of hypotension and hypertension in the 2 hour recovery period for cardiac patients. Hypotension may be caused by bradycardia, hypovolaemia, vasodilation, or cardiac dysfunction such as cardiac tamponade. Hypertension may also be caused by
inadequate sedation and analgesia, hypercarbia, hypoxaemia, hypothermia, shivering, or emergence from anaesthesia.

Postoperatively, an adequate perfusion pressure is generally defined as a MAP greater than 70 mmHg (see Table 2.4), or within 20 mmHg of a hypertensive patient's resting preoperative MAP (Higgins et al., 1996). The normal uppermost value of MAP is about 95 mmHg. Depending on the patient's needs, the range for an acceptable MAP may be narrower. The use of monitor alarms allows continuous assessment of the MAP while nurses attend to other aspects of patient management.

In order to meet the goal of maintaining the perfusion pressure within the commonly acceptable range of approximately 70 mmHg to 95 mmHg, nurses give colloid infusions and titrate infusion rates of inotrope and vasodilatory drugs. Nurses also consider pacemaker settings. A cardiac rhythm with atrioventricular synchrony and a rate of 90 bpm to 100 bpm may alleviate hypotension. The reason for keeping the MAP less than about 95 mmHg is to prevent undue stress on graft anastomosis sites. For patients with a friable aorta or friable suture lines, the MAP may be kept lower than 90 mmHg and for patients with preexisting hypertension, it may be allowed to reach 105 mmHg before therapeutic manipulation is deemed necessary (Morris & St Claire, 1999).

The patient's level of agitation has implications for the perfusion pressure. If patients are agitated from pain, confusion, discomfort, or any other reason, they tend to move about the bed. As patients cannot speak because of the endotracheal tube in situ, their agitation can intensify. Often patients' movements are purposeless, especially while they are emerging from the anaesthetic. Nevertheless, such movements are not benign. Invariably patients' MAP will rise markedly. Movement also increases patients' metabolic rates, which, in turn, increases myocardial oxygen consumption and may induce myocardial ischaemia. To protect the myocardium from ischaemia, agitation must be controlled. Assessments are made by nurses to determine the causes of agitation and subsequent interventions. Analgesia is administered for pain; reassurance is provided to reduce fear and confusion. If patients are intolerant of the endotracheal tube early in the 2-hour period before haemodynamic stability has been achieved, intravenous sedation is usually administered. Sedation is also given when the cause of the problem cannot be determined and patients are unwittingly placing themselves at risk. The complexity of decisions surrounding the MAP is apparent when one considers that
nurses usually manipulate the pacemaker; various combinations of fluid, inotropic, and vasodilator therapies; the patient's conscious state; and analgesic therapies in order to maintain an adequate perfusion pressure.

There is evidence to suggest that assessments and interventions of both the blood pressure and cardiac rate and rhythm should be prioritised in order to improve patient outcomes. Doering et al. (2001) found that the following postoperative factors accounted for a high proportion of variance in the intensive care unit length of stay: early haemodynamic instability defined as hypotension (systolic arterial pressure less than 90 mmHg) or hypertension (systolic arterial pressure greater than 140 mmHg) requiring either intravenous volume replacement or vasoactive pharmacological therapies (excluding less than 5 mcg·kg·min of Dopamine) within the first 3-hour period of admission to intensive care; presence of dysrhythmias (atrial fibrillation, atrial flutter, supraventricular tachycardia, ventricular tachycardia, ventricular fibrillation, atrioventricular blocks); 12-hour fluid balance; and duration of intubation. An earlier study by Miller (1998) found that atrial dysrhythmias and a low cardiac index were associated with a prolonged intensive care length of stay. Although the Doering et al. (2001) study used systolic arterial pressure to define haemodynamic instability, it is the MAP that is considered a key parameter when monitoring haemodynamic states of cardiac surgical patients (Finkelmeier, 2000; Higgins et al., 1996).

To ensure accurate blood pressure values are measured, nurses must attend to procedures of levelling and zeroing. To avoid repetition, the procedures of levelling and zeroing are discussed in the next section (see 2.2.1.3) as they are also relevant to accurate measurements of preload.

2.2.1.3 Preload

Postoperatively, there is an overall increase in body fluid as a consequence of haemodilution associated with cardiopulmonary bypass. That fluid, however, accumulates in the interstitial space not in the intravascular space, so the patient has a relative hypovolaemia. As the body rewarms, the accompanying peripheral vasodilation accentuates the relative hypovolaemia. Hence, most patients are admitted with a low preload due to an intravascular fluid deficit; but, they have more fluid in their body in the postoperative period than they did prior to surgery (Ley, 1988). It takes about 36 to
72 hours for fluid spaces in the body to normalise after cardiopulmonary bypass. Although most patients present to critical care with a low preload, some patients do have an increased preload due to activation of physiological mechanisms, such as the renin-angiotensin system, during the non-pulsatile blood pressure stage of cardiopulmonary bypass.

Preload is measured primarily by technological means through the PAC in the forms of the PCWP and the CVP. The normal ranges for the PCWP and CVP in postoperative cardiac patients are illustrated in Table 2.4 and represent figures for patients with minimal to moderate cardiac dysfunction (Ley, 1988). The PCWP and CVP are often referred to as filling pressures because, respectively, they reflect the blood volume in the left ventricle and right ventricle at end diastole. Physical measures of preload, for example, in the form of jugular venous pressure, are rarely taken in cardiac surgical patients due to the cannulation of the right jugular vein for the PAC. Nurses choose to monitor the CVP continuously or intermittently, but the PCWP can only be measured intermittently. For intermittently measured parameters, nurses use their discretion regarding frequency of assessment. Hence, frequency of PCWP assessments, and possibly those of CVP, can vary. In terms of interventions, a combination of colloid and crystalloid fluids are administered in the recovery period (Daily & Schroeder, 1994; Ley, 1988). Although currently a matter of some debate, colloid fluids have traditionally been used because such fluids remain in the intravascular space thereby preventing further exacerbation of fluid disturbances and third spacing (Gorman et al., 2000).

When assessing haemodynamically monitored pressures such as the PCWP, CVP, and blood pressure, evidence-based guidelines must be adhered to in order to achieve accurate values. To derive accurate pressure readings, each pressure transducer needs to be levelled and zeroed to eliminate hydrostatic and atmospheric pressures respectively (Bridges, 2000; Daily & Schroeder, 1994). Additionally, for the PCWP and CVP, the changes in thoracic pressure associated with respiration, called respiratory excursions, need to be eliminated (Bridges, 2000; Daily & Schroeder, 1994). The literature concerning techniques associated with levelling, zeroing, and eliminating respiratory excursions is presented in order to illustrate the complex technical attributes associated with measuring accurate parameters and how nurses can vary when
measuring haemodynamic pressures. It is clinically significant that nurses assess haemodynamic parameters accurately according to practice guidelines because the data obtained determines patient management decisions. Deviations from evidence-based practices may lead to less than optimal patient outcomes concerning cardiovascular performance.

All pressure transducers must be levelled to eliminate the effect of hydrostatic pressure in the monitoring system. Levelling involves the use of an anatomical marker called the phlebostatic axis. The phlebostatic axis is considered to be on the exterior thorax at the intersection of a line drawn to the side from the fourth intercostal space and a line drawn midway between the anterior and posterior chest (Bridges & Woods, 1993; Winsor & Burch, 1945). To accomplish levelling, each pressure transducer's air-fluid interface is placed either at the phlebostatic axis or on a manifold (which is a tray for holding transducers) and the height difference between the transducer's air-fluid interface and the phlebostatic axis is eliminated using a spirit level. The phlebostatic axis is the external reference point for the left atrium (Winsor & Burch, 1945) Patients must always be lying on their backs for levelling to the phlebostatic axis because in side-lying positions, the heart rotates thereby displacing the left atrium (Bridges, 2000) Also, by levelling the transducer to the phlebostatic axis, the central arterial pressure is monitored despite what artery is cannulated (McGhee & Bridges, 2002).

If levelling is not performed, the pressure value displayed on the monitor will be inaccurate. The displayed pressure will be too high if the transducer is positioned below the phlebostatic axis and too low if the transducer is sited above the phlebostatic axis. For every 1 cm a transducer is levelled above the phlebostatic axis, the measured, and therefore displayed, pressure decreases by 0.74 mmHg (Bridges, 2000) Although such differences may not impact greatly on blood pressure values, should the PCWP transducer be placed 10 cm above the phlebostatic axis, the PCWP will be overestimated by 7.4 mmHg. A difference of 7.4 mmHg is clinically significant for the PCWP which has a normal range of 10 to 15 mmHg in postoperative cardiac patients. Even a 5 cm offset in the position of the CVP or PCWP transducer could potentiate inappropriate interventions and risk adverse patient outcomes in cardiac surgical patients.

For levelling to be accurate, it has been consistently found that patients must be lying on their backs with the head of bed elevation up to, but no greater than, 45°
(Chulay & Miller, 1984; Dobbin, Wallace, Ahlberg, & Chulay, 1992; Wilson, Bemingham-Mitchell, Wells, & Zachary, 1996). Two early studies (Clochesy, Hinshaw, & Otto, 1984; Lalive, 1982) showed support for an elevated backrest up to 60°, but both had important methodological limitations. Not one study could be found that examined the effect of levelling accuracy with the head of bed lower than 0°. Thus, we have no understanding of the accuracy of pressures once the patient's head of bed is lowered. This knowledge deficit needs to be addressed because often in profoundly hypotensive patients, the head of bed is lowered and interventions are made on the basis of the pressures displayed on the monitor.

Overall, with regard to levelling, despite the relatively small samples sizes, the cumulative findings suggest that, provided patients are recumbent on their backs, cardiac and pulmonary pressures will be accurate if the head of bed is elevated at any position between supine (0°) and 45° upright.

In addition to levelling, nurses need to perform zeroing of the pressure transducers. For typical cardiac surgical patients with a standard PAC, zeroing the blood pressure, pulmonary artery pressure, and CVP transducers involves exposing the air-fluid interface to atmospheric pressure and activating the zero function on the monitor. The zeroing procedure effectively establishes atmospheric pressure as a zero baseline so that atmospheric pressure does not contribute to the measured pressures (Gawlinski, 1997).

For disposable transducers, which are in common use, the zeroing procedure is only required when setting-up the pressure to the monitor and when a disconnection occurs between the transducer and the display monitor (Ahrens, Penick, & Tucker, 1995). Zeroing is a fundamental component of haemodynamic monitoring systems to the point that when a transducer is disconnected, the monitor provides an audible and visual alert to clinicians to zero the relevant pressure.

The third procedure that nurses attend to in order to measure preload accurately is the elimination of thoracic pressure changes due to respiration. Such changes in pressure with breathing are called respiratory excursions. To eliminate respiratory excursions, the CVP, PCWP, and pulmonary artery pressures must be recorded at end expiration (Cathelyn, 1997) because of physiological reasons. At end expiration,
regardless of the mode of respiration, the pressure in the thorax approximates atmospheric pressure and is therefore considered constant and neutral.

To assess accurate cardiac or pulmonary parameters at end expiration, nurses can either use the stop cursor screen freeze method or the graphic strip recording method. The stop cursor method involves freezing the displayed pressure on the monitoring screen and shifting a cursor line to the end expiratory point on the waveform in order to display a digital value. This method is commonly used in clinical practice. The graphic strip recording method involves printing a scaled copy of the pressure waveform and identifying the value with a ruler. Although Lundstedt (1997) found that a printed graphic strip of the waveform facilitated greater accuracy than the stop cursor method, the study's findings were limited by the use of only one brand of monitor and the sample of only haemodynamically stable cardiac surgical patients. Hence, there is little evidence to suggest that graphic recording is superior in achieving accuracy to the commonly used stop cursor freeze screen method.

A third method of assessing cardiac and pulmonary pressures does not eliminate respiratory excursions and therefore provides inaccurate data, however, it may be used in clinical practice. Assessment of the pressure involves simply documenting the displayed digital value that corresponds to the relevant pressure waveform on the monitor. It is an inaccurate method because the digit displayed is a mean value averaged over the whole respiratory cycle (Levine, 1985). The degree of respiratory excursion during inspiration will determine the degree of error in the digital value displayed. This method clearly breaches the principle of eliminating the respiratory effects on cardiac and pulmonary pressures. Not surprisingly, two studies that compared the digitally displayed value to measurements obtained from a graphic recording at end expiration found that the graphic recording was more reliable in obtaining end expiration pulmonary pressures (Dobbin et al., 1992; Johnson & Schumann, 1995).

The following study highlights how nurses are free to vary in these clinical procedures and how our understanding of nurses' knowledge and skills regarding the elimination of respiratory excursions is in its infancy. In a questionnaire based study that explored nurses' knowledge of PACs, 39% of respondents failed to identify a PCWP value from a waveform recording on a graphic strip (Burns, Burns, & Shively, 1996). Furthermore, despite 90% of respondents correctly identifying end expiration as the
correct position to measure the PCWP, only 61% could actually do so accurately on a waveform recording; the remaining 39% of respondents deviated up to 10 mmHg away from the correct PCWP (Burns et al., 1996). If the findings of this study were translated into clinical practice, errors of PCWP assessment up to 10 mmHg may adversely affect patient outcomes. Interventions such as colloid fluid boluses may well be ordered by medical staff in response to a PCWP assessed as 10 mmHg below an expected value. An inappropriate fluid bolus would, in all likelihood, place the patient at risk of acute pulmonary oedema and respiratory compromise.

In order to make goal directed decisions concerning the optimisation of cardiovascular performance, it is important that nurses' patient management decisions are based on accurate assessments of cardiac and pulmonary pressures. The assessment of accurate cardiac and pulmonary pressures requires nurses to use evidence-based practices regarding levelling, zeroing, and the elimination of respiratory excursions. It is significant that many studies have examined the potential for inaccurate measurements arising from the highly technical nature of haemodynamic monitoring. Deviations from evidence-based practices surrounding the assessments of salient parameters may lead to inappropriate interventions and adverse patient outcomes.

2.2.1.4 Myocardial Contractility

Although no single parameter should be considered or treated in isolation, the centrality of myocardial contractility to cardiac function in the initial recovery period is undeniable. Impaired myocardial contractility may be prevalent because of poor preoperative left ventricular function, a perioperative myocardial infarction, prolonged cardiopulmonary bypass time, and electrolyte or acid/base disturbances. Forms of myocardial dysfunction are serious postoperative complications that have been reported to occur in as many as 96% of postoperative patients (Breisblatt et al., 1990). However, as myocardial contractility is measured intermittently through technological means, nurses are free to vary in the frequency and accuracy with which it is assessed. Variability in assessment frequency and techniques, can, in turn, affect detection of, and responses to, inadequate myocardial contractility. The following section contains a review of literature related to the significance of myocardial contractility for patient
outcomes and a discussion of the potential variability in nurses' decision making surrounding myocardial contractility.

Nurses assess myocardial contractility by measuring a cardiac output via the PAC and then calculating the cardiac index value. The cardiac index is derived by dividing the patient's body mass index into the cardiac output value and is therefore specific to each patient. Although the values that quantify cardiac output and cardiac index differ, the terms can be used interchangeably because they both refer to the concept of myocardial contractility. A cardiac index of greater than 2.2 L·min⁻¹·m⁻² is considered necessary for adequate myocardial contractility (Kumon, Tanaka, Hirata, Naito, & Fujita, 1986).

A cardiac index below 2.2 L·min⁻¹·m⁻² strongly suggests low cardiac output syndrome. Low cardiac output syndrome has been defined as impaired cardiac function which leads to an imbalance between tissue oxygen supply and demand (Dietzman, Ersek, Lillehei, Castaneda, & Lillehei, 1969). In terms of clinical identification, low cardiac output syndrome has been described as a cardiac index less than 2.2 L·min⁻¹·m⁻², peripheral vasoconstriction, and poor tissue perfusion requiring pharmacological or mechanical therapeutic interventions (Kumon et al., 1986). Despite low cardiac output syndrome being a shock state, classic signs of shock do not always accompany low cardiac output syndrome because of the thermal instability of postoperative patients, residual effects of anaesthesia, and osmotic diuresis that commonly follows cardiopulmonary bypass (DiSesa, 1991). Importantly, low cardiac output may occur in the presence of an adequate PCWP and MAP (Finkelmeier, 2000).

The effects of low cardiac index on patient outcomes are significant and highlight the need for frequent assessments. A low cardiac index has been found to increase intensive care length of stay (Miller, 1998). Miller's finding is not surprising in light of reports that a low cardiac index in the immediate postoperative period may be indicative of hypovolaemia, cardiac tamponade, or acute myocardial dysfunction (Higgins et al., 1996). More concerning, however, is that a low cardiac index has been associated with a high mortality (Kumon et al., 1986). In a review of 3003 cardiac surgical patients over a 7 year period from 1977 to 1984, 22.3% of patients (n = 669) were reported to have low cardiac output syndrome (Kumon et al., 1986). Kumon et al. (1986) reported that the mortality of those with low cardiac output syndrome was 22.8%
compared to the overall mortality of 5.6%. Advances in surgical and postoperative management over the 7-year period failed to improve the mortality rate associated with low cardiac output syndrome. In the final year of the review, low cardiac output syndrome mortality was 46.5% compared to overall surgical mortality of 3.8%. A seminal study on low cardiac output syndrome showed a direct correlation between low cardiac output syndrome and death (Dietzman et al., 1969). Although these data are old, there is no current literature to suggest that the problem is less significant now. Indeed, low cardiac output syndrome was reported to decrease over a 15 year period from 1982 to 1997; but, the overall operative mortality increased with low cardiac output syndrome (Yau, Fedak, Weisel, Teng, & Ivanov, 1999). Also, low cardiac output syndrome, along with postoperative inotropic use and myocardial infarction, have been found to be the most important determinants of critical care length of stay greater than 3 days (Christakis et al., 1996). The implications for nurses from these data are that frequent assessments of cardiac index are required and that a value less than 2.2 L·min⁻¹·m⁻² requires therapeutic interventions in order to optimise patient outcomes.

It is common practice for nurses to measure the cardiac index after patients are received into critical care in order to obtain a baseline postoperative assessment. The cardiac index is then used to evaluate current therapies and determine therapeutic interventions. The ongoing frequency of measuring the cardiac index is determined by the overall haemodynamic status of patients in terms of all relevant patient data and current therapeutic interventions. For unstable patients, measurements of cardiac index may be performed up to four times in the initial 2-hour period in order to evaluate patients' responses to changes in therapies or to assess the need for certain fluid or pharmacological therapies. For stable patients, the cardiac index is probably measured twice in the initial 2-hour recovery period.

For an accurate assessment of contractility through measurement of the cardiac output and calculation of the cardiac index, evidence-based practices associated with preparation, operator technique, and the averaging method need to be attended (Daily & Schroeder, 1994; Sommers, Woods, & Courtade, 1993). Studies that have examined the technical issues associated with assessing cardiac index are reviewed in the subsequent discussion in order to understand the practices required of nurses to meet the goal of optimising cardiovascular performance.
Cardiac surgical patients routinely have a standard PAC that measures cardiac output by thermodilution method. Several processes must be attended to during cardiac output assessment using the thermodilution method to ensure accuracy. The following review will be confined to cardiac outputs performed through the proximal injectate lumen of the PAC with closed injectate systems. The reason for limiting the review is because closed injectate systems are the most commonly used in clinical practice due to the risk of microbial colonisation associated with open delivery systems (Nelson, Martinez, & Anderson, 1986) and their ease of use. Cardiac output assessment can be divided into preparation, operator technique, and the averaging method. These three factors are presented in that order.

Preparation of the patient and equipment for determining the cardiac output requires five stages and these are illustrated in Table 2.6. The first stage involves checking that the PAC is correctly positioned in the pulmonary artery.

Second, the temperature and volume of injectate are selected. The injectate is the fluid, usually 5% Dextrose, used to measure the cardiac output. A volume of 10 mls of room temperature injectate has shown to be as advantageous in terms of accuracy and reproducibility as 5 mls of ice cold injectate and has the added benefits of reduced costs and greater ease of use (Kalassian & Raffin, 1996). As the common practice is to use 10 mls of room temperature injectate, care must be taken to ensure that a 10 °C to 12° C temperature difference exists between the injectate temperature and blood temperature (Daily & Schroeder, 1994; Thelan, Davie, Urden, & Lough, 1994). Indeed, an operating manual from a major manufacturer of cardiac output computers directs clinicians to ensure a difference between the blood temperature and injectate temperature of at least 10 °C (Hewlett Packard, 1989). On this point, however, the literature conflicts. Shellock, Riedinger, Bateman, & Gray (1983) found that, provided 10 mls of room temperature (19 °C to 25 °C) injectate was used, cardiac outputs were acceptable in mildly hypothermic (30.3 °C to 34.8 °C) postoperative cardiac patients. For clinicians, however, if the monitor is configured to require a certain temperature differential, the cardiac output will not be accurate unless it is met.

Third, the computer constant is checked. As a standard PAC and 10 ml volume of room temperature injectate is used routinely for cardiac surgical patients, it is likely
that the computer constant would default to the correct value. Nevertheless, nurses confirm that the computer constant entered into the monitor is correct.

### Table 2.6

<table>
<thead>
<tr>
<th>Preparation of Patient and Equipment For Cardiac Output Determination</th>
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<tbody>
<tr>
<td>Pulmonary artery catheter in correct position</td>
</tr>
<tr>
<td>Chest x-ray</td>
</tr>
<tr>
<td>Pulmonary artery waveform from distal lumen of catheter displayed on monitor</td>
</tr>
<tr>
<td>Central venous waveform from proximal lumen of catheter display on monitor</td>
</tr>
<tr>
<td>1 to 1.5 ml of air required in balloon port to gain a pulmonary capillary wedge trace</td>
</tr>
<tr>
<td>Little resistance to the insertion of the 1 to 1.5 ml of air during inflation of balloon</td>
</tr>
<tr>
<td>Temperature and volume of injectate</td>
</tr>
<tr>
<td>10 mls of room of room temperature injectate</td>
</tr>
<tr>
<td>Check computer constant</td>
</tr>
<tr>
<td>Correlate computer constant with type of pulmonary artery catheter, injectate temperature, injectate volume</td>
</tr>
<tr>
<td>Patient positioning</td>
</tr>
<tr>
<td>Supine</td>
</tr>
<tr>
<td>Head of bed elevation between 0° and 20°</td>
</tr>
<tr>
<td>Concurrent infusions</td>
</tr>
<tr>
<td>Avoid concurrent high volume intravenous fluid administration</td>
</tr>
</tbody>
</table>

Fourth, patients must be lying on their backs and high correlations have been found with a head of bed elevation between 0° to 20° (Grose, Woods, & Laurent, 1981; Kleven, 1984). Two studies (Cline & Gurka, 1991; Driscoll, Shanahan, Crommy, Foong, & Gleson, 1995) have reported a significant difference between cardiac outputs performed with a 45° head of bed elevation compared to supine 0°; so, a backrest elevation to 45° is not recommended.

Finally, it has been recommended in two review papers (Loveys & Woods, 1986; Sommers et al., 1993) that, if possible, concomitant high volume fluid administration
through other lumens of the PAC be suspended during cardiac output measurements. This recommendation may not always be clinically sound and should be interpreted with caution because a study cited by the review authors had methodological limitations. For instance, in the study by Hoel (1978), a decrease in cardiac output was reported due to a concomitant infusion of saline through the distal lumen of the PAC. The distal lumen is commonly used clinically to monitor pulmonary artery pressures and PCWP pressures, not to administer fluids (Daily & Schroeder, 1994). Infusions of intravenous fluids through other catheters may also influence the measured cardiac output. Rapid peripheral intravenous infusions just prior to measurement of the cardiac output have been found to significantly reduce the cardiac output whereas rapid intermittent peripheral intravenous infusions during cardiac output measurement can significantly increase the cardiac output (Wetzel & Latson, 1985). In light of these findings, Wetzel and Latson (1985) recommended that rapid infusions should be either discontinued 30 seconds prior to cardiac output measurement or maintained at their current rate for the duration of measurement. Clinically, the decision to suspend fluid administration may jeopardise the patient's haemodynamic state. Nurses may decide to maintain the current rate of an infusion or defer assessment of cardiac output until a fluid bolus is administered.

Once preparations are complete, issues regarding the operator's techniques are pertinent (see Table 2.7). First, the generally agreed number of cardiac outputs required to calculate and average is three to four cardiac outputs (Kalassian & Raffin, 1996; Sommers et al., 1993). Second, a volume of 10 mls of injectate fluid, usually 5% dextrose, is injected as a bolus over a time span of 2 to 4 seconds (Kalassian & Raffin, 1996).

| Table 2.7 |
| Issues Regarding Operator Technique During Cardiac Output Determination |
| Number of cardiac outputs required to calculate an average |
| Duration of injecting injectate |
| Timing the injection of injectate in relation to respiratory cycling |
Third, there is the issue of timing the injection of injectate in relation to the respiratory cycle. Although cardiac outputs were initially thought to be the most accurate when the injectate was timed for injection at end expiration (Loveys & Woods, 1986), later studies revealed that such timing achieved reproducibility, not accuracy (Stevens, Raffin, Mihm, Rosenthal, & Stetz, 1985). Accurate assessments are gained when each of the three or four cardiac outputs performed are equally spaced across the respiratory cycle (Jansen, Schreuder, Settels, Kloek, & Versprille, 1990; Kalassian & Raffin, 1996; Sommers et al., 1993). Adherence to the three operator techniques should facilitate cardiac output curves that are appropriately shaped. Nurses inspect each cardiac output curves after each cardiac output is performed to assess their technique. Specifically, nurses look for distortions of the baseline, slope, and overall shape to indicate a lack of integrity in the procedure.

To conclude the determination of cardiac output, nurses calculate the average cardiac output. To do so, a comparative check of all of the curves is carried out and distorted shapes are deleted. If less than three cardiac output curves remain, further measurements are performed because it is recommended that an average is taken from three cardiac outputs (Jansen et al., 1990; Kalassian & Raffin, 1996; Sommers et al., 1993). After the distorted shaped curves are deleted, the cardiac output with the median value is identified. Cardiac outputs measuring greater or less than 10% of the median are discarded (Weil, 1977). In practice, the deletion of distorted shaped curves invariably involves the deletion of cardiac output values that are 10% out of range from the median value. Stetz, Miller, Kelly, and Raffin (1982) have challenged the notion that 10% difference is important by analysing 14 studies of the clinical use of cardiac output determination by thermodilution. They concluded that a minimal difference of 13% among three cardiac output values is required to suggest clinical significance. This study suggests the commonly held view and clinical practice of 10% may be too narrow. Loveys and Woods (1986) have also rejected earlier research which suggested the first cardiac output must always be discarded. Thus, the first cardiac output should be judged for its relationship to the median value alone. All of these processes ensure that an accurate average cardiac output is calculated.

Once the average cardiac output is determined, it is recommended that the cardiac index, which accounts for body surface area and is therefore individualised, is
calculated. By using the cardiac index to guide interventions, decisions will be tailored specifically to the patient (Loveys & Woods, 1986). Derived parameters such as the SVR are calculated at this stage. In addition, parameters such as stroke volume and pulmonary vascular resistance may be calculated and documented.

Variability in preparation, operator technique, and the averaging method are possible when nurses assess the cardiac output. Given the centrality of cardiac index to the optimisation of cardiovascular performance and overall haemodynamic state of the patient, it is important that measurements of the cardiac output are performed according to the literature.

2.2.1.5 Afterload

Afterload refers to the resistance in the arterial circuit that the heart has to pump against. Following surgery, afterload may be increased because the blood vessels constrict in response to hypothermia and the activation of the renin-angiotensin system. However, substances such as complement and bradykinin which cause blood vessels to dilate are also released as a result of cardiopulmonary bypass. Therefore, afterload is usually high, but transient profound decreases may occur during the recovery period (Kam, Hines, & O'Connor, 1996) that can confound management.

The SVR is a quantitative measure of the afterload of the left ventricle and the normal range is illustrated in Table 2.4. Occasionally, the temperature of peripheral limbs are used as a crude physical measure of afterload where cold extremities may indicate vasoconstriction and thus a raised afterload. To measure SVR, a cardiac output is performed and then the SVR is calculated. Therefore, nurses can vary in the frequency of assessing SVR just as they can for assessing contractility.

Assessment of SVR is critical in order to detect and manage low SVR syndrome which can occur after cardiac surgery involving cardiopulmonary bypass. In the immediate postoperative period, low SVR syndrome results in hypotension and therefore an inadequate perfusion pressure that requires management with potent intravenous vasoconstricting agents such as noradrenaline (Myles, Leong, & Currey, 1997). Low SVR syndrome has been reported to occur in about 5% to 8% of cases and results in patients experiencing a more complicated and lengthy postoperative recovery in critical care (Myles et al., 1997). The syndrome has been defined as SVR less than 750
dynes·sec·cm$^{-5}$ on at least two occasions, at least 2 hours apart or on one occasion if the patient required treatment with noradrenaline (Myles et al., 1997). Currently there is little understanding of nurses' decision making surrounding this postoperative complication.

2.2.1.6 Arterial Oxygen Saturation

For cardiac surgical patients, an inadequate arterial oxygen saturation will severely compromise cardiac function. Specifically, cardiac dysrhythmias in the forms of bradycardia or a failure of the pacemaker to induce electrical activity in the heart are complications that can arise from a low arterial oxygen saturation. Likewise, chest pain or coronary artery spasm may occur. Problems of inadequate oxygenation can be minimised through appropriate ventilatory management of the patient. However, mechanical problems within the chest drainage system have the potential to induce hypoxaemia.

Arterial oxygen saturation is continuously measured non-invasively through pulse oximetry (SpO$_2$) and intermittently via analysis of arterial blood gases. The normal value is illustrated in Table 2.4. Alarm settings on the SpO$_2$ module of the cardiac monitor are used by nurses to continually assess the arterial oxygen saturation.

To ensure arterial oxygen saturation remains between 95% and 100%, the delivery of adequate oxygen is provided through appropriate settings on the ventilator. Second, mechanical problems that interfere with respiration are addressed. Such mechanical problems may include occlusions in respiratory tubing, the patient coughing sputum into the endotracheal tube, or kinking of the chest tubes. Third, activities that lead to increases in myocardial oxygen demand and consumption must be minimised. Such activities include agitation and shivering. These issues highlight how nurses are free to vary in both monitoring oxygenation, ensuring systems are in place to maintain adequate oxygenation, and responding to problems that can induce hypoxaemia.

In sum, the first goal of therapy in the initial 2-hour period after cardiac surgery is the optimisation of cardiovascular performance. The key parameters for optimising cardiovascular performance have been identified as cardiac rate and rhythm, MAP, preload in the forms of PCWP and CVP, cardiac index, SVR, and arterial oxygen saturation. The discussion has highlighted how nurses are free to vary their decision
making in terms of assessment frequency, particularly in relation to parameters that are measured intermittently, and assessment accuracy. To meet the goal of optimising cardiovascular performance, nurses' assessment and interventional decision making in the 2-hour recovery period will revolve around frequent, accurate assessments of those key parameters in order to prevent, detect, and manage haemodynamic instability. In the next section, key parameters in relation to the second goal of therapy, the promotion of haemostasis, will be identified. Nurses' techniques of management in relation to promoting haemostasis will also be discussed.

2.2.2 Promotion of Haemostasis

Haemorrhage is a major potential complication for patients in the initial 2-hour recovery period due to exposure to cardiopulmonary bypass. Postoperative bleeding may be caused by a coagulopathy or inadequate surgical techniques. Medical bleeding is associated with a coagulopathy and is characterised by chest drainage of greater than 100 mls/hr. Surgical bleeding is associated with surgical techniques and is characterised by chest drainage of greater than 200 mls/hr. The complexity of nurses' decision making in relation to the promotion of haemostasis arises from the high patient acuity, subtlety of cues related to bleeding, and the imperative for rapid responses during episodes of bleeding. In order to promote haemostasis, assessment and interventional decisions concerning haematological status, chest drain management, arterial blood pressure, and surgical wound management will be described and areas where nurses are free to vary will be highlighted. A summary of the clinical issues concerning the promotion of haemostasis appears in Table 2.8. The order in which these issues will be discussed represents the usual decision making process in the clinical setting whereby factors that predispose patients are assessed first, factors that may exacerbate bleeding are minimised, and actual blood losses are assessed via the chest drainage system and wound integrity. Goal-orientated decision making involves the promotion of haemostasis through the assessment of patients' haematological status, prevention of hypertension, and maintenance of chest tube patency.
2.2.2.1 Haematological status

As a consequence of the anticoagulation agents received whilst on cardiopulmonary bypass, the haematological status of patients does not return to normal until 2 to 4 hours after surgery (Harker, Malpass, Branson, Hessel, & Slichter, 1980). Even in the presence of sound surgical techniques, patients are still at risk of bleeding due to physiological disturbances to clotting factors and platelets. Postoperatively, it is important that the haematological status of patients is ascertained. It is especially important to determine the haematological status of patients who have displayed bleeding tendencies either during surgery or after separation from cardiopulmonary bypass.

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<th>Table 2.8</th>
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<tr>
<td><strong>Summary of Clinical Cues in Assessment of Haemostasis</strong></td>
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<tr>
<td>Parameter</td>
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<tr>
<td>Haematological status</td>
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<tr>
<td>Perfusion pressure</td>
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<td></td>
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<tr>
<td>Chest drainage system and chest tubes</td>
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<tr>
<td>Suction</td>
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<td>Chest tubes position</td>
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<td>Chest tube integrity</td>
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<td>Chest drain Loss</td>
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<td>Chest x-ray</td>
</tr>
<tr>
<td>Surgical wounds</td>
</tr>
<tr>
<td>Sternal</td>
</tr>
<tr>
<td>Saphenous vein graft</td>
</tr>
<tr>
<td>Radial arterial graft</td>
</tr>
</tbody>
</table>
To assess the risk of haemorrhage, blood samples are taken to measure patients' haematological status. Depending on the status of patients and unit protocols, nurses may measure activated clotting time in the critical care unit, send a full clotting profile to the laboratory, or measure both. Of particular interest is the activated partial thromboplastin time because it indicates the degree of anticoagulation induced by heparinisation whilst on cardiopulmonary bypass.

Following assessments of patients' haematological status, in consultation with medical staff, procoagulant drugs and blood products are given to normalise clotting function. Protamine sulphate is administered to reverse anticoagulation due to heparin and normalise the activated partial thromboplastin time. Platelets are given to correct platelet dysfunction or low platelet levels. Due to haemodilution and intraoperative bleeding, the haemoglobin may be low and that has implications for the balance between myocardial oxygen supply and demand. Therefore, transfusions may be required to treat anaemia. Usually, there is also blood from the cardiopulmonary bypass circuit, termed pump blood, returned with the patient for later infusion. Although pump blood contains haemoglobin, it is in a dilute form. Moreover, pump blood contains heparin which may potentiate bleeding. Commonly, nurses are free to exercise their discretion regarding the appropriateness of administering pump blood.

2.2.2.2 Perfusion pressure

Hypertension in the recovery period is characterised by a slow increase in MAP that begins after cardiopulmonary bypass and continues for the first 4 hours (Estafanous & Tarazi, 1980). The causes of hypertension include hypothermia, shivering, diminishing effects of preoperative antihypertensive agents, arousal from anaesthesia, agitation, hypoxaemia, hypercarbia, and use of inotropic agents. Usually, a MAP greater than 95 mmHg is considered hypertensive, although the specific value can range between 90 mmHg and 105 mmHg depending on unit protocols and surgeons' recommendations for individual patients. In some patients, MAP may be maintained below 80 mmHg during the initial recovery period (Finkelmeier, 2000).

The two major problems associated with hypertension are the stress placed on surgical suture lines and the risk of increased myocardial oxygen consumption which may adversely affect contractility (Higgins et al., 1996). The consequences of stressed
suture lines depends on the type of surgery and techniques used. A major haemorrhage may occur at the site where the aorta was cannulated for cardiopulmonary bypass. Less pronounced bleeding may arise near the coronary artery bypass grafts or on the chest wall from where internal mammary arteries were dissected. Bleeding may also occur in areas of the mediastinum not drained by chest tubes.

To assist in promoting haemostasis in the recovery period, the MAP is assessed and therapeutically managed to avoid hypertension. Commonly, nurses aim to keep the MAP less than 95 mmHg. As indicated in an earlier section (2.2.1.2), nurses set the upper limit on the MAP alarm to provide audible warnings of hypertensive episodes.

Nurses have some degree of freedom regarding the management of hypertension. Interventions are based on the cause of the hypertension and unit preference. For instance, hypertension due to agitation, endotracheal tube intolerance, endotracheal suctioning, or resistance to mechanical ventilation is treated with sedation. Propofol is a short acting sedative commonly given as a bolus or infusion in the recovery period. Opioid analgesia is administered for pain relief. Hypertension associated with the normal postoperative course for uncomplicated cardiac patients is commonly treated with sodium nitroprusside or glyceryl trinitrate (GTN) infusions (Higgins et al., 1996). As nurses titrate those drug infusion(s) to achieve an appropriate MAP for each patient, the continuation of hypertension and its potential for exacerbating bleeding lies within the realm of nurses’ decision making. Great care must be exercised during administration of vasodilatory drugs because, in combination with rewarmed measures, hypotension can be induced. Rewarming measures cause peripheral vasodilation which, in turn, lowers perfusion pressure. Colloid fluids can be given to prevent hypotension associated with concurrent therapies. Thus, to manage hypertension without precipitating hypotension, great skill is required in achieving a balance between the doses of vasodilator drugs, rewarmed the patient, and colloid infusion rates. Clearly, there is scope for variability in nurses’ responses to hypertension and therefore the promotion of haemostasis through such decision making.

2.2.2.3 Chest Tubes and Chest Drainage System

Depending on the type of cardiac surgery, two to four chest tubes are inserted near the completion of surgery to remove blood and haemoserous fluid from the
pericardium, pleural, or mediastinal cavity. Placement of drains depends on the surgery performed. A chest tube is commonly placed in the pericardial cavity to reduce the risk of tamponade. Similarly, a chest tube placed in the mediastinal cavity is designed to drain blood and haemoserous fluid away from the surgical area. A chest tube in the pleural cavity allows the drainage of air, blood, and haemoserous fluid thereby reducing the risk of pneumothorax and haemothorax. If either, or both, the left or right internal mammary arteries are used for bypass grafts, chest drains are placed in the relevant pleural space. If a particular chest tube displays excessive blood loss, nurses may ascertain the possible site of bleeding by consulting the history or viewing the chest x-ray.

Management of the chest drainage system is important to the goal of promoting haemostasis. Nurses manage the integrity of the chest drainage system which includes the level of suction pressure and chest tube patency. In addition, nurses assess the volume and consistency of blood loss, and the presence of an air-leak. Such assessments are made on receiving the patient and at least half-hourly during the initial 2-hour recovery period, although assessments every 15 minutes have been recommended (Daily & Schroeder, 1994). Certainly a high frequency of assessments is likely to occur in haemodynamically unstable patients or in patients who show signs of bleeding.

Chest drain systems which consist of a collection chamber, under-water seal, and suction chamber are used postoperatively. According to best practice, a negative pressure of 20 cmH₂O is used to promote drainage (Symbas, 1989). It is achieved by filling the suction chamber with sterile water to a 20 cm level in the operating room. On receiving the patient, critical care nurses establish suction to the system by connecting a negative pressure to the chest drain system and ensuring that all necessary taps in the system are in the correct position. The under-water seal chamber is assessed for an air-leak which would indicate a pneumothorax. The collection chamber is assessed and monitored for blood loss volume. Chest drainage of greater than 100 mls/hr alerts the nurse to the possibility that the patient may be bleeding. The chest drain tubing is also assessed for the consistency, colour, and rate of blood loss. Inspection of the chest tube site for clots at the insertion level and dressing integrity is also performed. Nurses document the volume loss, air-leak status, and dressing integrity on the patient's observation flow chart.
In terms of chest tube management, there are few research based guidelines for nurses to follow (Charnock & Evans, 2001). Consequently, expert opinion and unit protocols tend to guide nurses' decision making regarding chest tubes. In the recovery period, milking and stripping of chest tubes may be carried out to maintain tube patency (Symbas, 1989). Milking and stripping of chest tubes may be performed as a routine practice, when a cardiac tamponade is suspected, or in response to blood clots in the tubes. A review of studies that explored milking and stripping concluded that both milking and stripping actions were effective in maintaining tube patency, but that such actions were no more effective than allowing the tubes to drain freely without manipulation (Charnock & Evans, 2001). Nurses are encouraged to keep the chest tubing free of kinks and dependent loops by coiling the tubes to allow free drainage. Early evidence suggests that allowing a dependent loop in the tubing may restrict free drainage to the collection system (Gordon, Norton, Guerra, & Perdue, 1997). The risk to the cardiac surgical patient of an impedance to drainage is that fluid may accumulate in the pleura, mediastinum, or pericardium thereby predisposing infection and respiratory or cardiac distress.

In terms of positioning the patient to facilitate chest drainage, there is no evidence available to guide nurses' decision making. In the absence of any evidence to support a particular position for facilitating chest drainage, the patient's position in the 2-hour recovery period should be determined by the evidence regarding accurate recordings of haemodynamic data. Therefore, aside from rolling patients for nursing interventions or temporarily sitting them upright to as high as 90° for a chest x-ray to be taken, patients should be nursed on their backs. According to the research presented in Section 2.2.1.3, the backrest elevation should no greater than 45° in order to display accurate pressure-based haemodynamic parameters on the monitor. During cardiac output determination, the backrest elevation should be no greater than 20° in order to measure an accurate cardiac index.

2.2.2.4 Surgical wounds

Surgical wound sites are dressed at the completion of surgery by nurses in the operating room. All patients have a sternal wound dressing. If a radial artery or saphenous vein is used for grafting, dressings are placed accordingly. The aim is to
maintain integrity of the surgical wound by ensuring the dressing remains intact and dry throughout the 2-hour period. Dressings to the sternum, saphenous vein graft sites, and radial artery graft sites are assessed for their integrity and evidence of blood loss. Assessments of surgical wound dressings are made on receiving the patient and hourly for the first few hours. More frequent assessments are likely in the event of bleeding from wound sites.

In the event that haemorrhage at any site is detected, in the absence of haematological dysfunction, the surgeon should be notified. In the presence of a haematological dysfunction, a generalised oozing of blood may be expected and the dressing should be reinforced. In addition, the administration of specific blood products and procoagulant drugs may be carried out.

In sum, the promotion of haemostasis is an important goal of therapy in the 2-hour period following cardiac surgery. The key clinical cues that nurses assess and manage in order to promote haemostasis include patients' haematological status, perfusion pressure, chest tubes and the chest drainage system, and surgical wound sites. Decision making surrounding those clinical cues allows nurses to detect bleeding from either medical or surgical causes. Subsequently, medical or surgical interventions can implemented to correct the underlying problem. In the next section, key parameters in relation to the third goal of therapy, the reestablishment of normothermia, will be identified. Nurses' techniques of management in relation to reestablishing normothermia will also be discussed.

2.2.3 Reestablishment of Normothermia

Residual hypothermia is a common problem in the immediate period after cardiac surgery on cardiopulmonary bypass. Intentional hypothermia is a physiological principle of cardiopulmonary bypass that helps to protect the patient from cerebral ischaemia. Although patients are rewarmed to 37 °C before separation from cardiopulmonary bypass, body heat is lost during the last stages of surgery resulting in mild hypothermia. Moreover, as the body rewarms, normothermic blood mixes with hypothermic blood emerging from denser and less vascular tissues and motionless or vasoconstricted peripheries. Residual hypothermia can lead to haemodynamic instability and the onset of shivering which, in turn, can cause severe haemodynamic instability.
Therefore, a goal of therapy in the initial 2-hour recovery period is to reestablish normothermia.

The focus of this section is the decision making associated with nurses' assessments and interventions in relation to reestablishing normothermia. As illustrated in Table 2.9 nurses' decision making revolves around body temperature and the onset of shivering. Nurses use rewarming measures to reestablish normothermia during the 2-hour recovery period. The literature in relation to monitoring temperature and rewarming measures will be discussed in order to illustrate areas of practice where nurses may vary and to review evidence-based practices concerning the reestablishment of normothermia.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Clinical issues in 2-hour recovery period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td></td>
</tr>
<tr>
<td>Core temperature</td>
<td>Continuous monitoring of pulmonary artery temperature</td>
</tr>
<tr>
<td></td>
<td>Intermittent monitoring of tympanic temperature if no pulmonary artery catheter</td>
</tr>
<tr>
<td>Body shell temperature</td>
<td>Physical palpation of peripheries and torso at least hourly</td>
</tr>
<tr>
<td>Shivering</td>
<td>Assess frequently</td>
</tr>
</tbody>
</table>

2.2.3.1 Temperature

Residual hypothermia is commonplace in the cardiac surgical recovery period because of afterdrop (Moors et al., 1994; Whitman, 1991). Afterdrop infers that nurses need to monitor both core temperature and body shell temperature in order to determine when patients reach normothermia. As the risks of hypothermia include myocardial
ischaemia, coagulation changes, and shivering (Burns, 2001; Higgins et al., 1996), nurses rewarm patients and monitor temperature to reestablish normothermia. However, the frequency of what parameters are assessed and methods of rewarming are discretionary nursing decisions.

In the critical care context, continuous and reliable measurement of core temperature comes from the pulmonary artery thermistor of a PAC (Morley-Forster, 1986). In the absence of a PAC, tympanic membrane thermistors are preferred over axillary probes because the latter is a measure of muscle rather than core temperature (Morley-Forster, 1986). Palpation of the skin temperature on patients' peripheral limbs is also carried out to help monitor patients' thermoregulatory response to rewarming and the body shell temperature. In doing so, the success and extent of total body rewarming can be assessed. Intermittent assessments of the body shell temperature through skin palpation are carried out on receiving the patient and at the nurses' discretion thereafter. Most assessments are made when neurovascular observations are carried out and in response to indications from patients about their level of comfort. In addition to assessments of temperature, it is crucial that assessments are made for the onset of shivering.

2.2.3.2 Shivering

Shivering is a common and potentially deleterious complication for cardiac patients in the initial 2-hour recovery period (Guffin et al., 1987; Spaniol et al., 1994). Indeed, up to 50% of patients can shiver in the first 3-hour postoperative period (Spaniol et al., 1994). Although hypothermia is believed to cause shivering in the recovery period; shivering may also be caused by an inflammatory response secondary to cardiopulmonary bypass (Yared et al., 1998). As the current weight of opinion leans toward shivering being a consequence of hypothermia, discussion is limited to cold-induced shivering.

Shivering has three main adverse effects for postoperative cardiac patients. First, shivering increases the metabolic rate, carbon dioxide production, and oxygen consumption up to 200% (Holtzclaw, 1986; Mort, Rintel, & Altman, 1996). A large demand for oxygen from shivering may also result in a low mixed venous oxygen saturation and metabolic acidosis (Guffin et al., 1987). Shivering is therefore likely to
adversely affect the balance between myocardial oxygen supply and demand through increases in heart rate and MAP. For patients with severe left ventricular failure or fixed rate pacing, shivering may result in hypotension and a low cardiac index due to an inability of the myocardium to respond with normal physiological compensatory mechanisms. A study by Spaniol et al. (1994) found that the mean heart rate of patients who shivered was higher than the heart rate of patients who did not shiver in the first 4-hour period after cardiac surgery. Although, an increase in heart rate may be beneficial for some patients, an unnecessary increase in heart rate leads to increased myocardial workload and possible ischaemia.

Second, the excess carbon dioxide production associated with shivering confounds respiratory management. The rise in carbon dioxide can cause respiratory distress and be uncomfortable for patients who are unable to increase their minute ventilation to expel the carbon dioxide. The respiratory distress experienced by intubated and ventilated patients is compounded by their inability to verbally communicate the problem to nurses. Third, shivering is a very inefficient means of heating the body during the rewarming period (Holtzclaw, 1986) and so hypothermia persists.

To prevent shivering, it is essential that nurses assess for the onset of shivering in postoperative patients and promptly intervene to limit its extent and duration. In terms of assessing the onset and extent of shivering, some years ago Holtzclaw devised a scale which was validated with electromyogram measurement (Holtzclaw, 1986). The scale rates the extent of shivering based on a pattern of muscle involvement and body progression. The shivering scale is illustrated in Table 2.10. The palpation of mandibular vibrations is an ideal way for nurses to detect the onset of shivering because modern cardiac monitors can eliminate artifact on the ECG caused by shivering. By assessing for, detecting, and responding to, shivering in an early stage, the profoundly deleterious effects of high grade shivering on patients' haemodynamic status may be avoided.
Table 2.10

<table>
<thead>
<tr>
<th>Grade</th>
<th>Shivering scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No visible or palpable shivering</td>
</tr>
<tr>
<td>1</td>
<td>Palpable mandible vibration or electrocardiogram artifact</td>
</tr>
<tr>
<td>2</td>
<td>Visible fasciculations of head and neck</td>
</tr>
<tr>
<td>3</td>
<td>Visible fasciculations of pectorals and trunk</td>
</tr>
<tr>
<td>4</td>
<td>Generalised shaking of entire body and teeth chattering</td>
</tr>
</tbody>
</table>

When nurses detect the onset of shivering in their patients, drugs such as sedatives, opioid analgesics, or neuromuscular blocking agents are ordered by medical staff with the aim of rapidly stopping the shivering. In terms of nursing interventions to prevent shivering, it is commonplace for nurses to institute active rewarming measures in the recovery period. There is, however, little evidence to indicate whether shivering can be prevented by such measures. The purpose of the next section is to review the best available evidence concerning the reestablishment of normothermia and prevention of shivering through active rewarming measures. In particular, literature related to the parameters that signal the need for rewarming measures to be both instituted and discontinued as well as the optimum method for reestablishing normothermia will be reviewed. The findings of the studies will be used in the analysis of nurses' decision making concerning the reestablishment of normothermia.

2.2.3.3 Rewarming

Given that hypothermia is defined as 36 °C or below (Morley Forster, 1986; Vaughan et al., 1981), it is reasonable to expect that rewarming measures are warranted for patients with core temperatures at, or below, 36 °C. There is, however, a concern that patients who are peripherally cool to touch and mildly hypothermic with a core temperature of 36 °C to 36.5 °C on arrival to the critical care unit will experience afterdrop and consequently suffer adverse effects of hypothermia if rewarming measures are not instituted. Phillip and Skov (1988) defined mild hypothermia as 34 °C to 36.5 °C,
and, in recognition of the afterdrop phenomenon, suggested that postoperative patients with core temperatures between 34 °C and 37 °C require rewarming.

There is also a point of view that normothermia, that is core temperature of 36.6 °C to 37.5 °C (Phillips & Skov, 1988), does not guarantee thermal balance and that hypothermia can be underestimated if nurses rely solely on a specific core temperature to initiate rewarming (Mort et al., 1996). In addition to measuring core temperature, Mort et al. (1996) suggested that nurses need to assess the skin temperature of extremities such as toes, calves, or forearms in order to determine the need for rewarming. Furthermore, they argued, if nurses rely solely on core temperature to initiate rewarming, patients may be haemodynamically unstable because of adverse effects associated with hypothermia. By contrast, Whitman (1991) argued that skin temperature assessments of extremities are not helpful in the recovery period because of the gradient that exists between peripheral temperatures and core temperatures. That is, if patients have a core temperature of 37 °C, but are peripherally cool to touch, the core temperature should prompt the nurse to forgo a rewarming intervention. Whitman (1991) further argued that active rewarming in response to cool extremities can predispose the patient to core hyperthermia which can compromise cardiovascular performance. That is, patients will reach temperatures greater than 37.5 °C. Despite a lack of clear evidence, it seems reasonable that patients with a core temperature below 36 °C are actively rewarmed. For patients with core temperatures between 36 °C and 37 °C who have peripherally cool extremities, nurses are left with less clear guidance. Nevertheless, if patients with temperatures approaching normothermia are shivering, it is reasonable that nurses intervene with active rewarming measures.

In terms of an exact temperature at which rewarming should be discontinued, more research is required before clear guidelines can be developed for clinicians (Whitman, 1991). Two studies (Moors et al., 1994; Villamaria, Baisden, Hillis, Rajab, & Rinaldi, 1997) that examined rewarming methods discontinued active rewarming measures when the patients' core temperatures reached 37 °C. Clinically, many nurses cease rewarming at a core temperature of 36.5 °C rather than 37 °C. The rationale of using 36.5 °C as the signal to discontinue rewarming probably relates to a phenomenon known as hyperthermic overshoot whereby the patient's core temperature continues to rise despite the removal of rewarming measures. Hyperthermic overshoot may result in
less than optimal cardiovascular performance due to an associated tachycardia and increased oxygen demand (Whitman, 1991). When making the decision to discontinue rewarming, nurses need to consider the adverse effects of hyperthermic overshoot on patients' haemodynamic status.

In two studies that discontinued active rewarming measures in cardiac surgical patients when core temperature reached 37 °C, the core temperatures continued to rise afterward in virtually all patients (Moors et al., 1994; Villamaria et al., 1997). Indeed, Rafałowski (1987), demonstrated that removal of warmed blankets when the core temperature reached 37.4 °C resulted in hyperthermic overshoot requiring antipyretic drug administration. By comparison, in the patient group where the warmed blankets were removed at 36.9 °C, there was neither a hyperthermic overshoot response nor an afterdrop response (Rafałowski, 1987). No studies could be found that have ceased rewarming on the basis of peripheral temperatures. Based on the available evidence, it is reasonable that nurses discontinue rewarming measures when core temperatures range between 36.5 °C and 37 °C and shivering is absent.

Another factor for nurses to consider when reestablishing normothermia is the rate of increase in patients' temperatures. The rate of rewarming patients must be gradual. The commonly held view is to raise patients' core temperatures by no greater than 1 °C per hour. Therefore in the 2-hour recovery period, the mean core temperature of patients is likely to rise about 2 °C. Too rapid rewarming may compromise cardiovascular performance by increasing oxygen demand through an increase in metabolic rate (Holtzclaw, 1986). Rapid rewarming may also result in rapid vasodilation of peripheral vasculature which may cause a sudden dumping of metabolites into the central circulation leading to compromised myocardial function. The rapid vasodilation associated with too rapid rewarming may also lower the SVR causing further haemodynamic instability. As patients' temperatures increase, vasodilation, hypotension, and tachycardia replaces the vasoconstriction, hypotension, and bradycardia associated with hypothermia. To avoid haemodynamic instability, gentle methods of rewarming, close monitoring of core temperature, and intravenous fluid replacements are necessary. In some patients, despite those measures, a potent vasoconstricting drug infusion such as noradrenaline is required to maintain a MAP greater than 70 mmHg during periods of rewarming.
In terms of rewarming interventions, nurses can continue to use the warmed cotton blankets from theatre or use other measures such as a forced-air warming blanket or a reflective metallic blanket. A warm water blanket, electric blanket, or infra-red heat lamp may also be available for use. The following review of literature concerning the most optimal method for reestablishing normothermia in cardiac surgical patients is limited to studies centred around forced-air warming blankets because they are the most commonly used form of therapy. Five studies that have compared the rate of rewarming with a forced-air warming blanket to other rewarming methods in postoperative cardiac patients (Giuffre, Heidenreich, & Pruitt, 1994; Harrison & Ponte, 1996; Moors et al., 1994; Mort et al., 1996; Villamaria et al., 1997) are summarised in Table 2.11. Overall, with regard to reestablishing normothermia, despite the lack of replication studies, the relatively small samples sizes, and methodological limitations of some studies, the cumulative findings suggest that, core temperature, peripheral temperature, and shivering are useful assessments to determine rewarming interventions. Although Harrison and Ponte (1996) found that setting the blanket on high (43 °C) warmed patients significantly faster than reflective metallic blankets, as pointed out by Moors et al. (1994), the high setting breached recommendations from the manufacturers that only a medium setting of 38 °C should be used for immobile or poorly perfused patients. Although no other study showed that forced-air blankets warmed patients significantly faster than other methods, there were clinically significant outcomes from these blankets in terms of reduced incidence of shivering and reduction in drug usage to treat shivering (Giuffre et al., 1994; Harrison & Ponte, 1996; Mort et al., 1996). Therefore, forced-air warming blankets set to medium (38 °C) should be commenced on all patients with core temperatures less than 36 °C and in patients with a temperature between 36 °C and 37 °C who are shivering or have cool peripheries. Furthermore, using forced-air warming blankets until the patient reaches a core temperature of 37 °C may reduce the incidence and extent of shivering as well as drug usage to treat shivering. A reduction in the onset and extent of shivering and its associated haemodynamic instability will also assist in meeting the goal to optimise cardiovascular performance.
<table>
<thead>
<tr>
<th>Author, date journal</th>
<th>N</th>
<th>Types of rewarming devices / blankets</th>
<th>Temperature of forced-air blanket</th>
<th>Outcomes measured</th>
<th>Findings and comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giuffre, Heidenreich, and Pruitt 1994 * Nursing Research*</td>
<td>38</td>
<td>Forced-air blanket Noninfrared radiant heater</td>
<td>43 °C if core temperature less than 34 °C, 38 °C for remaining patients</td>
<td>Time taken for core temperature to reach 36 °C for a 30 minute period</td>
<td>Forced-air blanket did not significantly increase rate of rewarming as measured by core temperature when compared to other method Forced-air blanket led to lower incidence shivering, less severe afterdrop, and higher skin temperature Nurses expressed preference for forced-air blanket</td>
</tr>
<tr>
<td>Moors, Pickett, Woolman, Bethune, and Duthie 1994 * British Journal of Anaesthesia*</td>
<td>30</td>
<td>Two different forced-air blankets Reflective metallic blanket covered by cellular blanket</td>
<td>38 °C for both blankets</td>
<td>Time taken to reach 37 °C core and peripheral temperature Time to extubation</td>
<td>No statistical difference between groups for core rewarming times or time to extubation Core temperature rose 0.5 °C per hour in all three groups Peripheral temp. cooled at -0.5 °C in control group compared to warming of 1.3 °C in both blanket groups (p &lt; 0.001)</td>
</tr>
<tr>
<td>Harrison and Ponte 1996 * British Journal of Anaesthesia*</td>
<td>20</td>
<td>Forced-air blanket Reflective metallic blanket</td>
<td>43 °C</td>
<td>Rate of temperature rise in core and peripheral temperatures</td>
<td>Temperatures at all sites were significantly higher in the forced-air warming group 2 hours after surgery (p &lt; 0.01) Rate of increase in core temperature was 0.4 °C and 0.95 °C per hour for reflective metallic blanket and forced-air warming blanket groups (p &lt; 0.01) More patients with reflective metallic blanket required drugs to arrest shivering but statistical significance not reached Patients concurrently received 250 mcg/min glyceryl trinitrate IV</td>
</tr>
</tbody>
</table>
Table 2.11 Summary of Studies Examining the Role of Forced-Air Rewarming Blankets on the Rate of Rewarming in Postoperative Cardiac Patients (continued)

<table>
<thead>
<tr>
<th>Author, date</th>
<th>N</th>
<th>Types of rewarming devices / blankets</th>
<th>forced-air blanket</th>
<th>Temperature of</th>
<th>Outcomes measured</th>
<th>Findings and comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Villamaria, Baisden, Hillis, Rajab, and Rinaldi</td>
<td>84</td>
<td>Forced-air blanket</td>
<td>Nurses chose</td>
<td>Core temp 37 ºC</td>
<td>No significant increase in rate of core temperature rewarming nor</td>
<td>Rate of temperature increase was 0.25 ºC per hour (p = 0.9) in both groups</td>
</tr>
<tr>
<td>1997</td>
<td></td>
<td>to usual practices from</td>
<td>either 38º C or</td>
<td>Clinical outcomes of critical care length of stay, incidence of dysrhythmias,</td>
<td>A lack of control over temperature of forced-air blanket is important</td>
<td></td>
</tr>
<tr>
<td>Journal of Cardiothoracic and Vascular Anesthesia</td>
<td></td>
<td>cotton blanket, radiant heater above</td>
<td>43º C</td>
<td>duration of mechanical ventilation, use of analgesia, muscle relaxants, blood</td>
<td>methodological consideration</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>bed, or warmed solution bags around</td>
<td></td>
<td>products, chest drainage, survival</td>
<td>Use of 43 ºC temperature setting in blankets not recommended by manufacturers for</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>patient</td>
<td></td>
<td></td>
<td>immobile or poorly perfused patients</td>
<td></td>
</tr>
<tr>
<td>Mort, Rintel, and Altman 1996</td>
<td>47</td>
<td>Forced-air blanket</td>
<td>37.5 ºC</td>
<td>Shivering, core temperature at 5 sites and skin temperature at 9 sites</td>
<td>Incidence, magnitude, duration of shivering significantly reduced (p &lt; 0.001) in</td>
<td></td>
</tr>
<tr>
<td>Journal of Clinical Anesthesia</td>
<td></td>
<td>Warmed cotton blankets (36 ºC to 37.5</td>
<td></td>
<td></td>
<td>forced-air blanket group</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>ºC)</td>
<td></td>
<td></td>
<td>Drug therapy usage higher to arrest shivering higher in cotton blanket</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No statistical difference in rate of increase in temperature at any site between</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>groups</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pulmonary artery temperature rose approximately 1 ºC in 2 hours</td>
<td></td>
</tr>
</tbody>
</table>
In sum, the reestablishment of normothermia is an important goal of therapy in the 2-hour period following cardiac surgery. Nurses assess core and body shell temperature to monitor the degree of residual hypothermia because it has the potential to cause haemodynamic instability. The onset of shivering is a deleterious complication for patients' haemodynamic status in the postoperative period because of its potential for myocardial damage. To optimise patient outcomes, nurses implement rewarming measures to hasten normothermia. Current evidence suggests forced-air warming blankets are useful in reestablishing normothermia and minimising the extent of shivering.

2.2.4 Summary

In this discussion, the scene for nurses' decision making in the 2-hour recovery period was set by describing the unique aspects of cardiac surgical patients. The nature of cardiac surgery, the clinical sequelae of cardiopulmonary bypass, high patient acuity, and the numerous cues provided by advanced haemodynamic monitoring technologies all contribute to the complexity of nurses' decision making. An orienting framework for understanding complex haemodynamic decision making by nurses has been described in terms of three major goals of therapy in the context of cardiac surgery. The organising framework recognises nurses' decision making as working toward particular outcomes and has been used to identify variability in nurses' decision making that have the potential to impact upon patient outcomes. Literature was reviewed concerning haemodynamic decision making in the 2-hour recovery period following cardiac surgery related to each of those goals of therapy. Throughout the discussion, the complexity of nurses' decision making concerning the haemodynamic status of patients was highlighted along with potential areas where nurses are free to vary. The salient parameters identified in each section and the associated techniques of management were used in the analysis of data in this study to determine if participants' haemodynamic decision making was goal directed in the 2-hour recovery period. Given the haemodynamic and physiological status of postoperative patients, the potential for optimising patient outcomes is enhanced by nurses making decisions according to best practice in the 2-hour recovery period following cardiac surgery. In the following
section, the influences on nurses' haemodynamic decision making in terms of decision complexity, nurses' experience, and environmental characteristics are explored.

2.3 Influences on Haemodynamic Decision Making

For nurses, the maintenance of haemodynamic stability and the prevention, and detection, of complications in high acuity patients involves a complex array of decision tasks which must be made rapidly and accurately in order to optimise patient outcomes. Given the complexity of nurses' decision making in the recovery period, it is important that we understand how complex tasks can vary nurses' decision making. Furthermore, as nurses' of varying experience levels make complex decisions within a clinical environment, it is important that we understand the roles of experience and environmental characteristics on nurses' decision making. It is only by understanding the potential variability in nurses' decision making arising from decision complexity, experience, and environmental characteristics that we can identify areas for improvement in nurses' decision making and the potential implications for patient outcomes. In the next section, research findings concerning the role of task complexity on decision making are reviewed. Those findings are used to provide expectations about the variability in nurses' decision making as a result of complex haemodynamic decision tasks.

2.3.1 The Role of Decision Complexity in Decision Making

The discussion so far has provided a background for the complex nature of haemodynamic decision making and, in doing so, has set the scene for exploring critical care nurses' decision making in this context. To understand how decision complexity may influence nurses' decision making in terms of variability, it is useful to review literature that has explored the role of task complexity on decision making by people from various disciplines. The findings from these studies can provide expectations of the possible effects on nurses' decision making from haemodynamic task complexity. In particular, the influences of time restrictions and conflicting data are explored because decision making in the cardiac surgical domain involves rapid decision making and
conflicting haemodynamic data. Evidence suggesting that experience can moderate the difficulty associated with performing complex decision tasks is also explored because nurses of varying experience levels are involved in making complex haemodynamic decisions. Additionally, such literature can begin to explore relationships between influences on decision making and provide expectations of the effects of interplay between experience and complex decision making on the variability of nurses' decision making.

The high acuity of patients and forms of haemodynamic instability following cardiac surgery demands rapid haemodynamic decision making of nurses. The effect of time restrictions on nurses' assessment and utilisation of data is not well understood, but an early study by Wright (1974) offers useful insights. In a non-medical, simulated setting, where time restrictions were manipulated, decision makers under time pressure placed greater emphasis on different attributes of a problem than those not under time pressure. If time pressure affects the attributes that nurses consider relevant when making a decision about the cause of a patient's haemodynamic state, for example, attributes that do not support a hypothesised diagnosis of cardiac tamponade, there might be a delay in identifying the condition. Subjects in Wright's study not only concentrated on negative data, they used fewer data overall. Although assessing and using fewer data overall may not be problematic, there is the potential for adverse patient outcomes if salient data are disregarded. Limitations of Wright's study include its simulation basis and the fact that subjects' experience with the task was not controlled for. Nurses make decisions in a dynamic environment where feedback from decisions influence subsequent processing of data. For instance, continuing with the cardiac tamponade example, parameters indicating a worsening of the tamponade may deviate so profoundly over time that nurses recognise, and respond to, the condition. Nurses who constantly make decisions in a time-pressured environment may also show adaptation in important ways such as focusing on salient parameters or delegating decisions. Clinically based studies are needed to explore the effects of the clinical environment on nurses' decision making.

The potential for decision making variability can arise in situations where decision complexity is intensified by conflicting data. It is not known what nurses'
decision processes and responses are to situations where there are conflicting
haemodynamic cues but it is worth examining findings of a study that explored a similar
situation. Based on a simulation, Lewis (1997) found that nurses were more hesitant to
trial weaning a patient from mechanical ventilation when the case was complex. She
reported that conflicting cues significantly made the decision more complex. The nurses
in Lewis' study were all experienced in the process of weaning patients from respiratory
support, so it is not known how inexperienced nurses would respond to conflicting data.

Conflicting data are an everyday part of haemodynamic monitoring. For
instance, patients can feel cool peripherally, but have a low SVR. It is not known if
nurses are more hesitant when faced with conflicting haemodynamic cues, however, in
an acute situation, there is a risk that decisional hesitancy may prolong haemodynamic
instability and thus have profound implications for patient outcomes. A study based in
the clinical field could provide a deeper understanding of nurses' decisions regarding
conflicting data. Interviews with nurses may reveal their methods of resolving
haemodynamic data that conflict. Perhaps in a clinical environment, depending on time
constraints, additional data may be assessed by the nurse to clarify the situation. It is
probable that nurses make judgements in these situations about which data sources are
most accurate and subsequently intervene on that basis.

In a study that sought to study nurses' decision processes in the clinical setting in
order to overcome limitations associated with simulation-based studies, the roles of task
complexity and experience on nurses' decision making processes were explored. Based
on grounded theory, Ellis (1997) observed 17 participants making decisions in practice
on numerous occasions for a total period of 8 hours each. Nurses were interviewed
during the observation period to ascertain their decision processes in terms of why a
certain decision was made, what directed data assessment, and the alternative decisions
available at the time. Nurses appeared to consider more alternatives in response to
complex tasks which were described as problems involving numerous signs and
symptoms, and each cue had unclear or unidentifiable causes. In terms of experience,
Ellis (1997) found that, although all nurses used a hypothetico deductive approach to
decision making, nurses with greater than 3 years experience used goal-directed
processes whereas inexperienced nurses used rule-out processes. There was one
inexperienced nurse who used a goal-directed process. In goal-directed processes, nurses took actions to prevent both potential or known problems and complications occurring. By contrast, rule-out processes involved the generation and subsequent elimination of hypothetical problems, causes of those problems, and subsequent nursing actions. Ellis (1997) argued that the goal-directed process was a more holistic approach and that such decision processes were an indication that experienced nurses had surpassed the need for decisions to be based on rules. A limitation of Ellis' (1997) study is that only day-to-day decisions were observed, so the role of experience on decision processes during time-pressured situations is not known. A further limitation was the conduct of interviews during clinical practice because such questioning may have influenced nurses' decision making. During the observations, none of the nurses were observed to consult with peers about decision making. Given that peer consultation would be expected in a clinical setting, as acknowledged by Ellis (1997), its absence may have been an effect of the researcher's presence. Moreover, although this study was conducted in the clinical setting, it failed to provide any understanding of the influence of environmental characteristics on nurses' decision making. In this study, interactions between experience and decision complexity on the number of alternative decisions generated was not reported, but a study by Corcoran provides some understanding of these relationships.

Corcoran (1986a; 1986b) explored the relationships between task complexity, nursing expertise, and the planning aspects of a task to relieve chronic pain. Complexity was operationalised as the number and interrelation of pain-related problems as well as the extent that hospice pain protocols could be applied to the decision. Using think aloud, 6 experienced and 5 inexperienced participants completed the case study. Corcoran found experience did not alter the number of alternative decisions, however, consistent with Ellis' (1997) findings, a higher number of alternative actions were generated in the most complex task. Task complexity did not have an effect on the ultimate outcome of the decision, that is, the quality of the pain relief plan developed, but there was a trend toward expert nurses generating better quality pain relief plans than novices. The findings of the studies by Ellis (1997) and Corcoran (1986a; 1986b) suggest that task complexity may alter decision processes and that experience can moderate the complexity of tasks.
The limited literature that has explored task complexity and decision making suggests that decision processes can be influenced by highly complex decision tasks. In particular, more alternative decisions may be generated (Corcoran, 1986a, 1986b; Ellis, 1997), fewer cues may be used, and different emphases may be placed on certain attributes in a decision (Wright, 1974). In a study of decision making by midwives, intuitive decision processes in the forms of heuristics or rules of thumb were used by experienced midwives as task complexity increased (Cioffi & Markham, 1997). Decision making consistency has been found to be inversely related to task complexity (Corcoran, 1986b; Hicks, Merritt, & Elstein, 2003; Hughes & Young, 1990). A study of physicians provides further understanding of what is known about task complexity and decision processes.

As part of a broader study, Chinburapa et al. (1993) studied the effects of task complexity in terms of the number of alternative drug choices on the decision making processes used by physicians during a prescribing decision. Forty-eight physicians were randomly assigned to experimental and control groups. Subjects read a case study and made their decision using computer software. Process tracing techniques were used to measure and analyse information acquired by the physician, the decision time, and search strategies across alternatives and attributes. Results indicated that as task complexity increased, less attention was paid to certain attributes of the task. In other words, certain aspects of the decision were neglected.

In sum, evidence regarding the influence of task complexity on decision making suggests that decision making is contingent on the demands of the task (Payne, 1982). These studies also suggest that task complexity alone may not determine decision variability. Many studies have been based on simulations, limiting our understanding of nurses' decision making in the clinical domain. Excluding one clinical study by Ellis (1997), these studies provide little understanding of how environmental factors interplay with task complexity to vary decision making. However, studies that have explored the roles of task complexity and experience suggest an interaction between experience and task complexity. Those studies further suggest that experience is an important influence on decision performance. In the next section, the role of nurses' experience and knowledge on decision making is explored.
2.3.2 The Role of Nurses' Experience and Knowledge

The purpose of this section is to explore the role of experience on nurses' haemodynamic decision making. Current theories about the role of experience on decision making are discussed in order to set the scene for understanding variability in decision making as a function of experience. A useful way of exploring the notion of experience in a complex domain is to divide it into the two interrelated aspects of experiential learning through years of clinical experience and educational preparation. Although these components of experience have been separated for ease of discussion, both are closely interrelated during decision making in clinical practice.

2.3.2.1 Experiential Learning

When caring for patients in the immediate recovery period after cardiac surgery, nurses have available to them a vast array of patient data to inform decision making. In order to meet the goals of therapy, it is important that nurses assess the most relevant data for each patient at any given time. In analogous terms, nurses have to assess and respond to the signals, not the noise, to manage patients' haemodynamic status. Due to the critically ill and haemodynamically unstable nature of cardiac surgical patients, nurses must also make decisions rapidly and accurately. Studies that have explored the role of experience in relation to nurses' data collection strategies and abilities to respond rapidly are explored in this section because these issues are relevant to nurses' haemodynamic decision making in the postoperative context. In particular, research investigating skill acquisition through experiential learning is reviewed in order to provide an understanding of the potential effects of cardiac surgical intensive care experience on the complex haemodynamic decision making required of nurses.

Decision making can be thought of as a problem solving process whereby the solution is in the form of a decision which usually leads to an action (Newell, 1980). Typically, haemodynamic decision making involves a problem solving process whereby critical care nurses assess patient data and then make decisions in the form of interventions. Prior to assessing patient data however, nurses make decisions about what haemodynamic data to assess. In other words, both haemodynamic assessments and interventions can be thought of as problem solving or decision making processes. Nurses' cognitive processes during decision making are an important consideration.
because they determine nurses' actions in the forms of assessment and interventional decisions.

Experiential learning occurs with repeated exposure to particular clinical cases in a particular domain or specialty and affects data collection strategies and nurses’ ability to respond rapidly in clinical practice. Domain experience enables individuals to recognise patterns of information to make faster, more accurate decisions (Chi, Glaser, & Farr, 1988). To understand the role of experience on decision making, it is useful to review the novice to expert literature in nursing and medicine (Benner, 1984; Schmidt, Norman, & Boshuizen, 1990).

Benner (1984) described the development of expertise in nurses over five levels of novice, advanced beginner, competent, proficient, and expert. The development of nursing expertise described by Benner (1984) was based on the skill acquisition theory of Dreyfus and Dreyfus (1985). However, as explained by Benner (1984), expertise and its contribution to decision making skill is not merely a passage of time; but, rather, a process whereby preconceived notions and expectations are continually challenged, refined, or disconfirmed. According to Benner (1984), the decision making of novices is characterised by a reliance on abstract principles, the use of analytic and rule-based processes, a perception that situations are made up of many discrete parts, and a detached stance from situations. The advanced beginner has experience to enable decision performance at an acceptable level but still requires assistance in prioritising, particularly for complex decisions. A competent nurse, who has about 3 years clinical experience, can capably manage the unpredictable nature of clinical nursing and display mastery of nursing skills. The proficient nurse uses past experiences to promptly recognise normal and abnormal patterns in a situation and selectively focuses on important cues. An expert nurse draws upon past experiences, uses intuition, perceives situations comprehensively, and engages fully in the situation (Benner, 1984).

The Dreyfus model of skill acquisition was also found to be applicable to critical care nurses (Benner et al., 1992; Benner, Tanner, & Chesla, 1996). Findings in relation to data collection strategies and responses to patient data by nurses as a function of clinical experience provide insights into potential variability in nurses' decision making. First, the nurses deemed expert (according to 5 years clinical experience and peer and
supervisor review) in the study were able to discriminate between relevant and irrelevant cues (Benner et al., 1996). Decision making was easier for the experts because pattern recognition was used to obtain a grasp of dynamic and complex patient situations and make assessment and interventional decisions in a rapid and confident manner (Benner et al., 1992). Experienced nurses' superior perceptual ability allowed the simultaneous management of multiple complex therapies such as vasoactive infusions and fluid therapies and the consideration of other relevant nursing issues such as informing patients' relatives about changes in patients' conditions (Benner et al., 1992).

Second, without extensive clinical experience, advanced beginner nurses used cues learnt from nursing theory and principles of practice in their basic education, protocols, medical orders, and 'common practices' to guide decision making (Benner et al., 1996). Moreover, less experienced nurses did not have the ability to detect nuances or distinguish variations in cues for given situations (Benner et al., 1992). It was also noted that experienced colleagues were relied upon by inexperienced nurses to suggest assessments and interventions when patients' conditions were evolving such as during postoperative recovery periods (Benner et al., 1992). One priority of advanced beginners was to organise and prioritise tasks in order to feel a sense of safe practice. A failure to be organised raised anxiety in the nurses, and led them to feel both a lack of control and that their practice was unsafe (Benner et al., 1992). In such situations, experienced nurses were sought to provide guidance (Benner et al., 1992).

The notion of pattern recognition in experienced nurses is supported by a theory advanced by Schmidt et al. (1990) that advocated expertise in physicians was based on cognitive structures called illness scripts. Illness scripts hold clinically relevant descriptions of typical or actual patients and consequences of patient problems (Schmidt et al., 1990). Illness scripts also act as organisers of information in memory (Schmidt et al., 1990) and are similar to schemas which describe the format of an organised body of knowledge in memory (Chi & Glaser, 1985).

For physicians, the culmination of continual exposure to patients is a clinical reasoning strategy that is based on the recognition of similarities between a current situation and thousands of previous patients stored in memory. Decisions are made in a rapid, non-analytical manner whereby the recognition of patterns is not a shortcut
process, but an essential skill of the expert decision maker (Schmidt et al., 1990). Since each physician is exposed to different patients over years of practice, the idiosyncratic nature of illness scripts infers that physicians are only likely to make rapid decisions using pattern matching when patient presentations are perceived as familiar. Hence, expertise and associated decision making strategies are domain specific (Chi et al., 1988; Devine & Kozlowski, 1995).

Schmidt et al. (1990) suggested that since medical students lack clinical experience, they rely on pathophysiological knowledge to guide problem solving. This notion is comparable to findings in nurses whereby inexperienced nurses relied upon protocols and cues learnt from texts for clinical decision making (Benner, 1984; Benner et al., 1996).

Illness scripts are particularly useful for making complex decisions, providing those decisions are familiar. Studies conducted under time pressure that featured tasks with multiple cues which are both features of complex decisions, demonstrated that experienced medical practitioners performed better than those with less experience (Norman, Brooks, & Allen, 1989). So, even in complex tasks, experienced physicians can make rapid decisions faster than novices because of the matching of patterns and chunked nature of numerous cues in the illness script. Chunking involves putting together multiple cues as a single entity (Newell & Simon, 1972) in order to increase the capacity of short-term memory, which can hold five to nine symbols of information in conscious thought for a short period of time (Miller, 1956). In unfamiliar complex decisions, however, experts resort to active clinical reasoning (Boshuizen & Schmidt, 1995) and decision making is slower because familiarity with previous cases and pattern matching is essential to the activation of illness scripts.

The study of experienced decision makers in natural settings using the emerging paradigm of naturalistic decision making has yielded the Recognition-Primed Decision model (Klein, 1997a). The Recognition-Primed Decision model describes decision making as a form of complex pattern matching that relies extensively upon the strategies of situation assessment and mental simulations. Situation awareness involves the gathering of contextual information and the integration of that information with previous knowledge to form a mental image, which is then used to both guide further perception
and to anticipate impending events (Durso & Gronlund, 1999). A key feature of the model is that actions are chosen by the decision maker in a serial manner (Klein, 1998). That is, when the current situation is familiar and typical, a single course of action is generated and then taken without considering other courses of action. Familiarity in terms of cue salience, and an understanding of goals and priorities enables an action to be taken rapidly because the experienced person knows the consequences of the chosen action. Recognition-primed decisions can only eventuate from domain specific experience. Otherwise, critical cues and links to obvious goals will not be recognised by the decision maker.

Many aspects of the Recognition-Primed Decision model such as pattern matching and identification of salient cues are similar to illness scripts, schemas, and Benner's (1984) description of intuitive decision making in experienced nurses. The model shows how effective decisions are made rapidly in real-world settings without the need for decision makers to weigh up numerous alternatives, but it has limitations. The model is in its evolutionary state and does not describe how decision makers respond when options have to be compared in the field (Klein, 1998). Nevertheless, Klein (1997d; 1998) claims empirical support for the Recognition-Primed Decision model in many professional fields such as fire-ground commanders, tank platoon leaders, forestry workers, navy commanders, and neonatal intensive care unit nurses.

In support of the notion that experience-derived pattern recognition enables rapid decision making, Baumann and Bourbonnais (1982; 1983) found experience and knowledge were the factors that nurses considered most relevant in crisis decision making situations. A replication study confirmed the original study's findings that experience and knowledge were integral to nurses' rapid decision making abilities (Thompson & Sutton, 1985). The latter assertion is also supported by studies of decision making in nursing and other fields that demonstrated those with experience usually make faster decisions (Benner et al., 1992; Chi et al., 1988; Elstein et al., 1978). Baumann and Bourbonnais (1982; 1983) found that cardiac arrests and other cardiovascular problems such as postoperative haemorrhages and cardiac dysrhythmias were the most common patient situations that required rapid decision making by nurses. These findings have important implications for nurses recovering cardiac surgical
patients. Inexperienced and experienced nurses recover cardiac surgical patients who are at risk of postoperative haemorrhages and cardiac arrests. What these studies do not tell us is the effect of inexperience on the outcomes of nurses' decision making in a crisis situation. To ensure rapid responses in the event of a patient crisis and optimal patient outcomes, the findings of Benner and colleagues' study (1992) suggest that inexperienced nurses may require decision support in the form of an experienced colleague.

In addition to rapid decision making, the ability to discriminate between relevant and irrelevant cues is a key feature of experienced decision makers (Benner, 1984; Benner et al., 1992; Schmidt et al., 1990; Shanteau, 1992). Indeed, Shanteau (1992) found that the cues attended to by those with experience are the most salient, resulting in faster, more accurate decisions. In a study of cardiac nurses (Jacavone & Dostal, 1992), it was found that previous situations of managing cardiac pain were used to direct cue search and focus on relevant cues. Experienced nurses assessed salient data and rapidly responded with vasoactive drugs to alleviate chest pain (Jacavone & Dostal, 1992). Nurses in the study also spread their search for cues widely, accepting or rejecting a complex series of related categories. The wide search for cues suggests nurses were looking for the most relevant cues and had the ability to disregard irrelevant cues.

The role of experience in enhancing nurses' abilities to identify salient cues has been found in neonatal intensive care nurses where, significantly, cue discrimination skills had the potential to improve patient outcomes (Crandall & Getchell-Reiter, 1993). Crandall and Getchell-Reiter found that nurses were most likely to evaluate patient data using ipsative changes, that is, changes in an infant's current condition from the infant's previous condition. Expert nurses also evaluated infants' cues using normative comparisons, which are comparisons between like cases and can be likened to pattern recognition. Perhaps the most significant finding of Crandall and Getchell-Reiter's study was that experienced nurses used assessment cues indicative of sepsis in neonates that either were not documented previously in the literature or that conflicted with cues that were documented in the literature. These findings offer strong support for Benner's (1984) assertion that much advanced knowledge is embedded in clinical nursing.
The way inexperienced clinicians collect and interpret data has been described extensively in the work of Elstein and colleagues (1978) who described the hypothetico-deductive model of decision making in physicians. During cue acquisition, Elstein et al. (1978) found that students were noted to collect excessive data whereas experienced physicians were highly selective and collected only a small number of cues (Elstein & Bordage, 1988; Elstein et al., 1978). Medical students' lack of experience hampered their ability to identify relevant cues and so more data overall were collected. Likewise for inexperienced nurses, the search for cues and recognition of salient cues is hampered by their inability to draw on past experiences. Therefore, inexperienced nurses rely on opportune cues, regardless of decision complexity (Corcoran, 1986a), and consider a wide range of data important and equally relevant (Broderick & Ammentorp, 1979; Corcoran, 1986a).

A characteristic of experienced decision makers is the ability to recognise disconfirming cues. Disconfirming cues are items of information that suggest alternative hypotheses about clinical situations. Medical students have been found to use less disconfirming cues than more experienced physicians (Elstein et al., 1978). Medical students collected more cues overall rather than attend to disconfirming cues. In other studies of medical students (Arocha, Patel, & Patel, 1993) and nurses (Botti & Reeve, 2003; Tabak, Bar-Tal, & Cohen-Mansfield, 1996; Thomas et al., 1991), inexperienced subjects either used fewer disconfirming cues or failed to recognise the implications of disconfirming cues for alternative explanations for a clinical situation. The ability to identify disconfirming cues has been associated with experience and greater decision accuracy (Thomas et al., 1991).

The discussion so far has sought to provide a general framework for understanding the role of clinical experience in developing pattern recognition, particular for enabling nurses to discriminate between relevant and irrelevant cues, search for salient cues, and make rapid decisions. Little research has focused specifically on the role of experience on nurses' decision making related to receiving and recovering cardiac surgical patients. However, two studies offer insights into the potential advantages for patient management from nurses' familiarity with certain critical care equipment, procedures, and processes.
Critical care units contain highly technical monitoring and interventional equipment to which patients are connected, and dependent on, in the recovery period. Bucknall (1996) found that nurses considered familiarity with critical care equipment, processes, and procedures as well as their educational preparation enhanced their decision making abilities for high acuity patients. Nurses were aware of time constraints on their decision making and aimed to be as familiar as possible with patients' conditions so they could respond rapidly if deterioration occurred. To reach a state of readiness, detailed safety checks of equipment and a systematic assessment of patient parameters were performed. Clinical experience and familiarity with usual procedures and processes enhanced such preparedness. Moreover, familiarity with patient conditions provided nurses with confidence to make rapid decisions. These findings indicate a need to understand how inexperienced nurses' lack of familiarity with patient conditions impacts upon their ability to make rapid decisions and the subsequent potential for patient outcomes. In addition, it is important to understand how nurses of varying experience levels feel about making rapid, complex decisions for critically ill patients.

Experience as familiarity with procedural aspects of nursing practice also has the potential to improve patient care because nurses can focus directly on patient problems and not be distracted by events and technologies surrounding the patient. In a grounded theory study using participant observation, in-depth interviews, and analysis of hospital protocols and critical incidents, Radwin (1995; 1998) explored 13 experienced cardiac nurses' decision making. Experience was conceptualised as the application of knowledge learned through clinical practice situations. Radwin (1995; 1998) identified three attributes of experienced nurses: a patient centred focus, knowledge of the antecedents and consequences of certain patient conditions, and decision making confidence. Experienced nurses displayed a patient centred focus because familiarity with usual procedures and processes in the cardiology unit allowed nurses to see past the critical care technology and concentrate on patients' needs. Nurses' previous experiences with cardiology patients accounted for their knowledge of antecedents and consequence of patient conditions. Experience also gave nurses confidence in their ability to respond with appropriate interventions in patient crises. These findings suggest experiential
learning assists in patient management and nurses' level of confidence about their decision making.

The purpose of this section was to review the prevailing views of the role of experiential learning on the decision strategies of nurses. Domain specific experience facilitates the development of organised knowledge structures and the use of pattern recognition to optimise decision making. Evidence has been presented that suggests experiential learning leads to the ability of decision makers to identify salient cues, use fewer cues overall, and make rapid decisions in their domain. Additionally, clinical experience benefits nurses' decision making because critical care technologies, procedures, and processes are perceived as familiar. In addition to experiential learning, it is useful to understand experience in terms of educational preparation. The purpose of the next section is to review educational preparation in mediating the role of experience.

2.3.2.2 Educational preparation

Educational preparation may be in the form of formalised courses or informal education sessions. Theoretical knowledge gained from such educational preparation is likely to benefit nurses' decision making. The purpose of this section is to explore the role of educational preparation on the potential variability in nurses' haemodynamic decision making. In particular, studies that have examined nurses' knowledge of the theoretical underpinnings of haemodynamic monitoring are reviewed since such knowledge is critical to decision making in the initial recovery period.

As indicated earlier in this chapter, cardiac surgical intensive care knowledge refers to an understanding of the principles and potential complications of cardiopulmonary bypass, myocardial protection measures, cardiac surgery, and haemodynamic monitoring. Hence, cardiac surgical intensive care knowledge includes both theoretical and practical components. In Victoria, Australia, such knowledge is usually gained through a formal tertiary level critical care qualification. Mandatory clinical experience of between 24 hours and 38 hours per week is also gained during the one year qualification in order to facilitate theory to practice links and provide opportunities for experiential learning.

Haemodynamic monitoring associated with recovering cardiac surgical patients is of a highly technical nature. Therefore, nurses' knowledge of, and abilities and skills
related to, the principles of haemodynamic monitoring and the interpretation of haemodynamic data may be a source of decision making variability. No studies were found that explored Australian nurses' knowledge of haemodynamic monitoring, but two notable studies explored North American nurses' knowledge of clinical and theoretical aspects of PAC-specific haemodynamic monitoring using a multiple-choice questionnaire (Burns et al., 1996; Iberti et al., 1994). The 37-item questionnaire used by Iberti et al. (1994) for nurses was a modified version of a 31-item multiple choice questionnaire developed earlier for physicians by Iberti et al. (1990). The original questionnaire developed by Iberti et al. (1990) for physicians was piloted, revised, and validated using item analysis (Kuder- Richardson Formula 20 reliability estimate was .71). Criterion validity was established through a study of six expert physicians (mean test score 93%) (Iberti et al., 1990). The questionnaire used by Burns et al. (1996) involved a further modification of the questionnaire developed by Iberti et al. (1990) for physicians with the exclusion of two items that related to operator techniques during insertion of the PAC. Hence, both questionnaires were fundamentally similar and included items concerning complications associated with PAC use, calculations of haemodynamic variables, interpretations of waveforms and physiological parameters, and nurses' patient management responsibilities.

Both studies used non-random sampling. Iberti et al. (1994) posted the questionnaire to all nurses who were pre-paid registrants to a major conference of the American Association of Critical-Care Nurses (AACN) and to registrants of a haemodynamic workshop associated with that conference. Burns (1996) recruited nurses through critical care educators of various institutions and directly at a single day critical care conference. Sample sizes were 216 (Iberti et al., 1994) and 168 (Burns et al., 1996), representing 43% and 98% response rates respectively. In both studies, most respondents were experienced nurses, 77.2% had greater than 5 years experience in Iberti and colleagues' (1994) study and 56% had more than 6 years experience in Burns and colleagues' (1996) study. Additionally, 34.9% (Iberti et al., 1994) and 40% of respondents (Burns et al., 1996) claimed to use PACs at least 10 times per month in their practice.
The mean scores were 48.5 % (Iberti et al., 1994) and 56.8% (Burns et al., 1996). In both studies, areas of the questionnaires associated with low scores were knowledge concerning the assessment and interpretation of haemodynamic data provided by the PAC. In particular, Iberti et al. (1994) reported that only 52.2% of nurses correctly answered items related to interpretation of pressure waveforms, 50.5% of respondents correctly answered patient management items, and only 47.2% of respondents correctly answered items on positioning the PAC. Yet, 63.8% of nurses rated their knowledge of PAC as adequate and these nurses were responsible for repositioning the PAC. Lowest scores related to declarative knowledge, for example 40.9% for physiology. This latter finding may, in part, be explained by the high level of experience of nurses and the tendency of these nurses to function on procedural knowledge (knowing how) rather than declarative knowledge (knowing what) (Alexander, Schallert, & Hare, 1991; Anderson, 1982; Chi et al., 1988). The findings by Iberti and colleagues (1994) overall suggest nurses' knowledge of PAC monitoring is poor. Although the test scores were higher in Burns and colleagues' (1996) study, the results still reflect poor knowledge levels of respondents.

The knowledge deficits demonstrated by the questionnaire studies are concerning in light of the extensive use of PACs over the last 20 years in critical care. A clear finding of the two studies was that a higher mean score was significantly associated with critical care experience, certification as a critical care nurse, and frequent use of the PAC (more than 10 times per month). The latter finding suggests that clinical use of the PAC helps to reinforce the theoretical underpinnings of haemodynamic monitoring, catheter related psychomotor skills, and, ultimately, nurses' abilities to make PAC-related haemodynamic decisions. The finding that certification as a critical care nurse was significantly associated with a higher mean score suggests critical care education plays an important role in nurses' decision making. Both of these studies were based in North America where certification as a critical care nurse is conducted through a major professional organisation, the AACN, rather than through formal tertiary-based qualifications as in Australia. It was also found that attendance at haemodynamic monitoring sessions significantly increased nurses' mean scores on the questionnaires (Burns et al., 1996). Despite the differences between Australian and North American...
critical care education, the findings suggest haemodynamic educational preparation may enhance nurses' knowledge of the PAC.

Two other studies assessing North American nurses' knowledge of pulmonary artery pressure monitoring have been conducted (Bridges, 1991; Straw, 1986). Straw (1986) administered a 20-item questionnaire to 1000 nurses and received responses from 274 nurses. The questionnaire mean score was 59.2%. Demographic data revealed nurses with critical care certification from the AACN and those aged between 45 and 49 years had a significantly higher mean score. A similar study conducted 5 years later yielded a mean test score of 65% from 181 respondents (Bridges, 1991). The 29-item questionnaire had been issued to 1000 AACN members. Nurses with a higher degree, certification from AACN, and the senior appointment of Clinical Nurse Specialist also attained higher mean test scores. However, Bridges (1991) cautioned that there were wide variations in test scores in relation to demographic characteristics.

Both of these studies (Bridges, 1991; Straw, 1986) used criterion-referenced questionnaires. In the study by Bridges (1991), high test-retest reliability ($r = 0.85, p < 0.01$) was established. In the study by Straw (1986), despite 2 revisions based on pilot studies, the reliability coefficient was 0.34 and, as admitted by the author, it is possible that the low scores on the questionnaire reflected the poor reliability and validity of the tool. Both authors reported problems with using mail-out questionnaires in relation to knowing whether or not the questionnaires arrived at their destinations. The low response rates may indicate that nurses discarded the questionnaire due to a lack of knowledge. Despite the limitations associated with the study by Straw (1986) in particular, the results for both studies suggest a poor knowledge of haemodynamic monitoring by many American critical care nurses.

More recently, American nurses' knowledge of arterial blood pressure monitoring was explored (McGhee & Woods, 2001). Of the 391 critical care nurses from six critical care units who met the inclusion criteria, only 68 (17.4%) completed the 18-item questionnaire which covered the topics of physiology, technical aspects, monitoring complications, and interpretation of waveforms and data. The majority (83.9%) of participants had more than 4 years experience in critical care, 54.6% of participants held critical care certification with AACN, and 64.7% performed direct
arterial blood pressure monitoring between three and four times per week. Not one participant achieved the pass score which was set at 66% or 12 of 18 items correct. The mean score was 36.7% (SD = 11.76) or 6.6 questions correctly answered. No significant relationships were found between demographic characteristics and test scores. Although scores were low in some difficult technical items, low scores were also recorded for being able to recognise the complication of clotting in the arterial catheter. Items that scored highest included items related to procedural knowledge such as recognising the MAP as the optimal arterial pressure to guide therapeutic interventions and recognising factors that caused a damped arterial waveform. Nurses attributed their level of arterial pressure knowledge to acting as preceptors, attendance at hospital training programs, and continuing education. None of the participants indicated that research literature contributed to their knowledge. A strength of the study was development of the tool through a literature review, advice from content experts, and inclusion of feedback after a pilot study. Despite the study being limited by a low response rate, findings suggests that some critical care nurses have not reached a satisfactory knowledge and skill level of arterial blood pressure monitoring.

In sum, the purpose of this section was to review the role of nurses' experience in decision making. In a complex domain such as haemodynamic decision making, it was useful to describe experience as experiential learning through clinical experience and educational preparation. Models of decision making were reviewed to provide an understanding of the potential variability in nurses' haemodynamic decision making as a consequence of experience. In previous research, characteristics of experienced nurses’ decision making included the identification of salient cues and use of less cues overall, and rapid responses with appropriate interventions. Experienced nurses use previous experiences with similar patient presentations and respond to ipsative changes. Inexperienced nurses are more likely to make decisions using rules such as protocols, approach decision making as separate rather than integrated tasks, and seek decision making assistance from colleagues. Findings of studies that have explored nurses' knowledge of the principles of haemodynamic monitoring and the application of such in the clinical context suggest that nurses' knowledge in these regards is poor. The environment in which decisions are made is likely to have a significant impact on
decision outcomes particularly for inexperienced nurses and is discussed in the next section both in terms of its contribution to decision outcomes and in terms of the methodological implications for the study of nurses' haemodynamic decision making.

2.3.3 The Role of the Environment

Environmental influences on decision making include the notions of the social context, nursing colleagues, and the geographical layout of the critical care unit. Studies that have explored social interactions between nurses and the potential impact of group decision making on nurses' individual decision making are reviewed in this section. Additionally, studies that have explored the influence of the geographical layout of critical care units on nurses' individual decision making, nurses' social interactions with the unit, and group decision making are reviewed. These environmental characteristics are reviewed in order to identify how nurses' decision making may be influenced by these factors. Discussion will include an exploration of the potential interplay between the roles of environmental characteristics and nurses' experience. Methodological issues that need to be addressed in the study of nurses' haemodynamic decision making that arise from the role of environmental characteristics on decision making are also discussed.

In a seminal study that sought to describe the social context of critical care nurses' decision making from the perspective of nurses, it was found that the social aspects of clinical nursing in the forms of nursing roles and communication patterns between nurses were integrally involved in critical care nurses' decision making (Chase, 1995). Over a period of two years, 10 nurses were observed intensively in practice and these nurses with 6 other nurses, participated in private open-ended interviews. Additionally, informal interviews with, and observations of, another 20 nurses and 10 physicians occurred during fieldwork. Numerous data sources such as formal interview transcriptions, daily field notes, hand recorded notes from informal interviews, and documents such as patients' charts and policy manuals were analysed for themes. Chase (1995) found three main influences on nurses' decision making: a nursing hierarchy consisting of clinically appointed roles, a medical hierarchy, and nursing reports. Consistent with most hospital settings, nurses had specific roles according to their level of experience and appointed position in the nursing hierarchy. Experienced senior nurses
helped solve clinical problems faced by inexperienced nurses and monitored inexperienced nurses' decision making. A formal arrangement also existed whereby one assistant nurse was allocated to perform equipment-related procedures, such as connecting and establishing suction to the chest drainage system, when primary nurses received patients from cardiac surgery. The arrangement provided nurses with distinct roles and responsibilities similar to those outlined in Table 2.2 and meant that nurses clearly knew their responsibilities to the patient and to each other. Chase (1995) reported that the allocation of two nurses to receive patients sent a strong message to staff that nurses help each other. Although benefits of one assistant nurse during the reception of patients were outlined, the outcomes of more than one nurse assisting the primary nurse are poorly understood. No findings were provided in relation to situations where allocation processes broke down, friction between staff occurred, or roles while receiving patients were blurred. Moreover, deeper analysis of nurses' decision making due to the presence of the nursing hierarchy would have provided further understanding of how nurses' roles and experience may influence decision making. Given the close working relationship between nurses during the reception of patients, further studies are required to understand the effects of nurses' roles and communication patterns on decision making.

In terms of the influence of nursing reports on nurses' decision making, Chase found nursing reports or handovers set the scene for nurses' decision making processes. Incoming nurses relied heavily on the content of handovers, such as the patients' physiological parameters and responses to interventions, to gain a sense of trajectory for the patient and to inform immediate decision making. Nurses in the study claimed that their decisions could be impeded if a disorganised or incomplete handover was received. The strengths of Chase's study included the naturalistic approach, triangulation of data collection methods, and descriptions of decision making from the perspective of clinical nurses.

The influence of nursing colleagues on nurses' decision making has also been reported by Jenks (1993). Jenks employed a naturalistic design to describe practice-based patterns of knowing, which Carper (1978) believed to represent the essential knowledge of the discipline of nursing within the context of practice. Twenty-three
nurses with varying levels of experience participated in a 3.5 hour observation of their practice. The participants also attended a focus group interview. Jenks described 'knowing' as the dominant theme used by participants to describe the formation of interpersonal relationships with nursing colleagues, patients, and physicians during decision making. Knowing nursing colleagues influenced the value that nurses placed on the information heard during handover and, subsequently, the utility of that information in their decision making.

In Jenks' study, individual decision making was influenced by nursing colleagues in two other ways. First, the presence of colleagues contributed to patient management decisions because group decision making was observed in practice and reported by participants during interviews. Second, group decision making could alter an individual nurse's decision making. In one situation, an experienced nurse reversed her original decision not to administer a certain drug, which was ordered to be given at the discretion of nurses, to a patient and conceded to a decision made by her colleague, even when that judgment conflicted with her own. The nurse did so in order to preserve a good relationship with her colleague (Jenks, 1993). Jenks found that maintaining good relationships with colleagues was of paramount importance for experienced nurses. Furthermore, inexperienced nurses aspired to form such collegial relationships. Given the paucity of studies related to group decision making, a greater understanding of what group decision making means for nurses, their practice, and patient outcomes is required. Jenks did not report the effect on decision making when poor collegial relationships existed, but such interactions may be important to practice and patient outcomes. For instance, if inexperienced nurses do not feel comfortable approaching experienced nurses for decision making guidance, the ensuing autonomous decisions may be less than optimal.

Nursing colleagues in the forms of a nursing hierarchy and a mix of experienced and inexperienced nurses per shift have been found to influence nurses' decision making in a study of 18 nurses' decision making activities (Bucknall, 1996). Data were collected using a 2-hour non-participant observation and a follow-up semi-structured interview. When staffing levels and the staffing mix were adequate, the nursing hierarchy in critical care units, both in terms of experience and appointed roles, helped to maintain high
standards of patient care. Experienced nurses assisted inexperienced nurses to make decisions. In doing so, experienced nurses acted as role models and provided meaning to inexperienced nurses' decision making. Shifts that were staffed by few experienced nurses led to a higher frequency of decision making by senior nurses because they assisted inexperienced nurses to make decisions.

Bucknall (1996) also found the geographical layout of the critical care unit influenced decision making. Nurses in isolated cubicles made more autonomous decisions because of reduced access to colleagues in the forms of fellow clinical nurses and roving senior staff in charge of the shift. The strengths of this study were the naturalistic approach taken and use of multiple methods. There seems little doubt that some of Bucknall's findings, such as the influence of isolated cubicles on nurses' decision making, would not have been revealed in a simulation-based study because, as she noted, situational effects are often neglected in such studies.

There are methodological implications arising from the influence of environmental characteristics on nurses' decision making. To further our understanding of nurses' decision making, especially in terms of understanding the potential interplay between haemodynamic decision complexity, nurses' level of cardiac surgical intensive care experience, and environmental characteristics, a naturalistic study is required. In contrast to studies of decision making in simulated settings, decision making research based in the clinical setting can more realistically represent nurses' decision making because information is provided on events that occur before and after decisions are made (Cannon-Bowers, Salas, & Pruitt, 1996). A clinically based study could also add to the small body of current knowledge regarding the impact of environmental characteristics on nurses' decision making. By observing nurses' decision making during the reception and recovery of cardiac patients, the limitations of previous studies can be addressed and a deeper understanding of the variability of nurses' decision making practices can be gained.

In sum, the potential variability of nurses' decision making has been reviewed in terms of the social context of critical care in terms of nurses' roles and communication patterns, the availability of experienced nursing colleagues, and the geographical layout of critical care units. The potential interplay between group decision making and
experience of the nurse on nurses' decision making is poorly understood. Findings from studies reviewed in this section have shown that environmental characteristics can influence nurses' decision making, but there is little understanding of how such characteristics interplay with nurses’ experience and complex haemodynamic decision making to influence the outcomes of nurses' decision making.

2.4 Conclusions

Haemodynamic decisions are complex tasks carried out by nurses with varying levels of experience in a clinical environment. Our understanding of nurses' haemodynamic decision making has been restricted due to methodological approaches of previous studies that have neglected environmental characteristics. Additionally, few studies have explored inexperienced nurses' decision making. Moreover, decision making studies have not explicitly addressed the potential relationships between decision complexity, nurses' experience, and environmental characteristics. As a consequence, the implications of interplay between those three factors for nurses' decision making is not well understood.

In order to understand haemodynamic decision making in the postoperative cardiac surgical context such as the complex array of cues and how cues and decisions fit together, it is useful to develop an orienting framework. The framework developed for the literature review and analysis in this research program comprises three goals of therapy: the optimisation of cardiovascular performance, the promotion of haemostasis, and the reestablishment of normothermia. This framework is based on the clinical sequelae of cardiac surgery and incorporates the high acuity of patients and the haemodynamic technologies and numerous data sources used in nurses' assessment and interventional decision making during the initial recovery period. The literature review has detailed the complexity of haemodynamic decision making resulting from the clinical sequelae of cardiac surgery, but the actual haemodynamic status of cardiac patients during the initial recovery period has not previously been described.

This review of the literature identified decision complexity, nurses' experience and knowledge, and environmental characteristics as major influences on nurses'
decision making. Evidence was presented that suggested decision making is contingent on the demands of the task and that experience can modify the complexity of decision making. In terms of making complex decisions related to the goals of therapy, evidence suggests that experienced nurses will collect salient cues to enable faster, more accurate decision making than their inexperienced colleagues. The review also suggests experienced nurses are likely to identify emerging problems from patterns of cues in a prompt manner. Rapid pattern recognition is particularly useful for nurses making complex haemodynamic decisions, because clinical problems or complications are often identified by a pattern of cues rather than a single cue.

Variability in the timing of both recognising and responding to signs of haemodynamic instability is anticipated between nurses as a function of experience because previous experiences of similar events can direct experienced nurses to collect relevant patient data. As a result, it is possible that patients of experienced nurses may experience shorter periods of haemodynamic instability which, in turn, may lead to better patient outcomes. What remains unclear is how inexperienced nurses perform in real clinical situations where rapid decision making is essential, such as during patient crises. Moreover, social interactions with other nurses during this period are likely to occur. Yet, we have little understanding of how social interactions or collegial assistance during patient crises affects primary nurses' decision making and patient outcomes.

In addition to experiential learning, nurses' knowledge of the principles of haemodynamic monitoring may be a source of decision making variability. Some aspects of decision making associated with optimising cardiovascular performance are highly technical. Inexperienced nurses may be able to verbalise their rationales for adhering to procedures to ensure technical accuracy better than experienced nurses. This is because inexperienced nurses' knowledge is usually declarative whereas experienced nurses' knowledge is considered procedural.

Evidence has been presented that suggests important social interactions are likely to eventuate during the initial recovery period due to procedures associated with receiving patients. These social interactions were shown to influence nurses' decision making through the provision of decision support and the creation of group decision making. However, there has been insufficient research describing what type of collegial
guidance or assistance is provided to inexperienced nurses, how such assistance plays out in clinical practice, and whether it contributes positively to patient outcomes. Yet, interactions of that kind between nurses are important to understand because they have the potential to shape inexperienced nurses' behaviours, their current and future decision making, and patient outcomes.

The issue of nurses making autonomous decisions when patients were placed in geographically isolated cubicles or in situations where support from the nursing hierarchy broke down due to staffing deficiencies is significant. For experienced nurses in geographical isolation, there may be little decision making variability because their experience and knowledge of, and familiarity with, managing cardiac surgical patients suggests they are probably more self-reliant. However, for inexperienced nurses, evidence suggests there may be decision making variability as a consequence of autonomous decision making. A better understanding of the implications of independent decision making by inexperienced nurses for nurses, decision making practices, and patients outcomes is needed. An understanding of how nurses feel about being left alone to make complex decisions in such circumstances and the potential implications for patient outcomes are likely to be important for the ways in which cardiac patients are received and recovered.

This chapter was devoted to reviewing literature related to the complexity of haemodynamic decision making, nurses' level of cardiac surgical intensive care experience, and characteristics of the critical care environment in order to argue that each characteristic individually and jointly can influence nurses' decision making. Although, interplay between all three characteristics is likely to influence nurses' decision making, we currently have little understanding of the effects of interplay between the multifactorial influences on nurses' decision making because of methodological limitations of previous research. To gain an understanding of the variability of critical care nurses' decision making in the 2-hour recovery period following cardiac surgery as a function of interplay between the multifactorial influences on nurses' decision making, an innovative methodological approach is required. The following chapter discusses the methodological issues as well as the strengths and weaknesses of methods used in the study of decision making.
CHAPTER 3

THE RESEARCH PROGRAM AND METHODS

The purpose of this chapter is to outline the research program. The methodological issues and methods used to explore nurses' assessment and interventional decision making in the 2-hour period following cardiac surgery are discussed.

As demonstrated in Chapter Two, the complexity associated with haemodynamic decision making is due to the high patient acuity and clinical sequelae of surgery that necessitates advanced haemodynamic monitoring practices. Research findings were presented in Chapter Two that indicated decision making can vary when decision tasks are complex. Evidence was also presented that suggested experience can modify the difficulty in making complex decisions. With few exceptions, individuals with high domain experience and knowledge have shown superior decision making abilities. In particular, experienced individuals recognise patterns in patient presentations from experiences with previous patients. As a result, decisions are more likely to be made accurately and rapidly. For inexperienced nurses, rules and cues learnt from texts guide clinical practice, especially in complex decision making, because they do not have previous experiences to draw upon. Furthermore, inexperienced nurses may seek decision making assistance from experienced colleagues to help solve problems in clinical practice.

In critical care, it is customary for clinical nursing colleagues to assist primary nurses to admit postoperative cardiac patients. Those circumstances create a potential for interactions between the level of primary nurses' experience, nursing colleagues, and decision complexity. For instance, inexperienced primary nurses may request decision

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2 Core arguments of this chapter have been published in:

making assistance from experienced colleagues to help determine appropriate interventions for clinical problems. Currently, we have little understanding of how such circumstances play out both for nurses and the outcomes of nurses' decision making. Early work on the social context of decision making, in terms of nurses' roles and communication patterns, suggested that assistance from colleagues is beneficial for the nurses involved (Chase, 1995). Opposing those findings are reports of group decision making that have led to less than optimal experiences for the nurses involved (Jenks, 1993). There is also evidence to suggest that inexperienced nurses make complex decisions independently because either they are situated in isolated cubicles or access to experienced colleagues is limited due to staffing issues (Bucknall, 1996). All of these findings suggest interplay between haemodynamic decision complexity, certain environmental characteristics, and nurses' level of experience. Currently, the effects of that interplay on the outcomes of nurses' decision making is poorly understood.

3.1 Research Aims

In critical care, clinical nurses of varying experienced levels make complex haemodynamic decisions for high acuity patients in the 2-hour recovery period after cardiac surgery. The overall aim of this study was to explore nurses' decision making as a function of interplay between haemodynamic decision complexity, nurses' experience, and specific environmental characteristics.

The specific aims of the research program were to:

1. Describe the haemodynamic status of patients on admission to critical care following cardiac surgery and their haemodynamic progress over the subsequent 2-hour period.
2. Identify and describe the extent of variability in nurses' haemodynamic decision making during the initial 2-hour period following cardiac surgery as a function of decision complexity, nurses' experience, and environmental characteristics in relation to the following goals of therapy:
   a) Optimisation of cardiovascular performance
   b) Promotion of haemostasis
   c) Reestablishment of normothermia.
3. Describe the social context that surrounds the reception and recovery of cardiac surgical patients in the first 2-hour period by critical care nurses and the influences of this context on nurses' haemodynamic decision making.

4. Describe nurses' perceptions and perspectives of assuming responsibility for the reception and initial 2-hour recovery of postoperative cardiac patients.

In nursing and medical literature, the rates of specific postoperative complications and patient morbidity and mortality are discussed. No study could be located that described patients' haemodynamic status in the immediate period after cardiac surgery. The first aim will contribute to current gaps in the literature about typical haemodynamic trajectories of cardiac surgical patients within the 2-hour recovery period and set the scene for understanding the complexity of decision making within this context.

In Chapter Two, the effects of decision complexity, experience, and environmental characteristics on decision making were discussed. Research findings suggest that the three influences on decision making have an independent effect on decision making processes or performance. In particular, findings from previous studies suggest that individuals tend to be less thorough, less consistent, and less confident when making complex decisions. Evidence also suggests that experience can modify the difficulty of making complex decisions. In particular, experienced individuals tend to make faster and more accurate decisions. Furthermore, experienced nurses have been found to use a goal-directed decision making process when decision tasks are complex. The ways that nurses' decision making may vary as a function of environmental factors is poorly understood because of previous methodological approaches and limitations. This study sought to explore variability of nurses' decision making from interplay between decision complexity, experience, and environmental characteristics.

The role of social interactions in nurses' decision making is poorly understood. The third aim of this research program sought to further explore the notion put forward by Chase (1995) that critical care judgements take place within a social context. Chase reported that the social context in terms of nurses' roles and communication patterns influenced nurses' decision making in positive ways. Another study by Jenks (1993)
pointed to less than ideal outcomes for non-critical care nurses from decision making in a group context. It is commonplace for primary nurses in critical care to receive assistance from nursing colleagues during the reception of cardiac surgical patients. How that assistance plays out for nurses and nurses' decision making is not well understood.

With regard to the fourth aim of this research, little is currently known of nurses' perceptions of recovering cardiac surgical patients. Nurses perceptions of recovering patients may identify issues of concern and positive experiences that can be used to improve nurses' decision making.

3.2 The Research Program

The aim of the research program was to explore the extent of the variability in nurses' decision making as a function of interplay between complex decisions, nurses' experience, and environmental characteristics. Research findings have been presented that indicates each of the influences on decision making independently varies nurses' decision making in some form. There has not been an exploration of how nurses' decision making varies as a consequence of interplay between these influences on decision making. Specifically, neither the outcomes of the variability in nurses' assessment and interventional decisions nor the potential implications for patients have been investigated as a consequence of interplay between decision complexity, nurses' experience, and environmental characteristics.

In light of previous decision making research and the lack of evidence for certain aspects of haemodynamic management, it is expected that interplay between complex decisions, nurses' experience, and environmental characteristics will produce variability in nurses' haemodynamic decision making. Such decision making variability, however, could emerge in an infinite number of ways, some of which may be trivial or irrelevant. This study sought to uncover the variability in nurses' decision making that had the potential to influence patient outcomes in adverse ways. The forms of decision making variability that were studied were those that had implications for the haemodynamic stability of patients as well as for the prevention, and detection, of haemodynamic
complications. This study also sought to identify situations where nurses' management of patients could be improved by changing decision making practices. In order to explore the variability in nurses' decision making that had clinical significance, three issues needed to be addressed. First, a methodology was required to uncover the interplay between the multifactorial influences on nurses' decision making, the effects of that interplay on nurses' decision making variability, and the potential implications for patient outcomes from that interplay. Second, an organising framework to describe nurses' decision making during the 2-hour recovery period needed to be developed. Third, a framework for understanding the sequence of decision making events during the 2-hour recovery period needed to be developed.

A naturalistic decision making approach was chosen. Naturalistic decision making is the study of how people use their experience to make decisions in natural settings (Zsambok, 1997); it is descriptive rather than prescriptive. Essentially, there is an emphasis on three factors that influence decision making: factors associated with the task, such as the complexity level; factors associated with the decision maker, primarily knowledge and experience; and factors associated with the environment such as whether decisions are made individually or in consultation with others.

The naturalistic decision making framework was critical to the aims of this study because it accommodated two important considerations. First, neither the complexity of nurses' haemodynamic decision making nor the environment was manipulated by the researcher. A significant feature of naturalistic decision making is that it "seeks explicitly to understand how people handle complex tasks and environments" (Salas & Klein, 2001, p. 3). Furthermore, naturalistic decision making does not reduce the variables of complex tasks and environments; but, rather "examines the phenomena themselves in the context of the situations where they are found" (Salas & Klein, 2001, p. 3). In order to satisfy those requirements, the researcher in a naturalistic decision making study enters the field of the decision maker and does their best not to alter that environment in any way. For this study, the researcher collected data in critical care units while nurses made haemodynamic decisions for patients recovering from cardiac surgery. No attempts were made to manipulate the settings. Attempts were made by the researcher to minimise disruptions to nurses' interactions with the patient, colleagues,
and relatives. That is, the researcher did not become involved in patient care activities, seek eye contact with nurses, colleagues, or relatives, or seek to speak to nurses, colleagues, or relatives. Additionally, the researcher was positioned outside of patients' cubicles so that the nurses' usual work environment as much as possible was not infringed upon.

Like the environment, the complexity of haemodynamic decisions was not manipulated by the researcher. Haemodynamic decision tasks fit the criteria for a complex task as defined by Payne (1982). The complexity of haemodynamic decision making can be sourced to the technologies that are used to monitor high acuity patients for haemodynamic instability and postoperative complications associated with the clinical sequela of cardiopulmonary bypass. No attempt was made to select patients in terms of type of cardiac surgery or haemodynamic technologies.

The second issue of importance for this study was the role of experience on nurses' decision making. The naturalistic decision making paradigm supports the manipulation of experience by the researcher in order to gain understandings of the ways that decision making can vary between individuals. For this research, it was critical that both inexperienced and experienced nurses' decision making was studied so that judgements about the role of experience on the outcomes of nurses' decision making could be made. Therefore, purposive sampling for experience and inexperience in cardiac surgical intensive care was carried out.

In sum, naturalistic decision making was an ideal framework for exploring nurses' variability in decision making because only nurses' experience was manipulated in this study. As the environment and decision complexity were not modified, the decision making variability of nurses described in the findings was the consequence of interplay between decision complexity, nurses' experience, and environmental characteristics.

Naturalistic decision making emerged from traditional decision research in response to questions about the generalisability of laboratory-based research to real-world performance. In contrast to investigations of decision making in simulated settings, research based on naturalistic decision making takes place in the domain of the decision maker. One advantage of the clinical setting is that information on events that
occur before and after a decision is made are captured (Cannon-Bowers et al., 1996). Indeed, as distinct from classic decision research, the entire decision episode rather than just the moment of choice is the locus of interest of naturalistic decision making research (Klein, 1997a). By studying the entire decision episode, data about the decision itself as well as interactions between the decision maker and surrounding environmental characteristics can be collected. As noted earlier, such data are collected without manipulation of the decision task or environment. Another advantage of conducting studies in clinical settings is that researchers can be confident that some nurses will have experience in the haemodynamic decision tasks under investigation. How a person uses experience and knowledge to make complex decisions is of great interest to researchers using naturalistic decision making (Pruitt, Cannon-Bowers, & Salas, 1997), but not to the point of excluding inexperienced participants. Indeed, manipulation of experience has been an important way of uncovering decision making strategies of individuals in naturalistic decision making studies (Crandall & Getchell-Reiter, 1993; Kirschenbaum, 1992; Militello & Lim, 1995; Randel & Pugh, 1996).

In order to explore clinically significant variability in nurses' decision making, an organising framework that could systematically describe nurses' decision making during the 2-hour recovery period needed to be developed. As noted earlier, the complexity of haemodynamic decision making arises from issues of high patient acuity, haemodynamic technologies, numerous haemodynamic data sources, and an imperative for nurses to make decisions rapidly and accurately. In order to capture nurses' haemodynamic decision making and the multitude of haemodynamic decision tasks carried out in the 2-hour recovery period, an organising framework was required for the study. The organising framework developed by the researcher consisted of three goals of therapy: the optimisation of cardiovascular performance, the promotion of haemostasis, and the reestablishment of normothermia. The development of three goals of therapy specific to haemodynamic decision making in the 2-hour recovery period allowed for the variability in nurses' decision making to be revealed in a systematic and comprehensive manner. In particular, nurses' complex decision making in terms of managing haemodynamic technologies, haemodynamic instability, and haemodynamic complications could be studied within the clinical setting.
Prior to the admission of patients, nurses prepare equipment in the cubicles in anticipation of receiving and recovering patients. Such preparations can be considered decision making events and are important in the whole scheme of understanding nurses' postoperative haemodynamic decision making. To incorporate nurses' preparatory actions and their actions during the recovery period, a framework for understanding nurses' assessment and management actions was required. The researcher developed an organising framework (see Figure 3.1) that consisted of nurses' preparations in anticipation of meeting goals of therapy and continuous appraisal, evaluation, and responsiveness during the 2-hour recovery period. This framework represents the decision making events for nurses in the clinical setting. The framework of assessment and management (see Figure 3.1) was critical in the analysis of data and allowed descriptions of nurses' decision making variability. A scheme depicting the frameworks for identifying variability of nurses' decision making is presented in Figure 3.1.

The research program comprised two phases. Phase One was an exploration of observation as method and emergent themes. Phase Two was an investigation of the variability of critical care nurses' haemodynamic decision making in relation to three goals of therapy in the 2-hour recovery period after cardiac surgery as a function of interplay between influences on nurses' decision making.

Due to the innovative nature of this research, observation as method was piloted in Phase One of the research program. Naturalistic decision making is an emerging paradigm. Although observation is well suited to naturalistic decision making, there are few studies of decision making that have employed observation both within, and external to, the paradigm. As indicated in Chapter Two, most studies of decision making have not been conducted in the clinical setting. By piloting the method of observation, refinements were able to be made in order to meet the aims of this study. Phase One also identified emergent themes that were further explored in Phase Two.
Figure 3.1. Scheme for identifying variability of nurses' haemodynamic decision making in 2-hour recovery period.
The aim of Phase Two was to implement changes as a consequence of Phase One. Phase Two also aimed to describe the variability of critical care nurses' haemodynamic decision making related to three goals of therapy in the 2-hour recovery period after cardiac surgery as a function of interplay between the multifactorial influences on nurses' decision making. In order to explore and describe the effects of environmental characteristics on the outcomes of nurses' decision making, a 2-hour observation of nurses' decision making during the recovery of immediate postoperative cardiac patients was used. Observation offered the opportunity to capture potential interplay between environmental characteristics, nurses' varying experience levels, and the complexity of haemodynamic decision making in terms of the high patient acuity, types of decision tasks, and haemodynamic technologies. A follow-up interview enabled clarification of observed behaviours and incorporation of participants' perspectives. Phase Two also explored two emergent themes from Phase One. The first theme was the social context on the outcomes of nurses' decision making. The second theme explored the way nurses used technology to inform decision making.

In the next section, the methodological issues associated with naturalistic decision making are discussed together with justification for the approach used for this research program. An outline of the design, sampling procedures, data collection procedures, and data analysis follows. Issues of research rigour related to the methods used in this research are addressed. Finally, ethical considerations relevant to this research are discussed.

3.3 Methodological Issues

The study reported in this thesis explored the proposition that interplay between decision complexity, nurses' experience, and environmental characteristics would produce variability in nurses' decision making that may have implications for patient outcomes. In order to explore that proposition, it was necessary to have a methodological approach that could reveal the multifactorial influences on nurses' decision making in an inclusive and simultaneous way.
Naturalistic decision making is expressly focused on decision tasks in natural settings that incorporate specific characteristics (Cannon-Bowers et al., 1996; Orasanu & Connolly, 1993). The specific characteristics of decision tasks and settings in naturalistic decision making outlined by Cannon-Bowers et al. (1996) and Orasanu and Connolly (1993) are listed in Table 3.1. Nurses' decisions about patients' haemodynamic status in the immediate period after cardiac surgery have these characteristics. Haemodynamic decisions are complex; there are multiple information cues that may be ambiguous and dynamic, rendering uncertainty; rapid time frames surround most assessments and interventions, particularly during stages of patient instability; and outcomes from interventional decisions form assessment criteria of subsequent decisions in a feedback loop. Frequently, goals for haemodynamic parameters alter according to patient responses to therapeutic interventions. In terms of patient welfare, there are high stakes related to decisions from nurses' abilities to recognise, and respond to, periods of haemodynamic instability. High stakes also exist for nurses who are accountable for decisions. This takes place in a dynamic environment.

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<th>Table 3.1</th>
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<td>Characteristics of Naturalistic Decision Making Tasks and Settings</td>
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<tr>
<td>Decisions are complex</td>
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<td>Information is ambiguous and uncertain</td>
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<td>The quantity of information to consider is large</td>
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<td>Problems are ill-structured</td>
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<td>Goals are shifting, ill-defined or competing</td>
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<td>Decision outcomes are iterative because they require further evaluation</td>
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<td>Decisions have high stakes and consequences ensue for the decision maker</td>
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<td>Decisions are made individually or in consultation with others</td>
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<td>Organisational goals and norms must be taken into consideration</td>
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<tr>
<td>Decisions take place within a dynamic environment</td>
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<td>Time constraints exist</td>
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Simulations in the form of case studies, whereby individuals respond to certain paper-based clinical scenarios, have been used extensively to study critical care nurses' decision making (Baumann & Bourbonnais, 1982; Henry, 1991; Lewis, 1997; Sims & Fought, 1989; Thompson & Sutton, 1985). Through those studies, we have gained an understanding of the roles of task complexity and experience on nurses' decision making. There is little understanding of the role of the environment on nurses' decision making because of the difficulty in accurately representing environmental characteristics in a case study approach. Moreover, a case study approach is limited in being able to represent the totality of haemodynamic decision making tasks and the possible interplay between the influences on nurses' decision making. To understand real-world decision making of nurses, research methods must enable the researcher to examine complete tasks. Although proponents of naturalistic decision making do not mandate field studies as method, they do favour clinical settings due to difficulties in reproducing the characteristics specified in the Table 3.1 in an all encompassing way (Klein, 1997c; Zsambok, 1997).

Methodological limitations with simulations include ecological validity and external validity. Ecological validity is a form of external validity that refers specifically to the extent to which the results of a study may be generalised to a real-world setting (Polgar & Thomas, 2000). With regard to this study, ecological validity was demonstrated by including relevant characteristics of the social context and clinical setting of nurses' decision making environment in the design (Cohen, Manion, & Morrison, 2000). A laboratory-based study was not appropriate to explore the variability in nurses' decision making because of the difficulty in representing contextual issues such as patient acuity, haemodynamic technologies, and specific critical care environmental characteristics.

For some time, there have been problems with the external validity of laboratory-based research on decision making. Over four decades ago, Brunswick (1956) advocated the principle of representative design and realistic tasks in order to optimise the external validity or generalisability of findings of human judgement research. Indeed, as argued by Thomas et al. (1991), it is not desirable to report findings from simulations that are not applicable to clinical settings where real decision making occurs. In a study that
compared judicial decision making between simulated and courtroom settings, Ebbesen and Konecni (1980) concluded "There is considerable evidence to suggest that the external validity of decision making research that relies on laboratory simulations of real-world decision problems is low" (p. 42). Likewise, after a review of decision making in the real-world, Thomas et al. (1990) concluded that performances in simulated settings may not be strongly related to performances in naturalistic settings. To address these concerns the authors recommended high fidelity studies of decision making needed to be conducted in real clinical settings (Thomas et al., 1990).

To achieve the aims of this study, the research design needed to yield data suitable for qualitative and quantitative analysis. Qualitative field research involves an investigation of certain individuals in their natural settings in order to understand participants' thoughts, emotions, and experiences (Polgar & Thomas, 2000). However, data collection methods considered qualitative in design, such as observation, can also generate data suitable for quantitative analysis (Polgar & Thomas, 2000; Suen & Ary, 1989).

An important methodological issue with observation, however, is that it takes many forms, some of which involve interactions between the researcher and participants. Verbal interactions between the researcher and the participant have the potential to alter participants' decision making processing and, as a result, contaminate data. Therefore, non-participant observation within the naturalistic decision making framework was chosen for this research. Non-participant observation is a form of observation that discourages verbal interactions between the participant and the researcher in order to minimise interference with participants' decision processing (Cooke, 1999). However, as the presence of a non-participant observer may still influence the nurse or environment in some way (Kellehear, 1993; Polit & Hungler, 1995; Suen & Ary, 1989), this issue is discussed in detail in Section 3.5 of this chapter.
3.4 Methods

This study was conducted in two phases using observation, follow-up interview, chart review, and demographic survey to explore the variability in nurses' decision making as a function of interplay between task complexity, nurses' experience, and environmental characteristics. Both qualitative and quantitative information was obtained using these methods. The aim of the first phase was to explore observation as method and identify emergent themes. The aim of the second phase was to integrate the findings of Phase One and describe the variability of critical care nurses' haemodynamic decision making related to three goals of therapy in the 2-hour recovery period after cardiac surgery as a function of interplay between the influences on nurses' decision making.

3.4.1 Research Design

The research program comprised a study with two phases based on naturalistic decision making that employed observation and follow-up interview. The combination of observation and interview is common, particularly in exploratory or descriptive studies (Russell, 1999). Furthermore, the use of multiple methods has been strongly advocated by Payne, Braunstein, and Carroll (1978) for research on decision making. Enhanced interpretability arises from using qualitative and quantitative methods in a complementary fashion (Robson, 1993). An analysis of patients' observation flow charts was also conducted in Phase Two.

Phase One was conducted to explore observation as method and emergent themes. Exploratory studies using qualitative methods are appropriate when attempting to understand a new topic (Minichiello, Fulton, & Sullivan, 1999). Exploratory studies are often preliminary and designed to test or refine a particular data collection method (Polit & Hungler, 1995).

Phase Two was a descriptive study that investigated the variability of critical care nurses' haemodynamic decision making related to three goals of therapy in the 2-hour recovery period after cardiac surgery as a function of interplay between the multifactorial influences on nurses' decision making. Descriptive studies differ slightly
from exploratory studies in terms of data collection. Data collection is more structured in
descriptive study than in an exploratory study (Lackey & Wingate, 1998). Lackey and
Wingate (1998) also point out that the terms exploratory and descriptive may be used
synonymously and that both studies seek to understand phenomena that are poorly
understood or insufficiently described in existing literature.

The immediate 2-hour period following cardiac surgery was chosen for two
reasons. First, there is homogeneity of cardiac surgical patients in terms of
haemodynamic monitoring and time since surgery. Second, it is a time of marked patient
haemodynamic instability (Finkelmeier, 2000), which, in turn, infers a high level of
decision making by nurses. During the patient admission to critical care phase, there is
also an intensity of collegial involvement in patient management decisions; thus,
decision making variability due to the social context could be observed.

3.4.2 Setting

The observations and interviews were performed in three critical care units of
two major metropolitan teaching hospitals in Melbourne, Australia. Two hospitals were
chosen in order to include public and private contexts of care. In doing so, two different
surgical teams and patient groups were included. Although higher acuity patients tend to
have their operations in public hospitals, both hospitals were tertiary referral centres,
and, as such, predominantly admitted patients with comorbidities and poor cardiac
function. The critical care units in both hospitals had a mix of cardiac surgical and
general intensive care patients. Two units had an annual throughput of about 600
patients and 400 to 500 cardiac operations were performed annually. The third unit had
an annual throughput of about 800 patients, 750 of whom received cardiac surgery.
Nurses with varying levels of experience in cardiac surgical intensive care and general
critical care worked in each of the units. The staff mix could be attributed to the different
types of patients, staff turnover from current retention issues, recruitment difficulties,
and the conduct of university affiliated critical care courses in each unit.
3.4.3 Procedure

Initial approval to conduct the study in the units was sought and gained from the nurse manager of each critical care unit involved in the study. Overall permission was granted by the Hospitals and University Human Research and Ethics Committees.

The purpose of the study and the participation requirements were presented to staff at meetings in each unit. A flyer (Appendix A) advising interested nurses how to contact the researcher was displayed on notice boards in tea rooms and in designated communication folders. Nursing staff volunteered to participate in the study following attendance at information sessions or after seeing the flyer. Some of the participants were recruited by an Associate Charge Nurse of each critical care unit by drawing the attention of clinical nurses to the study. Associate Charge Nurses are deputy managers of critical care units. If nurses indicated their interest to the Associate Charge Nurse, they were directed to contact the researcher for participation details. Sometimes following a period of data collection, other clinical nurses approached the researcher to enquire about the study.

Nurses provided written consent to be observed in practice and to be interviewed subsequently. Nurses were assured confidentiality would be maintained. Nursing and medical staff who were incidentally observed during the 2-hour period did not provide consent to be observed; however, they were made aware by the observer that their involvement with the primary nurse or the patient occurred during the conduct of nursing research. These people were assured that they would not be named or identifiable in publications arising from the study.

To arrange data collection, participants who were assigned to receive a postoperative cardiac patient were contacted by the researcher. Sometimes, to arrange data collection, the researcher telephoned the Associate Charge Nurses in the units to ascertain if any of the nurses who had indicated their willingness to participate had been assigned to receive a postoperative patient that day. Data collection either occurred that day or arrangements were made between the Associate Charge Nurse and nurse for data collection to take place within the forthcoming week. Nurses indicated their willingness to participate, but were often hampered in doing so due to general workload or staffing issues in the units that limited their assignment to immediate postoperative patients.
The researcher arranged to be in the unit prior to the time that the patient was estimated to return from theatre to facilitate completion of consent forms, demographic documentation, and to answer any questions raised by the participant.

3.4.4 Research Participants

Non-probability sampling in the form of purposive sampling was used to select nurses. The purpose of selection was for cardiac surgical intensive care experience and inexperience across the two hospitals. Experienced nurses were designated as those who possessed more than 3 years cardiac surgical intensive care experience (Benner, 1984). Inexperienced nurses possessed less than 3 years cardiac surgical experience (Benner, 1984).

Sample size was determined by the methodology chosen. Although generalisation of results was neither possible, nor sought from this research, 38 participants were recruited to the study. While fewer participants and, therefore, observations, may have been acceptable, the greater the number of observations, the greater the reliability of data because emergent categories can be verified (Cohen et al., 2000). The use of both observation and interview provided large volumes of data, so to ensure that an in-depth analysis was feasible, less than 50 nurses participated (Sandelowski, 1995). The sample of 38 was considered sufficient to assist in providing a deep and broad exploration of variability in nurses' haemodynamic decision making as a function of interplay between the multifactorial influences on nurses' decision making (Mays & Pope, 1995; Sandelowski, 1995).

Phase One consisted of 8 participants. Phase Two consisted of 30 participants. The demographic characteristics of the participants for Phase One and Two are summarised in Table 3.2. There were 35 females and 3 males, a ratio that reflects the ratio of women to men in the nursing workforce. Twenty-nine participants were aged between 24 and 35 years and 5 participants were aged between 35 and 44 years. Two participants were aged less than 24 years and 2 participants were aged between 45 and 54 years.

Sixteen participants were Clinical Nurse Specialists responsible for direct patient care. Performance expectations of Clinical Nurse Specialists relate to preceptoring staff, providing formal and informal education sessions, and completing administrative tasks.
such as writing protocols for patient care. Two participants were Associate Charge Nurses. Associate Charge Nurses manage the unit in terms of assigning staff to patients, supervising all nurses, and coordinating patient admissions and discharges. The Associate Charge Nurses may also provide direct patient care, for example, on occasions when another Associate Charge Nurse is rostered on the same shift or a Clinical Nurse Specialist is acting in charge for the shift. Sixty percent of participants regularly nursed immediate postoperative cardiac patients at least once per week.

Nurses' qualifications and experience levels are summarised in Table 3.3. Thirty participants possessed a recognised critical care qualification. In terms of general Registered Nurse experience, 17 participants (71%) had up to 10 years experience. Twenty participants had more than 3 years cardiac surgical intensive care experience and 18 participants had less than 3 years cardiac surgical intensive care experience.

Patients were included in the study if their nurse was a participant. This inclusion strategy had the potential for a systematic bias in patient sampling if experienced nurses were allocated to higher acuity patients, however this did not appear to be the case because of the method of patient allocation. Associate Charge Nurses. Nurses were allocated to receive and recover postoperative patients at the beginning of each shift. Associate Charge Nurses consulted an operating list that included patients’ name, age, and gender; the proposed surgical procedure; and the names of the surgeon and anaesthetist. If there was only one patient scheduled for surgery, and the Associate Charge Nurse did not require the participant nurse for other duties, the participant nurse was allocated to recover the patient. In both institutions where this study was set, it was common for two theatres to be in use at the same time. Therefore, two patients scheduled for morning operations could be expected for early afternoon admissions. In that situation, a participant nurse and non-participant nurse were each allocated to a patient according to the arrival sequence of patients. In other words, the participant nurse received the first patient and the non-participant nurse received the second patient or vice versa. The method of allocation used by Associate Charge Nurses did not appear to be based upon patients’ preoperative, intraoperative, or projected postoperative haemodynamic status. As a result of what may be considered ad hoc allocation, it is unlikely that a systematic bias occurred in the inclusion of patients into the study.
<table>
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<tr>
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<tr>
<td>Characteristic</td>
<td>Frequency</td>
<td>%</td>
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<tr>
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<tr>
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<tr>
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<td>55.3</td>
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<tr>
<td>Cardiac surgical intensive care experience (years)</td>
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<td></td>
</tr>
<tr>
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</tr>
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<td>20</td>
<td>52.6</td>
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</table>
3.4.5 Data Collection

3.4.5.1 Demographic Survey

A self-administered survey of participating nurses was used to determine demographic information, level of nurse education, experience (general nursing, critical care, and cardiac surgical), employment status, and appointed position. Nurses completed demographic documentation prior to participation in the study (Appendix B) and were selected on this basis.

3.4.5.2 Observation

To meet the aims of this study, observation was the logical and most appropriate method of data collection. Observation involves gaining direct access to individuals in their own setting. In doing so, authentic descriptions of specific activities can be understood and reported (Polgar & Thomas, 2000). Indeed, Robson (1993) proposed that direct observation provides a lack of artificiality rarely encountered with other data collection methods.

As nurses’ assessment and interventional decision making is readily observable, inferences about cognitive processes can be made in an observation study (Carroll & Johnson, 1990). Indeed, observation studies have been used to infer cognitive processes of anaesthetists (Xiao, 1994) and critical care nurses and doctors (Bucknall, 2000; Ellis, 1997; Patel, Cytryn, Shortliffe, & Safran, 2000).

On separate occasions, all participants were observed in clinical practice once for a continuous 2-hour period. The observation period commenced as the patient was wheeled into a critical care cubicle from theatre. Participants were told that the purpose of the research was to explore the sorts of decisions nurses made for patients following cardiac surgery and the complexity of nurses’ decision making from a contextual perspective. Although participants were advised that data collection could take place any time of the week, surgical scheduling dictated most observations were performed on midweek afternoons or evenings. All the observations were performed by the researcher who is an experienced cardiac surgical intensive care nurse. The observations were performed with the researcher in the role of complete observer. The researcher did not contribute to patient care, nor discuss patient care with nurses.
The observations in Phase One were unstructured. An observation tool was not used to guide data collection; rather, the observer attended to nurses’ assessment and interventional decisions to guide the observation. In doing so, narrative observational data were obtained (Brandt, 1981).

The researcher used an audio-tape recorder (Optimus Micro-41 with lapel microphone or Sony M-100MC) to describe nurses’ actions that demonstrated decision making. That is, the observed actions could not have occurred without decisions being made to undertake those actions. Indeed, decision making can be considered a problem solving process whereby the solution is in the form of a decision which usually leads to an action (Newell, 1980). The advantages of dictating observations to a tape are the comprehensiveness of the report and time saved (Brandt, 1981; Patton, 1990). Patton (1990) cautioned that the tape recording should be unobtrusive to avoid inhibition of participants' responses. The researcher was positioned just outside patients' cubicles. Most cubicles only had a back wall, some had side walls; all had curtains to draw for privacy when required. When curtains were drawn, observations could take place either through a narrow opening or by the researcher moving inside the cubicle. Sitting or standing on the cubicle perimeter enabled visualisation of nurses' decision making, interpersonal interactions, and technologically-derived patient parameters. The position chosen by the researcher also allowed most of the conversations that took place in the cubicle to be heard. The participants, however, could not hear the researcher speaking quietly into the audio-tape recorder's microphone.

Decision activities observed included all visualised assessments of haemodynamic data from physical or technological sources, for example, pedal pulses and arterial blood pressures. Interventions such as titrating the dose of intravenous sodium nitroprusside or applying a rewarming blanket were also recorded. Decision activities also included primary nurses seeking guidance from nursing colleagues to assist in prioritising patient management decisions or, more commonly, to assist in selecting the most appropriate interventions for a patient’s current haemodynamic state. The observer paraphrased and recorded nurses’ interactions regarding decisions with other staff. In the main, commentary focused on describing the primary nurses’ haemodynamic assessment and interventional decisions; but, assessment and
interventional decisions made by nursing colleagues were also included. For example, if the primary nurse was zeroing the arterial blood pressure transducer and watching the monitor while an assistant nurse was assessing the volume of chest drainage, the decision activities of both nurses were recorded.

During each 2-hour observation period, in addition to the taping, brief field notes were taken in relation to decision activities that required clarification. These field notes guided the subsequent interview. Extensive field notes traditionally associated with observation (Russell, 1999) were not used. It was not possible to describe the variability of nurses' decision activities in such a detailed and comprehensive manner without continuous recording for the 2-hour period. The sheer number of decisions and interactions that occurred could not be captured without real-time taping.

In order to perform observations well, practice and critical reflection are required (Patton, 1990). Issues that arose during observations were noted in a reflexive journal and discussed with the research supervisors. For example, the first participant sought eye contact and called out information about the patient's progress to the researcher. Discussion with research supervisors led to the researcher avoiding eye contact with subsequent participants and informing participants prior to the observation that they did not need to explain their actions during the observation period. After each observation was performed, some overall thoughts regarding the decision making of nurses and the observation experience were recorded. The process of reflection assisted in refining the researcher's observation skills over time. An interim analysis was conducted after Phase One.

Phase Two observations differed from Phase One observations. Phase Two observations were both narrative and semi-structured with the use of a 2-page checklist (Appendix C). Thus, both narrative and checklist observational data were yielded (Brandt, 1981). The checklist was developed to minimise a selective attention observational bias identified during analysis of Phase One data (see Section 3.5 for further detail). In particular, the checklist was developed to ensure data collection in Phase Two was more systematic and comprehensive than data collection in Phase One.
3.4.5.3 Observation Checklist

The observation checklist consisted of two pages. The first page elicited information concerning patients' haemodynamic status over the 2-hour period, particularly patients' haemodynamic data related to the three goals of therapy at 15 minute intervals. Patient data outside 15 minute intervals were also documented when sudden deviations occurred. For instance, if the patient was normotensive at one of the 15 minute intervals and 3 minutes later became profoundly hypotensive, the time of the event and the patient's vital signs were documented. Nurses' interventional decisions in terms of manipulating fluid and vasoactive therapies were also recorded on page one of the checklist. The second page of the observation checklist was designed to collect data about nurses' decision making concerning the goals of therapy and two themes identified in Phase One. It allowed for identification of decisions made by primary nurses and assistant nurses. Not all sections of the checklist were always filled in; rather, it was used as a prompt to ensure certain aspects of nurses' activities were recorded either on the form or on the audio-tape.

3.4.5.4 Interview

An interview may be defined as a conversation between an interviewer and an interviewee with the purpose of eliciting information from the interviewee's perspective (Patton, 1990). In particular, interviews are useful to elicit participants' descriptions of their behaviours, actions, and activities during the observation period; to draw out domain knowledge; and to understand their feelings and views (Charness & Schultetus, 1999; Patton, 1990).

In Phase One, interviews were conducted at the completion of the 2-hour observation in a private room within the critical care unit. The interviews were semi-structured, guided by the observations and field notes. A semi-structured approach facilitated freedom in the sequencing and content of questions while simultaneously enabling the researcher to address the research aims (Robson, 1993). Clarification of observed decision making was sought from the nurses to minimise bias from observer assumptions, to incorporate the participant’s perspective, and to facilitate member checks. Interviews were audio-taped to allow transcription of data for analysis. The taping of interviews provides for recording of both questions and answers and enhances
accuracy and validity of the information (Minichiello, Aroni, Timewell, & Alexander, 1990). During Phase One, the interviews ranged in duration from 10 to 25 minutes.

Phase Two interviews were conducted in the same manner as Phase One, but varied in terms of content and duration. In Phase Two, the interviews were semi-structured according to an interview schedule and lasted from 20 to 45 minutes. The purpose of using an interview schedule was to remind the researcher of the issues to be explored during the interview (Minichiello et al., 1990). The themes pursued in Phase Two interviews emerged from Phase One data analysis. Specific themes were team decision making and the ways that nurses used technologies to inform decision making. Some of the questions asked in the interview included the following:

1. How did you feel the last 2 hours went?
2. Were you satisfied that everything went well?
3. Let's go back to the start; how did you feel about the help that you received?
4. Did the assistants make any decisions that you prefer to make?
5. Did the assistants communicate their actions to you?
6. Do you have a method for determining the average cardiac output? What is it?
7. I noticed that you used the procedure (or main monitor) screen to measure a pulmonary capillary wedge pressure. Why do you use that particular screen to measure the pulmonary capillary wedge pressures?
8. What factors determine whether you initiate artificial warming measures?
9. Is there a specific temperature at which you initiate warming?
10. Is there a temperature at which you cease warming?
11. What meaning does the patient's observation flow chart hold for you?
12. What are your priorities when the patient returns to the unit?
13. Were you aware of my presence during the last 2 hours?
14. Is there anything that you would like to add?

The first two questions were designed to ascertain the participant's overall perspective of receiving and recovering the patient during the 2-hour observation period.
Questions three to five aimed to reveal a deeper understanding regarding the emergent theme from Phase One concerning team decision making. The first two questions sometimes provided information regarding team decision making as well. The second emergent theme from Phase One concerning variability in the ways that nurses used technology to inform decision making was explored using questions six to ten. In addition to these questions in the interview schedule, other questions were asked in relation to notes taken during the observation period to clarify observed behaviours. Participants' responses to these questions provided the researcher with information about the experience level of nurses who provided help to the primary nurse during the observations.

3.4.5.5 Chart Analysis

To meet the aims of the study and to assist in addressing a selective attention observation bias identified in Phase One, the patient's observation flow chart was photocopied during Phase Two. Nurses were asked if their documentation was complete prior to photocopying the chart. Information that identified patients was removed from patient charts in the process of photocopying. On an observation flow chart, haemodynamic data, physical assessment findings, laboratory data, and interventional decisions such as fluid and vasoactive drug dosages are documented. The information documented on the chart was used to cross-check and clarify observed data, including data on the checklist. Information on the chart aided in analysis of patients' haemodynamic states, nurses' assessments, and nurses' interventional decisions.

3.5 Issues of Rigour

Both qualitative and quantitative forms of addressing rigour were used. The main advantage of observation was that the researcher was able to see nurses' decision making. In doing so, an understanding of interplay between several influences on nurses' decision making and its effect on the outcomes of nurses' decision making was gained. Nurses' decision making priorities were also identified because observation yields information about participants' assessments of data and the order in which data are collected (Carroll & Johnson, 1990).
The presence of the researcher in the clinical setting raised issues of potential biases and disruptions to both patient care and nurses' decision processing. The researcher may pay attention selectively to certain features during the observation, misinterpret and therefore misrepresent observed activities, or influence participants' behaviours (Robson, 1993). To minimise biases arising from the observation, the researcher's role, in terms of the level of participation, and the information gathering structure can be manipulated (Robson, 1993).

Observations took place with the researcher in a complete observer role (Gold, 1958). Observations of that kind are also called non-participant observations (Spradley, 1980). Complete observer precludes interaction with participants (Gold, 1958; Spradley, 1980) and was chosen to minimise disruptions to nurses' decision processing. Indeed, to minimise interference with decision making, the observer must be as non-intrusive as possible (Cooke, 1999). It was considered that participation or interaction with nurses by the researcher had the potential to either distract nurses away from decision making or inadvertently prompt decision making.

The second reason why complete observer was chosen related to patient care concerns. The first 2-hour period following cardiac surgery is a time of high patient acuity, necessitating frequent decision making by the primary nurse. In addition, anaesthetists, surgeons, and relatives visit the patient. To ensure patient care was least disrupted by the researcher's interactions with the nurse, complete observer was deemed the most appropriate role.

The third reason for adopting the role of complete observer was to reduce the Hawthorne effect (Polit & Hungler, 1995). The Hawthorne effect refers to the tendency for participants to behave differently while being observed (Suen & Ary, 1989). As recommended by Suen and Ary (1989), verbal interactions between the researcher and participant were discouraged through the use of non-participant observation. Likewise, non verbal interactions were minimised by the researcher avoiding eye contact with the participant during the observation (Suen & Ary, 1989). In addition to minimising interactions with participants, the conduct of observation over a prolonged time span may lessen the threats to validity through the Hawthorne effect (Robson, 1993; Suen & Ary, 1989). In a study of critical care nurses' decision making, Bucknall (1996) noted
that participants' awareness of being observed decreased over a continuous 2-hour period. Based on those findings, this study used continuous observation over a 2-hour period.

Non-participant observation provided an opportunity for an understanding of behaviours and processes within a context and with direct access to nurses' clinical decision making; but, explanations by participants were not gained during the observations (Keith, 1986; Minichiello et al., 1999). Hence, a limitation of the complete observer role was that it precluded access to important information about decision making from the nurses' perspective as it occurred. It was important in this study that nurses' perspectives about their decision making were gained and a follow-up interview provided that opportunity.

The information gathering structure used during observation is the second major issue considered when attempting to increase research rigour. It is acknowledged that adoption of the complete observer role by the researcher provided a lot of power and discretion in the researcher to decide what was recorded and what was not recorded (Hall & Callery, 2001). Both Polgar and Thomas (2000) and Suen and Ary (1989) suggest that structured data collection may lessen observer bias. Data collection is considered structured when an observation tool is used. Phase One observations were unstructured in order to explore the field, identify potential biases in observation, and identify unexpected aspects. With such a flexible approach in Phase One, rich in-depth data about the effects on nurses' decision making from interplay between the multifactorial influences on nurses' decision making were recorded. Content analysis later revealed gaps in the data due to an observational bias of selective attention. For instance, when a patient’s blood pressure was particularly labile, rich descriptions of the nurse’s assessments of blood pressure and related interventions were recorded, but less detail of other patient data, such as core temperature were recorded. An observation tool can address the issue of selective attention and help to obtain comprehensive data collection in terms of increased accuracy and detail (Polgar & Thomas, 2000). Since selective attention posed a threat to rigour of observation, the observational checklist (as described in Section 3.4.5.3) that consisted of two pages was designed for use in Phase Two.
Issues of rigour in Phase Two observations were those associated with structured observations and the observation tool or checklist. Interobserver reliability checks were performed to establish that data collected about nurses' assessment and interventional decision making were consistent between the researcher and two independent observers. During observations 15 and 25, an experienced cardiac surgical nurse observed the participant receive and recover the patient. A different experienced cardiac surgical nurse observed participant 25 receive and recover the patient to the nurse in observation 15. Interobserver reliability was established using the percentage agreement index (Suen & Ary, 1989). A third experienced cardiac surgical intensive care nurse and the researcher independently performed the percentage agreement index on the transcripts from the two observations. Interobserver reliability tests of the structured observations, that is, those supported by the observational checklist, showed a reliability of 100% on the first occasion and 100% on the second. These results indicate a high level of confidence in relation to the reliability of structured observations supported by a checklist to collect data about nurses' haemodynamic decision making.

The purpose of the checklist was to assist in collecting comprehensive data about patients' haemodynamic status, nurses' decision making concerning the goals of therapy, and two themes identified in Phase One. The tool was easy to use and, to a large extent, achieved its purposes. Data analysis revealed little missing data from Phase Two observations. Therefore the checklist minimised the selective attention bias identified in Phase One. Additionally, as the interobserver reliability results attest, the reliability of observation was high and that was due, in part, to the checklist. Despite these advantages, the checklist was rudimentary. If used in future studies, the tool could be further developed to provide more specific, and deeper, data about nurses' decision making. Moreover, rather than being considered a checklist to prompt the researcher, it is recommended that all sections of the checklist are fully completed rather than relying on the tape recordings.

Although the checklist minimised selective attention bias, other potential observational biases that were considered included the researcher's selective encoding and selective memory (Robson, 1993). In terms of selective encoding, the researcher attempted to keep an open mind concerning decision activities. In addition, analysis did
not take place until all observations were complete so that partial information was not used to rush data interpretation (Robson, 1993). Delaying analysis until data collection is complete contrasts with some types of qualitative studies such as grounded theory where data analysis is usually conducted throughout the data collection phase (Strauss & Corbin, 1998a, 1998b). Issues related to selective memory biasing the research were addressed by audio-taping observed behaviours (Robson, 1993).

A final issue that had the potential to bias the observations was the researcher's background as an experienced cardiac surgical intensive care nurse. Reflexivity suggests that researchers ought to acknowledge and disclose themselves in the research (Cohen et al., 2000) and that the researcher's background may affect what is studied, the findings considered most appropriate, and the framing of conclusions (Malterud, 1991). The researcher’s background was known to most participants. The researcher's experience enabled rich descriptions of observed decisions. It is acknowledged that such experience may also provide a source of judgements. Indeed, it is important for the researcher to address reactivity through reflexivity by monitoring one's role, reactions, and biases, and any interactions with participants (Cohen et al., 2000; Malterud, 1991). To minimise bias of that kind, assumed decision activities were noted in field notes and clarified in the interviews. Additionally, decision activities were audio-taped in real time and all interpretations or assumptions related to patient data or nurses' decisions were both acknowledged during taping and transcribed as such. Analysis of data indicated that the interview aided in clarifying observed behaviours and assisted in reducing observer bias.

Retrospective interviews have been extensively used in the study of nurses' decision making in combination with observation. However, the dependability or reliability of retrospective interviews can be impacted by three issues. First, participants' recall of events can be subject to memory lapses and are therefore open to inaccuracy (Carroll & Johnson, 1990). Second, participants may reconstruct events based on either their usual behaviour, or what is usually expected of them in certain circumstances, rather than what really occurred (Carroll & Johnson, 1990). Third, participants may provide answers to questions posed by the interviewer that participants presume the interviewer may want to hear (Clarke, 1999). To minimise the first issue, interviews were conducted immediately after the 2-hour observation periods in order to maximise
participants' recall of events. While participants attended the interview, the patients were cared for by the Associate Charge Nurse. To address the second issue, the interview was supported by the observer's notes on participants' observed decision making. With regard to the third issue, the frankness of participants' remarks about their decision making, especially in relation to deviations from best practice guidelines, suggests that participants answered questions in the interview to the best of their ability.

The methods of observation and interview are often used in combination for the express purpose of increasing the rigour of a study. The interviews allowed for observed decision making practices to be clarified (Lincoln & Guba, 1986). The use of mixed methods increased research rigour from triangulation of methods (Lincoln & Guba, 1986; Mays & Pope, 2000) and enhanced interpretability (Robson, 1993). Issues of transferability and confirmability were addressed using the techniques of purposive sampling and a reflexive journal (Lincoln & Guba, 1985; Malterud, 1991). Issues of dependability and credibility of field observations were addressed using the techniques of triangulation (methods and sources), member checks, and a reflexive journal (Lincoln & Guba, 1985; Mays & Pope, 2000). During Phase One and Phase Two, triangulation of methods was achieved using observation and follow-up interview. Additionally, in Phase Two, documentation analysis was performed. The use of mixed methods increased the study's rigour as the strengths of one data type partially compensated for the weaknesses of another (Patton, 1990). In terms of triangulation of sources, data were gleaned from three critical care units across two different hospitals. Member checks were performed in the interviews that immediately followed the observation to optimise participants' recall of their decision making. As distinct from triangulation of methods, where data from one source are checked against a second source, member checks involve asking the participants if the observations were credible (Lincoln & Guba, 1985). Member checks in an informal manner are intended to provide the participant with the opportunity to correct and challenge observer interpretations, give an assessment of their performance, and to put their views across directly (Lincoln & Guba, 1985).

It is also important to note that the researcher sought to qualitatively describe nurses' decision making (Sandelowski, 2000) rather than generate theory in relation to
nurses' decision making as may be possible using grounded theory (Hall & Callery, 2001; Strauss & Corbin, 1998a, 1998b).

In summary, observation was a useful method of describing the outcomes of nurses' decision making from interplay between decision complexity, nurses' experience, and environmental characteristics. The observational bias of selective attention impacted on the reliability of unstructured observations in Phase One, particularly in relation to gathering data for quantitative analysis. To provide for a quantitative analysis, and to aid systematic and comprehensive data collection during Phase Two, a checklist was designed. The patients' observation flow charts were photocopied to supplement information provided by the semi-structured observation in Phase Two. Interviews provided clarification of observed behaviours and participants' perspectives. The combination of observation and interview are recommended for future naturalistic studies of nurses' decision making in this context.

3.6 Data Analysis

The tape-recordings of observations and interviews were transcribed verbatim by the researcher for Phase One once data collection was complete. A professional transcriber, as well as the researcher, transcribed Phase Two data. Phase One analysis involved identifying themes related to team decision making and the ways in which technologies were used to inform decision making. Analysis of Phase Two data confirmed the themes identified in Phase One analysis. A subsequent deeper analysis was performed on both Phase One and Two data that yielded the study's final results. As the findings of Phase One and Phase Two analysis concurred, they are presented together in Chapters Four to Seven. However, as indicated earlier in this chapter, missing data from Phase One is related to certain aspects of nurses' decision making and patients' haemodynamic status not obtained.

Real-world research produces data that calls for both qualitative and quantitative analysis (Robson, 1993). Hence, data were analysed using qualitative and quantitative methods. Data analysis in relation to describing nurses' decision making could take many forms. This research sought to describe nurses' decision making particularly in relation to nurses' responses to patients' haemodynamic status. In order to understand variability in nurses' decision making, it was considered appropriate to describe the
diversity in patient presentations and nurses' responses. In the context of the observations, nurses' decision making was operationalised as the identification of patient problems, whether or not actions were taken, and descriptions of those actions. In the clinical context, patient cues such as technologically-derived parameters are continuously displayed and, in situations where that data indicated haemodynamic instability, four responses by nurses were possible. First, nurses recognised the problem and acted to reestablish haemodynamic stability. Second, nurses recognised the problem and decided to wait and see how the data trended. Third, the problem was not recognised because nurses were otherwise occupied and the condition had not breached alarm settings. Four, nurses saw the data on the monitor, but did not recognise the problem and, therefore, took no action.

Analysis of behavioural observation data can include parametric and nonparametric techniques (Suen & Ary, 1989). Additionally, several techniques are structured around time series analysis on the basis that behaviours are often serially dependent, that is, certain levels of behaviour at one point in time are related to actions carried out previously (Suen & Ary, 1989). With such analyses, cycles of behaviours or forecasts about what behaviours will increase or decrease in frequency in the future can be detected (Suen & Ary, 1989). However, none of the time series analysis techniques were considered appropriate for describing variability in nurses' decision making in this study.

A broad brush approach to analysis was considered necessary and appropriate to describe variability in decision making. As a result, two limitations are raised. First, the sample size may be considered small. However, for an in-depth analysis, sample size was considered appropriate. Second, there were many different case scenarios because the context kept changing and there was no control over the environment. Patients continually changed in their clinical presentations as a function of physiological changes associated with cardiopulmonary bypass and in response to nurses' interventions. As the context was dynamic, and confounding variables were unable to be controlled, an analysis of decision sequencing was considered inappropriate.

The process of analysis used during Phase One and Phase Two comprised four stages. The first stage involved the development of an organising framework. The
scheme for the organising framework can be seen in Figure 3.2. As illustrated, the
organising framework for analysis involved the roles of the multifactorial influences on
nurses' decision making and three haemodynamic goals of therapy.

The second stage of analysis involved the identification of decision episodes
pertaining to the three haemodynamic goals of therapy. Content analysis was performed
on transcriptions of the naturalistic observations. Content analysis was used to analyse
data because it is objective, systematic, and quantitative (Berelson, 1971). An important
assumption of content analysis is that the quantitative description of content is
meaningful (Berelson, 1971). Content analysis is recommended for decision analysis
(Carroll & Johnson, 1990) and has been used extensively for that purpose (Bettman &
Park, 1980; Bucknall, 2000; Crandall & Getchell-Reiter, 1993; Patel et al., 2000; Payne,
1976; Xiao, 1994). More specifically, content analysis has been used to analyse
observation data (Patel et al., 2000; Xiao, 1994) and interview data (Crandall &
Getchell-Reiter, 1993) in studies based on naturalistic decision making.

During the third stage of analysis, content analysis of decision episodes was
performed for frequency, nurses' techniques of management in relation to best practice
recommend examination of frequency when analysing behavioural observation data.
Frequency is the number of times that target behaviours occur within the observation
period (Suen & Ary, 1989). In particular, frequency refers to target behaviours by the
participant. In addition to data from the observation transcripts, this stage of analysis
involved data from patients' observation flow charts, the observation checklists, and
interview transcripts. Descriptive statistical analysis was conducted on data collected
during Phase One and Phase Two using the Statistical Package for the Social Sciences
Version 10.0.

For the fourth stage of analysis, a different lens was used to analyse the data. As
illustrated in Figure 3.2, the purpose of stage four analysis was to identify themes that
transcended across decision episodes. In particular, the role of experience was contrasted
across decision episodes and the roles of specific environmental characteristics were
explored. Framework, an analytic process, (Ritchie & Spencer, 1994) was used to
achieve this aim. Framework is a five stage analytic process of familiarisation,
Organising framework

Role of Experience
- Purposive sampling

Role of Environment
- Naturalistic decision making paradigm

Role of Decision Task
- Complex haemodynamic decision making
  - High patient acuity
  - Haemodynamic technologies
  - Numerous haemodynamic parameters
  - Rapid and accurate response

Three goals of therapy in 2-hour recovery period
- Optimisation of cardiovascular performance
- Promotion of haemostasis
- Reestablishment of normothermia

Identification and description of decision episodes pertaining to three haemodynamic goals of therapy
- Framework of assessment and management

Analysis of decision episodes
- Frequency
- Techniques of management in relation to best practice guidelines
- Patient haemodynamic stability

Themes that transcend across decision episodes
- Contrasting the role of experience
- Exploring the role of environmental characteristics
  - Nursing colleagues
  - Geographical layout of critical care
  - Social context

Researcher requirements for data collection and analyses

Experience in cardiac surgical intensive care
Domain knowledge
Accompanying study aims
Faithfulness to data

Figure 3.2. Scheme of organising framework for analysis.
identifying a thematic framework, indexing, charting, and mapping and interpretation. QSR NVivo (Richards & Richards, 1999), a computer software package designed to assist in the management of large volumes of textual material during data analysis, was used. This description of how the five stages of Framework was used to generate some of the findings in relation to team decision making is presented in this section. Team decision making arose from description of the social context of decision making in critical care. Excerpts related to stages in the process are provided in this section to assist the reader in understanding the analytic process carried out.

Familiarisation (Ritchie & Spencer, 1994) is a process of immersing oneself into the data. In this study, familiarisation was achieved by the following measures: listening to tape recordings of the observations and interviews, transcribing data, and reading the observation and interview transcriptions over and over. During the familiarisation stage, patterns in nurses' decision making began to be identified such as communication patterns and the roles of assistant nurses while nurses received patients. It was noted that some assistant nurses prompted primary nurses to make decisions while the primary nurses were receiving patients. Some primary nurses were noted to delegate decisions to assistant nurses.

The identification of a thematic framework in the second stage of Framework involved attempts to identify key issues, concepts, and themes. In doing so, issues raised from the literature review, participants' comments, and early emergent themes were drawn upon to assist in identifying a thematic framework (see Figure 3.3). From the literature review, issues related to a social context of decision making and group decision making were considered. Second, the emergent issue of communication was raised by the participants in the interviews. Third, analytic themes related to teamwork and assistance were observed by the researcher and spoken about by participants in interviews. These three sources were instrumental in developing themes for use in the next stage of analysis.

The third stage of analysis with Framework involved indexing, the systematic search of data and application of the theoretical framework to all the data (Ritchie & Spencer, 1994). The key issues, concepts, and themes identified in the second stage of analysis are illustrated in the left text box in Figure 3.3. The issues and themes listed in
the left text box were refined through further analysis and the text box on the right hand side of Figure 3.3 lists the themes that emerged from that analysis. Data in the transcripts were allocated to those themes in a systematic and careful process. In Figure 3.4, an excerpt from observation 34 is provided as an example of how the themes were found in the transcripts of the observations and interviews. New ideas also emerged during this stage.

In charting, the fourth stage of Framework, data are traditionally lifted from their original context and arranged according to the major themes. Such lifting of data is redundant when certain computer software is used for data analysis. The use of NVivo (Richards & Richards, 1999) to manage data analysis in this research meant that no data were taken out of their original context; but, rather, the data were coded at nodes according to the major themes. Nodes in NVivo can be used to represent themes. In this study, nodes were labelled according to the key themes identified during analysis, for example, three of the nodes were labelled assistants direct patient care, teamwork, and lack of communication. Coding at nodes achieved the same purpose as charting in that all the data relevant to each theme were identified and grouped together. One advantage of NVivo is that while all the data relevant to each theme are grouped together under nodes, the original transcripts remain intact. Moreover, further refinement of those nodes and titles of the themes can be altered as analysis deepens.
Themes: Second stage analysis

Identifying a Thematic Framework

A Priori Issues From Literature Review
Social context of decision making

Group decision making

Influence of colleagues on individual decision making

Technical assistance from colleagues during immediate postoperative phase

Emergent Issues
Different communication patterns between primary nurses and assistant nurses

Analytic Theme
Assistance
Helpful
Hindrance

Themes: Third stage analysis

Assistants direct patient care

Directing assistant nurses

Lack of communication

Teamwork

Figure 3.3. The second and third stages of identifying a thematic framework and coding using Framework.
<table>
<thead>
<tr>
<th>Time</th>
<th>Excerpt from Transcript</th>
<th>Theme</th>
</tr>
</thead>
</table>
| 18:57  | Primary nurse is sequentially zeroing each of the pressures, the patient has a pulmonary artery catheter. So she has got…an arterial pressure… it is showing a flat line which she is trying to troubleshoot… pulmonary artery pressures, and central venous pressures both have a question mark on the monitor and the saturation is 94%…Primary nurse is now taking a non-invasive blood pressure. Blood pressure was only reading a systolic pressure of 72. {a voice informs primary nurse that the drains are now up to 220 from 150 - alarm sounds} The patient now has a blood pressure of 84 and primary nurse has come down to feel the patient's feet...Primary nurse is pumping in some pump blood to get the patient's blood pressure up. Assistant nurse 2 has come in with a warming blanket for the patient…Assistant nurse 3 and assistant nurse 2 are putting a sheet on top of the warming blanket and connecting the warming blanket up | Lack of communication  
Teamwork  
Communication  
Assistants direct patient care  
Assistants direct patient care |

**Figure 3.4.** Indexed transcript of observation 34.
The final stage of analysis in Framework is called mapping and interpretation (Ritchie & Spencer, 1994). During this phase, further intensive analytic thinking occurred. Guided by the research aims, the data were systematically analysed and scrutinised. For example, data at nodes were revised and refined according to one of the main themes. It became clear through deeper analysis that the themes of teamwork, assistants directing patient care, and lack of communication were part of an overall theme of team decision making. Indeed, deep and careful analysis revealed two forms of team decision making. One form of team decision making was integrated and the other form was non-integrated. In addition, this final stage of deep analysis revealed nurses' responses, nurses' decision making practices, and patient outcomes associated with each form of team decision making. In Figure 3.5, the key criteria associated with integrated team decision making are listed in the left text box. On the right hand side, the outcomes and effects of integrated team decision making identified are listed. As noted by Ritchie and Spencer (1994), mapping and interpretation involves searching for a structure rather than multiplicity of evidence. The process also involved comparing and contrasting data and searching for data that could be described as negative cases whereby the major theme of team decision making was not applicable. Negative cases were found where nurses received patients alone. The final result of these processes yielded the major themes reported in this thesis in relation to the social context of decision making.
### MAPPING AND INTERPRETATION

**Team decision making - Integrated**

- Primary nurses made most haemodynamic patient management decisions
- Continuous referral to primary nurses from assistant nurses
- Usually one or two assistant nurses helped primary nurses to admit and recover patients

### MAPPING AND INTERPRETATION

**Team decision making - Integrated**

Nurse Outcomes
- Aware of colleagues' actions

Nurse Responses - Action
- Keeping watch
- Staying informed

Nurse Responses - Emotional
- Grateful for colleagues' support
- Being in control

Practice Outcomes
- Coordinated clinical practice
- Smooth and easy clinical practice

Potential for Patient Outcomes
- Optimised

---

*Figure 3.5.* The final stage of mapping and interpretation in Framework.
During data analysis, peer debriefing was also performed to enhance research rigour. Peer debriefing involved sporadic conversations with a professional peer regarding aspects of data analysis. The process of peer debriefing allowed for testing of propositions, checking of biases, and challenges to current interpretations and coding categories. Lincoln and Guba (1985) argue that peer debriefing; triangulation of data sources, methods, and analysis; and evidence of persistent observation contribute to the credibility of findings. All of those measures were carried out in the conduct of this research.

Throughout the following chapters, quotations taken directly from participants or the researcher's observations are presented in indented paragraphs and the source of the quote is provided. The use of an ellipse indicates that extraneous words have been removed without altering meaning.

The observations and interviews of each participant share the same numerical code which ranges from 1 to 38. Thus, data provided by the observation of participant number 32 will read observation 32. If a quotation originates from the interview with the same participant, the participant's code number is used; for example, participant 32. Similarly, the patient recovered by participant 32 is referred to as patient 32 or identity 32 (ID, 32). This numbering system assists in following participants' decisions and perspectives, while clearly demonstrating that the coding and categories originated from the data.

3.7 Ethical Considerations

Initial approval was sought and obtained from the Human Research and Ethics Committee of Deakin University and the two institutions. A plain language statement was provided to participants prior to each observation and interview (Appendix D). Nurses consented to participate in the study.

Every effort was taken to maintain confidentiality and anonymity of the nurses participating in this study. Participants were assured that neither their identities nor the hospitals would be revealed in publications arising from the study. To assist in maintaining anonymity, exemplars used in publications, conference presentations, and reports back to units have been slightly modified and de-identified. For instance, the gender of certain participants have been altered to protect their identity. Additionally,
delays in publishing results in professional nursing journals may assist in maintaining anonymity of participants by introducing a delay period between data collection and publication.

To assist in privacy and confidentiality of details about participants' practice, knowledge, and thoughts about receiving patients, the transcripts of observations and interviews were coded numerically. The professional transcriber employed to transcribe some of the audio-tapes signed a confidentiality contract regarding the subject matter. Only the researcher and supervisors had access to the transcription records. The tapes and computer disks are being kept according to the University Human Research and Ethics Committee's guidelines.

Two other issues in relation to observation of nurses in clinical practice are important considerations. The first was that consents from patients were not obtained. However, due to the sampling process whereby patients were included on the basis that their nurse was a participant, it was not possible to consent patients prior to the observation period because the patients involved in the study could not be anticipated by the researcher. The Ethics Committees at Deakin University and the two institutions agreed that patient consents were not required because the focus of the research was on the decision making of nurses. There are two major reasons why on balance it was considered appropriate not to obtain patients' or families' consent to participate in the observation study. First, nurses were the focus of the observation. In particular, the focus was on the way nurses responded to the haemodynamic status of patients within the critical care environment. Second, patients' medical records were not accessed and unique attributes of patients such as age, past history, or comorbidities were not recorded. Only information related to the postoperative haemodynamic status of patients was recorded. Indeed, information that was recorded about patients during the 2 hour observation period was information that could be derived from the monitoring and medical devices attached to the patient. The photocopying of patients' observation flow charts was performed without any identifying data.

The second issue was the potential to see unsafe practice. After discussion with members of the Ethics Committee, a decision was made that the researcher had an obligation to ensure that patients were not harmed. In the event of observing unsafe
practices, data collection would have been ceased and advice offered. This situation did not arise.

3.8 Summary

In this chapter, the research program and methodological defence regarding the selection of naturalistic decision making using observation and follow-up interview as method was discussed. The ways that data were collected and analysed, along with measures taken to increase research rigour have been described. Research procedures and ethical considerations were also provided. In the next four chapters, the research findings are presented.
CHAPTER 4

HAEMODYNAMIC STATUS OF CARDIAC SURGICAL PATIENTS
IN THE 2-HOUR RECOVERY PERIOD

The purpose of this chapter is to present the findings related to the complexity of postoperative cardiac patients in order to set the scene for, and describe the context of, haemodynamic decision making by nurses. The first aim of the research program was to describe the haemodynamic status of patients admitted to critical care following cardiac surgery and progress over the subsequent 2-hour period. The dynamic nature of the haemodynamic status of cardiac surgical patients in the initial 2-hour recovery period although recognised clinically, has not been observed empirically and described in the literature. Literature regarding patients' haemodynamic status after cardiac surgery tends to describe the causes and therapeutic management of haemodynamic instability rather than describe the expected instability in patients' haemodynamic status. Furthermore, previous studies of nurses' decision making during the recovery of cardiac surgical patients have focused on specific aspects of haemodynamic management such as nurses' use of pulmonary artery pressure monitoring (Aitken, 2000), and have not emphasised patient status. In order to understand potential variability in the way nurses respond to haemodynamic changes in patient status, and the complexity associated with decision making in this context of instability, it is necessary to describe the dynamic clinical presentation and responses of patients.

Despite the routine nature of cardiac surgery, patients are invariably haemodynamically unstable and at risk of life-threatening complications in the initial 2-hour recovery period. Postoperative haemodynamic instability is due to the physiological disturbances associated with cardiopulmonary bypass and is primarily related to problems achieving optimal cardiovascular performance, haemostasis, and normothermia. Therefore, it is useful to describe patients' recoveries in terms of salient haemodynamic cues in relation to cardiovascular function, bleeding, and hypothermia. Cardiac function, bleeding, and hypothermia are closely interrelated both in terms of patient presentation and therapeutic interventions.
Impaired cardiovascular function may present in many forms such as rate and rhythm disturbances, hypotension, low cardiac output syndrome, low SVR syndrome, and hypoxaemia. Although all of the aforementioned complications have the potential to cause inadequate perfusion to organs and tissues, two complications can significantly impede patient recovery. Low cardiac output syndrome has been associated with increased lengths of stay in critical care (Christakis et al., 1996) and a surgical mortality ranging from 22.8% to 46.5% (Kumon et al., 1986). Low SVR syndrome has been reported to occur in about 5% to 8% of patients (Myles et al., 1997) and may also result in increased lengths of stay. The risk of postoperative bleeding is increased in cardiac patients because cardiopulmonary bypass causes significant disruptions to normal clotting mechanisms. The incidence of postoperative bleeding has been reported to be between 2% and 12% of cardiac patients (Hall et al., 2001). Although systemic hypothermia induced during surgery to protect organs from ischaemic damage is reversed prior to separation from cardiopulmonary bypass, core temperature falls in the first 45 to 90 minute recovery period. Clinically, the most detrimental effect of residual hypothermia is the onset of shivering because it can increase heart rate, blood pressure, and oxygen consumption by up to 200%, all or any of which can lead to myocardial ischaemia (Guffin et al., 1987; Holtzclaw, 1986; Mort et al., 1996). To optimise patients' recoveries, shivering must be avoided and treated promptly when it occurs.

Patients in the immediate postoperative period are at risk of impaired cardiovascular function, bleeding, and residual hypothermia. Importantly, all of the aforementioned complications are neither mutually exclusive nor benign. For instance, postoperative bleeding or shivering can cause profound hypotension which, in turn, may progress to cardiac ischaemia or cardiac arrest. The goal of this chapter is to describe the haemodynamic status of patients during the initial 2-hour recovery period after cardiac surgery.

4.1 Methods

The methodological approach and method of observation to collect data about patients' haemodynamic status were described in detail in Chapter Three. Specific issues
in relation to sampling, missing data, and data analysis will be addressed in the following sections.

4.1.1 Sample

Purposive sampling was used to select nurses for the study. Nurses were included in the study on the basis of years of experience in cardiac surgical intensive care nursing. Patients were included in the study if their nurse was a participant. Although this inclusion strategy had the potential for a systematic bias in patient sampling, as discussed in Section 3.4.4 of Chapter Three, the ad hoc allocation of nurses to patients rendered such a bias unlikely.

4.1.2 Data Collection

Data were collected using non-participant observation and an observation tool in four critical care units in two hospitals. Missing data occurred because of three issues. First, selective observation bias was identified during analysis of data from Phase One. As described in Chapter Three, Phase One of the study sought to explore observation as method in the context of cardiac surgery recovery. However, the unstructured observations led to selective observation bias which was minimised in Phase Two with the development of a 2-page observation checklist. Second, the need to maintain patient privacy restricted access to patients’ histories. Third, nurses were purposively sampled for experience and inexperience and patients were included in the study if their nurse was a participant. Thus, as explained in the previous section, information about patients prior to the observation period could not be collected because the patients involved in the study could not be anticipated by the researcher.

4.1.3 Data Analysis

Patient data from the observations and observation flow charts were collated and analysed using content analysis. Content analysis was considered appropriate for describing the diversity in haemodynamic status of patients. Content analysis provided objective, systematic, and quantitative descriptions of data (Berelson, 1971). As outlined in Figure 3.2 and discussed in Section 3.6, data analysis involved four stages. The first three stages of analysis are relevant to data reported in this chapter. In the first stage, an
organising framework was developed around the therapeutic goals of optimising cardiovascular performance, promoting haemostasis, and reestablishing normothermia. Second, decision episodes related to the goals of therapy were identified.

Third, content analysis and descriptive statistical analysis of decision episodes in terms of patient haemodynamic stability were performed. Where patient parameters are normally distributed or there are common characteristics, means and standard deviations are reported. To meet the research aim reported in this chapter, the use of summary statistics has limited application. Therefore, the minimum and maximum is also displayed where relevant in order to show the variability of all the patient presentations. Where data are skewed, medians are reported, and the measures of dispersion are the 25th (Q1) and 75th (Q3) percentile ranks of the distribution.

As discussed in Section 3.6, a broad brush approach to analysis was required to meet the aim of describing the diverse patient presentations and variability in nurses' decision making. During analysis, it was apparent that each patient presented with a unique combination of haemodynamic instability and postoperative complications and that it was not possible to describe this patient cohort in terms of particular combinations of instability and complications.

4.2 Findings

The discussion of results is divided into two major sections. The first section contains an outline of patients' characteristics and includes details of haemodynamic monitoring technologies. The haemodynamic status of patients on admission in terms of cardiovascular function, bleeding, and hypothermia are also discussed in the first section. In the second section, patients' haemodynamic status over the 2-hour period in relation to cardiovascular function, bleeding, and hypothermia are presented. Additionally, the frequency of haemodynamic critical incidents during the 2-hour recovery period is reported.

The experience level of nurses and major patient events in terms of frequency of critical incidents, and postoperative haemodynamic instability and complications for each goal of therapy are shown in Table 4.1. These data are presented to assist in understanding the complexity of patient presentations and to provide a sense of each patient's overall haemodynamic status during the recovery period.
<table>
<thead>
<tr>
<th>ID</th>
<th>Experience level of nurse</th>
<th>Type of Surgery</th>
<th>Frequency of critical incident</th>
<th>Haemodynamic instability and postoperative complications related to three goals of therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Experienced</td>
<td>CABGS</td>
<td>0</td>
<td>CI 2.2 - 2.5 L/min/M²</td>
</tr>
<tr>
<td>2</td>
<td>Inexperienced</td>
<td>CABGS</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Experienced</td>
<td>CABGS and MVR</td>
<td>0</td>
<td>Hypotension</td>
</tr>
<tr>
<td>4</td>
<td>Experienced</td>
<td>AVR</td>
<td>0</td>
<td>Low cardiac output syndrome</td>
</tr>
<tr>
<td>5</td>
<td>Inexperienced</td>
<td>AVR</td>
<td>3</td>
<td>Hypotension, SVR &lt; 800 dyne/sec/cm²</td>
</tr>
<tr>
<td>6</td>
<td>Inexperienced</td>
<td>CABGS</td>
<td>0</td>
<td>Hypotension, low SVR syndrome</td>
</tr>
<tr>
<td>7</td>
<td>Experienced</td>
<td>CABGS</td>
<td>0</td>
<td>Hypotension</td>
</tr>
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<td>8</td>
<td>Experienced</td>
<td>CABGS</td>
<td>0</td>
<td>Hypotension, CI 2.2 - 2.5 L/min/M², low SVR syndrome</td>
</tr>
<tr>
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<td>CABGS and AVR</td>
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<td>Hypotension</td>
</tr>
<tr>
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<td>CABGS and AVR</td>
<td>1</td>
<td>Hypotension</td>
</tr>
<tr>
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<td>CABGS</td>
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<td>Hypotension, SVR &lt; 800 dyne/sec/cm²</td>
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<td>CABGS</td>
<td>1</td>
<td>Hypotension, SVR &lt; 800 dyne/sec/cm²</td>
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<tr>
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<td>Inexperienced</td>
<td>CABGS</td>
<td>0</td>
<td>Hypertension, SVR &lt; 800 dyne/sec/cm²</td>
</tr>
<tr>
<td>14</td>
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<td>AVR</td>
<td>0</td>
<td>Low SVR syndrome</td>
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<tr>
<td>15</td>
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<td>CABGS</td>
<td>0</td>
<td>Hypotension, CI 2.2 - 2.5 L/min/M²</td>
</tr>
<tr>
<td>16</td>
<td>Experienced</td>
<td>CABGS</td>
<td>0</td>
<td>Low SVR syndrome</td>
</tr>
<tr>
<td>17</td>
<td>Inexperienced</td>
<td>AVR</td>
<td>0</td>
<td>Hypotension, hypertension</td>
</tr>
<tr>
<td>18</td>
<td>Inexperienced</td>
<td>CABGS</td>
<td>0</td>
<td>Hypotension, CI 2.2 - 2.5 L/min/M²</td>
</tr>
<tr>
<td>19</td>
<td>Inexperienced</td>
<td>CABGS</td>
<td>0</td>
<td>Hypotension, low cardiac output syndrome, cardiac tamponade</td>
</tr>
<tr>
<td>20</td>
<td>Inexperienced</td>
<td>CABGS &amp; AVR</td>
<td>0</td>
<td>Hypotension</td>
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</tbody>
</table>

- Cardiovascular: Medical bleed, Surgical bleed
- Haemostasis: Shivered
- Normothermia: Shivered
<table>
<thead>
<tr>
<th>ID</th>
<th>Experience level of nurse</th>
<th>Type of Surgery</th>
<th>Frequency of critical incident</th>
<th>Haemodynamic instability and postoperative complications related to three goals of therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>Inexperienced</td>
<td>CABGS</td>
<td>0</td>
<td>Hypotension, low SVR syndrome</td>
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<tr>
<td>22</td>
<td>Inexperienced</td>
<td>CABGS</td>
<td>0</td>
<td>Hypertension, low cardiac output syndrome</td>
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<tr>
<td>23</td>
<td>Experienced</td>
<td>CABGS</td>
<td>0</td>
<td>Hypertension</td>
</tr>
<tr>
<td>24</td>
<td>Experienced</td>
<td>CABGS</td>
<td>0</td>
<td>CI 2.2 - 2.5 L/min/M²</td>
</tr>
<tr>
<td>25</td>
<td>Experienced</td>
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<td>0</td>
<td>Hypotension, hypertension, low SVR syndrome</td>
</tr>
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<td>26</td>
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<td>0</td>
<td>Low cardiac output syndrome</td>
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<td>27</td>
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<td>AVRs and MVR</td>
<td>8</td>
<td>Hypertension</td>
</tr>
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<td>28</td>
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<td>AVR</td>
<td>0</td>
<td>Hypertension</td>
</tr>
<tr>
<td>29</td>
<td>Experienced</td>
<td>CABGS and TVR</td>
<td>1</td>
<td>Hypotension</td>
</tr>
<tr>
<td>30</td>
<td>Experienced</td>
<td>AVRs and TVR</td>
<td>0</td>
<td>Hypotension, CI 2.2 - 2.5 L/min/M²</td>
</tr>
<tr>
<td>31</td>
<td>Experienced</td>
<td>CABGS</td>
<td>0</td>
<td>Medical bleed</td>
</tr>
<tr>
<td>32</td>
<td>Experienced</td>
<td>CABGS</td>
<td>2</td>
<td>Hypertension, low cardiac output syndrome</td>
</tr>
<tr>
<td>33</td>
<td>Inexperienced</td>
<td>CABGS</td>
<td>0</td>
<td>Shivered</td>
</tr>
<tr>
<td>34</td>
<td>Inexperienced</td>
<td>CABGS</td>
<td>1</td>
<td>Hypotension, SVR &lt; 800 dynes/sec/cm²</td>
</tr>
<tr>
<td>35</td>
<td>Inexperienced</td>
<td>CABGS and AVRs</td>
<td>1</td>
<td>Medical bleed</td>
</tr>
<tr>
<td>36</td>
<td>Inexperienced</td>
<td>CABGS</td>
<td>1</td>
<td>Hypertension</td>
</tr>
<tr>
<td>37</td>
<td>Experienced</td>
<td>CABGS</td>
<td>1</td>
<td>Shivered</td>
</tr>
<tr>
<td>38</td>
<td>Inexperienced</td>
<td>CABGS and TVR</td>
<td>0</td>
<td>Low cardiac output syndrome</td>
</tr>
</tbody>
</table>

**Note:** CABGS = coronary artery bypass graft surgery. CI = cardiac index. MVR = mitral valve replacement. AVR = aortic valve replacement. SVR = systemic vascular resistance. < = less than. TVR = tricuspid valve replacement.
4.2.1 Characteristics of Patients

Seventy-one percent of patients (n = 27) were male and 29% of patients (n = 11) were female. As illustrated in Figure 4.1, the majority of patients (63%) had CABGS. Aortic valve replacement surgery (16%) and a combination of CABGS and aortic valve replacement surgery (10%) were the next most frequently performed operations.

In terms of haemodynamic monitoring technologies, 97% of patients (n = 37) had a PAC. One patient (ID, 30) who received a tricuspid valve replacement and CABGS had a central venous catheter in lieu of a PAC. All patients had a radial arterial line, urinary catheter, and two chest tubes. Ninety percent of patients (n = 34) had pacing wires. Five percent of patients (n = 2) did not have pacing wires (missing data, n = 2). Sternal wounds were dressed. Where relevant, radial artery and saphenous vein graft sites were bandaged.

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![Bar chart showing types of cardiac surgery](chart.png)

**Figure 4.1.** Types of cardiac surgery (N = 38).

**Note.** CABGS = coronary artery bypass graft surgery, AVR = aortic valve replacement, MVR = mitral valve replacement, TVR = tricuspid valve replacement.
4.2.2 Haemodynamic Status on Admission

All patients were admitted to the critical care unit in an anaesthetised, sedated, and fully ventilated state. Sixty percent of patients \( n = 23 \) were receiving sedation via propofol infusions. In another 3 patients, propofol infusions used during general anaesthesia were ceased by the anaesthetists just prior to discharge from theatre. However, on admission 1 patient had the propofol infusion reinstated by the primary nurse.

4.2.2.1 Cardiovascular Function

Haemodynamic parameters used to describe cardiovascular function on admission were heart rate, MAP, PCWP, CVP, and SpO₂. The mean parameters measured on admission along with the range, to illustrate the variability in presentation, are displayed in Table 4.2. The frequencies for the PCWP and the CVP indicate the actual number of patients who had those parameters measured.

Temporary pacing controlled 74% of patients' rhythms by either atrial (34%) or atrioventricular pacing (40%). The mean pacing rate was 89 (SD = 6.8, min. = 72, max. = 100) bpm and therefore strongly influenced the mean heart rate of 87 (SD = 8.6) bpm illustrated in Table 4.2. A further 16% of patients had pacing wires connected, but they were not in use on admission. Twenty-six percent of patients \( n = 10 \) were in sinus rhythm on admission.

Thirty-four percent of patients \( n = 13 \) presented with a MAP below 70 mmHg. Significantly, 13% of patients \( n = 5 \) presented with a MAP between 50 mmHg and 60 mmHg. Hence, based on MAP, only 66% of patients \( n = 25 \) had adequate perfusion to organs and tissues on admission. Preload values were in a low to normal range for this cohort, except for one patient who had a high PCWP of 20 mmHg. The normal values for cardiac surgical patients are 10 to 15 mmHg for a PCWP and 8 to 12 mmHg for a CVP. The mean preload data suggest patients were admitted in a slightly hypovolaemic state which may account, in part, for the number of hypotensive patients.
Table 4.2

Cardiovascular Data on Admission to Critical Care

<table>
<thead>
<tr>
<th>Haemodynamic parameter</th>
<th>M</th>
<th>SD</th>
<th>Min., Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart rate per minute (N = 38)</td>
<td>87</td>
<td>8.6</td>
<td>68, 100</td>
</tr>
</tbody>
</table>

Pressures (mmHg)

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean arterial pressure (n = 36)</td>
<td>74</td>
<td>13.5</td>
<td>50, 107</td>
</tr>
<tr>
<td>Pulmonary capillary wedge pressure (n = 9)</td>
<td>12</td>
<td>4.4</td>
<td>5, 20</td>
</tr>
<tr>
<td>Central venous pressure (n = 18)</td>
<td>9</td>
<td>3.6</td>
<td>4, 13</td>
</tr>
<tr>
<td>Percentage oxygen saturation (n = 34)</td>
<td>97</td>
<td>4.1</td>
<td>83, 100</td>
</tr>
</tbody>
</table>

The normal value for oxygen saturation is 95% to 100%. Although 71% of patients had an SpO₂ greater than 95%, 7 patients presented with an SpO₂ less than 95%. The cardiac index and SVR were not measured immediately on patients' admissions because the cardiac output systems are assembled during settling-in procedures. The data illustrated in Table 4.2 suggest that despite an adequate heart rate, 34% of patients (n = 13) may have had less than optimal coronary, cerebral, and renal perfusion on admission due to a MAP below 70 mmHg.

The high usage of temporary pacing and vasoactive infusions suggest that patients at this stage in their recovery require a substantial level of cardiovascular support. To support cardiac rate and rhythm, 87% of patients (n = 33) were admitted with a temporary pacemaker. One other patient had a permanent pacemaker from previous surgery. One patient was admitted with an intra-aortic balloon pump and inhaled nitric oxide to augment left and right ventricular contractility respectively. The majority of patients (92%) were admitted with at least one vasoactive infusion. Eighty-four percent of patients (n = 32) were treated with a vasodilator infusion, 21% of
patients \((n = 8)\) with an inotrope infusion, and 5\% of patients \((n = 2)\) with an inodilator infusion. In 1 patient, an inotrope infusion was ceased by the anaesthetist during transit from theatre to critical care. The inotrope infusion was recommenced by the primary nurse 19 minutes after admission because the patient's condition had deteriorated. A detailed discussion of the various vasoactive infusions administered to patients can be found in Section 4.2.3.1 of this chapter.

### 4.2.2.2 Bleeding

Haemodynamic parameters recorded in order to describe patients' level of bleeding on admission were the incidence of haemostatic infusions, the volume of blood in the drainage receptacle, and the integrity of surgical wound dressings.

Patients presented with wide variations in the volume of blood in the drainage receptacle. Data for the volume of blood in the drainage receptacle on admission were positively skewed. The median volume of blood drainage for patients \((n = 37)\) on admission was \(83\) (\(Q_{25}, Q_{75} = 25, 100\)) mls. The reason that the amount of chest drainage was not normally distributed was probably because 10\% of patients \((n = 4)\) had substantial bleeding during the final stages of surgery. For those 4 patients, the surgeon had determined that the amount or form of bleeding warranted being placed back on cardiopulmonary bypass to effect haemostasis. Another 8\% of patients \((n = 3)\) were also admitted after bleeding in the final stages of surgery, but they were not placed back on cardiopulmonary bypass. In total, 18\% of patients \((n = 7)\) exhibited bleeding complications on admission.

To prevent bleeding and promote haemostasis, 53\% of patients \((n = 20)\) were admitted with either an aminocaproic acid infusion (43\%) or an aprotinin infusion (10\%). These data suggest that prior to leaving theatre approximately half of the patients had haematological data indicative of a coagulopathy. As noted earlier, 18\% of patients \((n = 7)\) had already bled internally or externally during or immediately after surgery. In terms of wounds, neither the sternal, arm, nor leg dressings showed signs of ooze.

### 4.2.2.3 Hypothermia

The haemodynamic parameters recorded in order to determine the presence or absence of hypothermia on admission were core temperature and the occurrence of
shivering. Core temperature was measured either via the PAC (n = 37) or via a tympanic membrane thermometer (n = 1).

The mean core temperature of patients (N = 38) on admission was 35.6 (SD = .85, min. = 32.6, max. = 37.3) °C. Ninety-two percent of patients (n = 35) were hypothermic, that is, had a core temperature of 36.5 °C or less (Phillips & Skov, 1988) on admission. Eight percent (n = 3) of patients were normothermic on admission. Two of the normothermic patients had a core temperature of 37.3 °C, which was probably attributable, in part, to having partial forced-air warming blankets over their lower limbs during surgery. On admission, the forced-air blankets were left in place so that they could be used for rewarming at the nurses' discretion. A partial forced-air warming blanket was also in place on another 8 patients. However, the mean temperature of those 8 patients was 35.8 (SD = 0.6) °C suggesting that the use of partial rewarming blankets in the operating theatre did not necessarily lead to normothermia on admission.

On admission, patient 21 was noted to be shivering when the assistant nurse felt the patient's forehead. The patient's oxygen saturation was 93%. A bolus dose of propofol was administered from the existing infusion and the shivering ceased.

4.2.2.4 Classification of Haemodynamic Status on Admission

Although detailed information about patients' haemodynamic status is obtained from considering parameters specific to cardiovascular function, bleeding, and hypothermia, it is important to gain an overall sense of patients' level of haemodynamic stability on admission. In order to achieve that aim, patients were classified as haemodynamically stable on admission if all of the following criteria were met: MAP greater than 70 mmHg, heart rate greater than 70 bpm and less than 120 bpm, absence of cardiac dysrhythmia, chest drainage less than 100 mls, and SpO2 greater than 95%. Forty percent of patients (n = 15) met these aforementioned criteria. The remaining 60% of patients (n = 23) did not meet one or more of the aforementioned criteria and were considered to be haemodynamically unstable. Thirty-four percent of patients (n = 13) were admitted with a MAP less than 70 mmHg. In those 13 patients, the mean MAP was 61 (SD = 5.2) mmHg. Twenty-one percent of patients (n = 8) arrived with more than 100 mls of blood in the drainage receptacle. For those 8 patients, the mean drainage was 214 (SD = 95) mls. That volume of blood had accumulated in the receptacle within
approximately 30 minutes because the chest drains are inserted approximately half an hour prior to patients leaving theatre. Eighteen percent of patients (n = 7) were admitted with hypoxaemia. The mean SpO₂ was 90.4 (SD = 3.9, min. = 83, max. = 94) %. These data indicate the importance of nurses to be prepared to respond rapidly with interventions in order to establish haemodynamic stability as soon as the patient is admitted.

4.2.2.5 Summary

The cardiovascular data presented in this section suggest that nurses must remain vigilant and responsive to haemodynamic instability from the moment that the patient is admitted. Sixty percent of patients were haemodynamically unstable on arrival due to hypotension (34%), bleeding (21%), and hypoxaemia (18%). The majority (92%) of patients were hypothermic and 1 patient was shivering. More than half of the patients (53%) were receiving haemostatic drugs. Furthermore, most of the patients required a high level of cardiovascular support in the forms of temporary pacing (74%), vasodilator infusions (84%), inotrope infusions (21%), and inodilator infusions (5%). One patient was admitted with an intra-aortic balloon pump and inhaled nitric oxide to support cardiovascular performance. All patients were fully sedated and ventilated on arrival. Therefore the level of haemodynamic instability suggested by the aforementioned data was neither due to agitation nor arousal from anaesthesia. These data illustrate the high acuity of patients' haemodynamic status in terms of cardiovascular function, bleeding, and hypothermia. The data show that many patients had multiple signs of haemodynamic instability and that combinations of therapies are required to recover from cardiac surgery. In light of the high acuity of patients on admission, nurses need to be adequately prepared so that they can respond with appropriate interventions to optimise patients' recoveries.

In the next section, the haemodynamic status of patients during the 2-hour recovery period following admission are described. Patients' overall neurological and respiratory status are described briefly before a detailed discussion of patients' haemodynamic parameters concerning cardiovascular function, bleeding, and hypothermia.
4.2.3 Haemodynamic Status During 2-hour Recovery Period

The majority of patients (n = 33, 87%) remained sedated throughout the 2-hour recovery period from either a propofol infusion (71%) or the residual effects of the anaesthetic (16%). Of the 87% of patients, 63% (n = 24) had arrived with a propofol infusion in progress. Another 8% of patients (n = 3) commenced a propofol infusion after admission. Thirteen percent (n = 5) regained consciousness, but remained drowsy. None of the patients were extubated.

All patients (n = 14, 37%) who had a valve replaced as part of their surgical procedure experienced haemodynamic instability. These forms of haemodynamic instability included hypotension, hypertension, low cardiac output syndrome, low SVR syndrome, bleeding (both medical and surgical), and shivering. The patient (ID, 3) whose cardiovascular function was supported by an intra-aortic balloon pump and nitric oxide had received CABGS and a mitral valve replacement. These data suggest nurses need to be particularly alert to various forms of haemodynamic instability in patients who receive valve replacements during surgery.

4.2.3.1 Cardiovascular Function

In order to describe cardiovascular function during the 2-hour recovery period, the mean, standard deviation, minimum, and maximum of key parameters at half-hourly intervals are shown in Table 4.3. The mean heart rate remained stable for most patients throughout the recovery period because of pacing induced rhythms. None of the patients had a bradycardia. Patient 22 had a sinus tachycardia which varied between 101 bpm to 113 bpm for the 2-hour period and patient 23 had a sinus tachycardia of 101 bpm for the first 90 minutes. Two patients (ID, 5 and 6) were paced at 110 bpm and 105 bpm respectively in response to hypotension in the last hour (see Table 4.3).

The ranges of MAP recorded throughout the recovery period indicate that hypotension (MAP less than 70 mmHg) was more prevalent than hypertension (MAP greater than 95 mmHg). Indeed, 55% of patients (n = 21) suffered hypotension during the recovery period. It is probable that MAP trended down rather than up during the recovery period due to vasodilation associated with rewarming, hypovolaemia, and myocardial dysfunction.
As discussed later in this chapter, 79% of patients were actively rewarmed. Vasodilation caused by rewarming often leads to hypotension if adequate infusion of colloid fluids does not occur concurrently. Similarly, hypotension from hypovolaemia is inevitable if patients who bleed substantial amounts do not receive fluids to replace the losses from their circulating volume. As discussed in the next section of this chapter, 21% of patients bled significantly during the recovery period. In circumstances of rewarmed and bleeding, hypotension should be anticipated by nurses and readily treated with infusions of colloid fluid. To ascertain if hypovolaemia contributed to hypotension in this cohort of patients, consideration of preload values can be useful. As illustrated in Table 4.3, the range and standard deviations of both the PCWP and CVP indicate that some patients had very low preload values and others had particularly high preload values throughout the recovery period. Given this high variability, it is not possible to judge whether fluid replacement therapies adequately compensated for vasodilation during postoperative rewarmed or for blood losses. The third main cause of hypotension is myocardial dysfunction which can be attributed to cardiac tamponade, low cardiac output syndrome, or low SVR syndrome. As discussed in the next section, those complications were evident in this cohort. Therefore, it is likely that myocardial dysfunction, rather than rewarmed or bleeding may have accounted for the trend towards hypotension in these patients.
Table 4.3
Cardiovascular Data During 2-hour Recovery Period

<table>
<thead>
<tr>
<th>Haemodynamic parameter</th>
<th>30 min</th>
<th>60 min</th>
<th>90 min</th>
<th>120 min</th>
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<tbody>
<tr>
<td>Heart rate per minute</td>
<td>88</td>
<td>9</td>
<td>62, 105</td>
<td>89</td>
</tr>
<tr>
<td></td>
<td>(n = 36)</td>
<td></td>
<td></td>
<td>(n = 36)</td>
</tr>
<tr>
<td>Pressures (mmHg)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean arterial pressure</td>
<td>83</td>
<td>20</td>
<td>54, 145</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td>(N = 38)</td>
<td></td>
<td></td>
<td>(n = 36)</td>
</tr>
<tr>
<td>Pulmonary capillary wedge pressure</td>
<td>13</td>
<td>4.8</td>
<td>6, 23</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>(n = 24)</td>
<td></td>
<td></td>
<td>(n = 20)</td>
</tr>
<tr>
<td>Central venous pressure</td>
<td>11</td>
<td>4.6</td>
<td>1, 22</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>(n = 31)</td>
<td></td>
<td></td>
<td>(n = 24)</td>
</tr>
</tbody>
</table>
Sixteen percent of patients (n = 6) had low cardiac output syndrome and 16% (n = 6) displayed low SVR syndrome. In addition, one patient (ID, 30) suffered persistent and profound hypotension (MAP X = 61.4, SD = 4.8 mmHg) throughout the recovery period suggesting severe myocardial dysfunction, but he did not have a PAC to confirm the probable diagnosis of low cardiac output syndrome. In sum, 35% of patients (n = 13) developed myocardial dysfunction that manifested as hypotension, low cardiac output syndrome, and low SVR syndrome. Appropriate therapeutic interventions, such as vasoactive infusions and colloid infusions were implemented for all of these patients.

A further 18% of patients (n = 7) recorded cardiac index values between 2.2 L·min·m⁻² and 2.5 L·min·m⁻² on at least one occasion suggesting that they may have been at risk of developing low cardiac output syndrome. An additional 13% of patients (n = 5) had an SVR lower than 800 dynes·sec·cm⁻⁵, and were at risk of developing low SVR syndrome. These data suggest that patients are at a high risk of developing impaired cardiovascular function in the immediate period after cardiac surgery. The implications of these data are that nurses need to assess for, and anticipate, cardiovascular complications such as myocardial dysfunction, during the 2-hour recovery period so that therapeutic interventions such as vasoactive infusions aimed at correcting the underlying problems can be initiated.

The high incidence of myocardial dysfunction (35%) indicated by low cardiac output syndrome, low SVR syndrome, and profound hypotension probably accounted for the high frequency in the use of vasoactive drug infusions in this cohort (see Figure 4.2).
To support cardiovascular function, all patients received one or more potent vasoactive infusions during the 2-hour recovery period. Vasoactive infusions included the following: vasodilators in the forms of GTN or sodium nitroprusside; inotropes such as adrenaline, noradrenaline, or dopamine; and milronone, an inodilator. Sixty percent of patients (n = 23) received one vasoactive infusion, 37% of patients (n = 14) received two drugs infusions, and 3% of patients (n = 1) received three infusions. In addition to vasoactive infusions, a propofol infusion was administered to 71% of patients (n = 27). Although a sedative and not a vasoactive agent, propofol can help to establish and maintain haemodynamic stability by preventing or managing mental and physical agitation. The use of multiple infusions in the majority of patients for the duration of the 2-hour period illustrates the importance of pharmacological therapies in this cohort to prevent and treat impaired cardiovascular function. The data also suggest that nurses need to understand how the different vasoactive agents act, how the drugs interact with each other, and how to titrate them in order to optimise cardiovascular performance.
Every patient in this study required vasoactive support to optimise cardiovascular performance. As indicated in Section 4.2.2.1, 92% of patients \((n = 35)\) were admitted with at least one vasoactive infusion in progress. The 8% of patients \((n = 3)\) who were admitted to critical care without a vasoactive infusion were commenced on noradrenaline at a mean time of 93 (SD = 46, min. = 40, max. = 120) minutes into the recovery period. One of those patients was simultaneously commenced on milronone in addition to noradrenaline. Nurses need to remain vigilant to the risks of impaired cardiovascular performance during the 2-hour recovery period by repeatedly assessing for, and responding to, salient haemodynamic data such as MAP, cardiac index, and SVR. To provide a greater understanding of the level of cardiovascular support required by patients during the immediate recovery period, a detailed discussion of the types of vasoactive infusions administered to patients is included in the next section.

The purpose of using inotrope infusions in the recovery period is to augment cardiovascular performance by improving myocardial contractility and perfusion. Noradrenaline was used to treat low SVR syndrome and profound hypotension. Adrenaline was used to treat low cardiac output syndrome, often in combination with a vasodilatory agent. Fifty percent of patients \((n = 19)\) required a potent inotropic infusion to support cardiovascular performance. In this study, 42% of patients \((n = 16)\) received noradrenaline, adrenaline, dopamine, or a combination thereof and 8% of patients \((n = 3)\) received milronone. Two patients were admitted with milronone infusing and one patient was started on milronone during the recovery period.

As illustrated in Figure 4.3, 21% of patients \((n = 8)\) who received noradrenaline, adrenaline, dopamine, or a combination thereof were admitted with the infusions in progress. Those 8 patients continued to receive the inotrope infusions throughout the recovery period. A further 18% of patients \((n = 7)\) required the commencement of an inotropic infusion. For those 7 patients, the mean time at which those infusions were started was 81 (SD = 45, min. = 30, max. = 120) minutes after admission.
Figure 4.3: Frequency of inotropic drug use during recovery period.

Vasodilator infusions were used extensively in this patient cohort. Eighty-nine percent of patients (n = 34) were treated with vasodilator infusions such as GTN or sodium nitroprusside. Glyceril trinitrate was commonly used to prevent coronary artery spasm in patients who had undergone CABGS. Sodium nitroprusside was commenced to reduce hypertension or to augment myocardial contractility in low cardiac output syndrome by reducing the peripheral vasoconstriction associated with the syndrome.

In addition to pharmacologic interventions to augment and sustain cardiovascular function, patients received colloid fluid infusions. Colloid fluid infusions were used in all patients to either establish or maintain an adequate preload, treat hypovolaemia induced hypotension, and replace blood losses in patients who bled substantially. The mean volume of colloid fluid administered was 744 (SD = 440) mls. The volume of colloid fluid infused varied from 100 to 1800 mls and this figure illustrates that some patients received minimal fluid replacement and other patients received substantial fluid replacement. The main colloid fluid used was synthetic plasma. Where indicated by clotting profiles and haemoglobin levels, blood products such as red cell concentrate, fresh frozen plasma, and platelets were also used.
In sum, 55% of patients were hypotensive at some stage during the recovery period despite adequate heart rates and rhythms. Of those with severe cardiovascular complications (35%), the causes were low cardiac output syndrome (16%), low SVR syndrome (16%), and profound hypotension (3%). The high acuity of patients and the incidence of cardiovascular complications in the 2-hour recovery period was associated with a high rate of multiple vasoactive infusion usage (100%). In addition to the inotrope and vasodilator infusions, colloid fluid infusions were used in all patients to treat hypovolaemia and optimise cardiovascular performance. Clearly, postoperative cardiac patients have a high acuity and develop clinically significant complications that demand rapid decision making by nurses. The data concerning cardiovascular function presented in this section suggest that nurses must remain vigilant and responsive to haemodynamic instability throughout the recovery period. In doing so, patient recoveries may be optimised through therapeutic interventions. In the next section, patients' haemodynamic states during the recovery period concerning the extent of bleeding complications will be presented.

4.2.3.2 Bleeding

Four haemodynamic parameters were recorded and analysed in order to describe the extent and manifestation of bleeding in patients over the 2-hour recovery period. These parameters were the amount of chest tube drainage, the incidence of both surgical bleeding and medical bleeding, the occurrence of hypertension (MAP greater than 95 mmHg), and the integrity of surgical wound dressings.

Surgical bleeding in the form of an acute haemorrhage was a serious complication for 8% of patients (n = 3). Patient 12, who had been in the critical care unit for nearly 2 hours, suddenly bled 300 mls over a 2 minute period and was immediately returned to the operating theatre. Patient 5 demonstrated signs of persistent, profound hypotension, a low preload despite colloid fluid boluses, and continuous bleeding to a total volume of 525 mls over the 2-hour recovery period. A routine postoperative chest x-ray taken after two episodes of profound hypotension, whereby the MAP had dropped to 45 mmHg and 29 mmHg, revealed a widened mediastinum. The x-ray was taken 110 minutes after admission. The patient was returned to theatre for bleeding about 30 minutes after the 2-hour recovery period elapsed. Patient 19 was the third case. During
the final 30 minutes of the observation period, the participant nurse suspected that patient 19 had a cardiac tamponade. Further investigations confirmed the participant's suspicions and the patient was returned to theatre nearly 2 hours later.

Prior to the detection of bleeding in the three aforementioned patients, each patient had experienced episodes of hypotension and other forms of instability. For instance, patient 5 had a MAP that ranged between 45 and 69 mmHg, and patients 12 and 19 had experienced mean arterial pressures of 68 mmHg. Additionally, patients 5 and 12 had a low SVR and patient 19 had low cardiac output syndrome. All patients were treated with vasoactive infusions. Patients 5 and 19 required frequent manipulations of their inotrope and vasodilator infusions in an attempt to maintain haemodynamic stability. Nurse 19 manipulated the vasodilator infusion 27 times during the last 90 minutes of the 2-hour period to keep the MAP greater than 70 mmHg. The mean volume of colloid fluids received by the 3 patients who bled was 1367 \( \text{SD} = 115 \) mls, a volume that represents nearly twice the average \( (X = 744, \text{SD} = 440 \text{ mls}) \) received by all patients in the study. In the act of suddenly bleeding, patient 12 became hypotensive (MAP = 59 mmHg) and suffered acute myocardial ischaemia as signified by marked elevation of ST segments on the ECG. These data indicate that the haemodynamic instability resulting from surgical bleeding has the potential to be life-threatening. Furthermore, rapid responses and intensive management with fluid and vasoactive therapies are required by nurses to optimise patients' recoveries in such situations.

Patients who were classified with surgical bleeding lost significant volumes of blood. As indicated in Table 4.4, the mean blood loss for patients with an acute haemorrhage was 632 (\( \text{SD} = 125 \)) mls.

<table>
<thead>
<tr>
<th>Table 4.4</th>
<th>Mean Volume of Drainage and Incidence of Haemorrhage (mls)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incidence of Haemorrhage</td>
<td>( X )</td>
</tr>
<tr>
<td>Surgical (( n = 3 ))</td>
<td>632</td>
</tr>
<tr>
<td>Medical (( n = 5 ))</td>
<td>498</td>
</tr>
<tr>
<td>No haemorrhage (( n = 27 ))</td>
<td>151</td>
</tr>
</tbody>
</table>
Five patients lost more than 100 mls/hr of blood from the chest drains during the recovery period as a consequence of a coagulopathy and therefore met the criteria of medical bleeding. As illustrated by Table 4.4, patients with medical bleeding lost less blood ($\bar{X} = 498, SD = 112$) than those with an acute surgical haemorrhage. The mean volume of blood lost by patients who did not meet the criteria for either a medical or surgical bleed was only 151 ($SD = 85$) mls for the 2-hour period. At the end of the 2-hour recovery period, the mean volume of chest drainage for patients ($n = 35$), irrespective of bleeding status, was 242 ($SD = 193$) mls.

Of the 21% of patients who bled greater than 100 mls/hr in the 2-hour recovery period, none had hypertension (MAP greater than 95 mmHg). Therefore, it is unlikely that hypertension contributed to the incidence of bleeding in those patients. However, as noted earlier, all patients who bled suffered hypotension. It is postulated that patients with surgical bleeds (8%) may have been recipients of less than perfect operations in terms of surgical technique. The only significant data related to wounds during the recovery period was a small amount of ooze on the arm bandage of patient 8, and the bandage was reinforced by the nurse.

Patients admitted with an aminocaproic acid (43%) or an aprotinin infusion (10%) continued to receive the infusions to promote clotting during the recovery period. Twenty-six percent of patients ($n = 10$) received one dose of protamine sulphate (50 mg) to promote haemostasis. Blood products such as platelets were administered to 24% of patients ($n = 9$) in order to promote haemostasis. All of the patients ($n = 3$) who had a surgical bleed were given protamine sulphate, but none of the patients with a medical bleed ($n = 5$) were given protamine sulphate. The coagulopathies of the latter patients were treated with either aminocaproic acid or aprotinin infusions and blood products.

In sum, 21% of patients experienced bleeding complications that necessitated therapeutic interventions during the 2-hour recovery period. The incidence of surgical bleeding was 8% and the incidence of medical bleeding was 13%. These data illustrate that bleeding is a prevalent problem in the recovery period and that nurses need to be prepared with the knowledge and skills of detection and treatment. The data also suggest that the ways in which postoperative bleeding presents is not always obvious because the accompanying cardiovascular instability can confound detection. However, in light of
the haemodynamic instability associated with bleeding, nurses need to be prepared to take actions in both urgent and non-urgent situations to effect haemostasis. In the next section the status of patients in terms of hypothermia will be presented.

4.2.3.3 Hypothermia

Haemodynamic parameters recorded in order to describe the incidence, manifestations, and treatment of hypothermia during the 2-hour period were core temperature, the occurrence of shivering, and the frequency with which patients were rewarmed.

Patients presented to the critical care unit with varying degrees of hypothermia. The core temperatures of patients were recorded as soon as the cardiac output temperature cables were connected to the monitor. The mean time taken for nurses (N = 38) to record the first temperature was 14 SD = 6) minutes into the 2-hour recovery period. As illustrated in Table 4.5, the majority of patients presented with hypothermia and remained mildly hypothermic during the first hour of the recovery period. These data suggest nurses need to be prepared to institute rewarming measures in order to reestablish normothermia.

<table>
<thead>
<tr>
<th>Time</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 minutes (n = 33)</td>
<td>35.6</td>
<td>.88</td>
</tr>
<tr>
<td>30 minutes (n = 30)</td>
<td>35.7</td>
<td>.92</td>
</tr>
<tr>
<td>60 minutes (n = 29)</td>
<td>36.0</td>
<td>.70</td>
</tr>
<tr>
<td>90 minutes (n = 29)</td>
<td>36.1</td>
<td>.75</td>
</tr>
<tr>
<td>120 minutes (n = 26)</td>
<td>36.5</td>
<td>.74</td>
</tr>
</tbody>
</table>
Seventy-nine percent of patients (n = 30) received active rewarming with a forced-air warming blanket during the recovery period. Core temperature reached 37 °C in 21% of patients (n = 8). Despite the discontinuation of forced-air warming blankets, hyperthermic overshoot occurred in 2 patients when core temperature reached 38.3 °C and 38.4 °C in patients 21 and 24 respectively. Hyperthermic overshoot can lead to vasodilation, which, in turn, may cause hypotension and haemodynamic instability. These data suggest nurses must carefully and continuously monitor patients' temperatures when rewarming measures are in place in order to avoid hyperthermic overshoot. However, neither patient 21 nor 24 became hypotensive nor haemodynamically unstable as a result of their elevated core temperatures.

Twenty-four percent of patients (n = 9) shivered in the recovery period. The mean duration of shivering was 45 (SD = 30) minutes. The extent and duration of shivering in this cohort suggests that nurses may not have optimally treated shivering in the recovery period. It is also noteworthy that all of the patients who shivered also had complications related to cardiovascular function and bleeding. Of the 9 patients who shivered, 6 had hypotension, 2 had hypertension, and 1 had hypoxaemia. Two patients who shivered also had a medical bleed and 1 had a surgical bleed. Although it cannot be concluded that shivering was a cause of bleeding, it is possible that deviations in blood pressure and the deterioration in oxygenation were associated with shivering. These data suggest that the haemodynamic status of patients in the recovery period was extraordinarily complex because patients experienced complications in relation to cardiovascular function, bleeding, and hypothermia.

In sum, the mean core temperature of 36.5 (SD = 0.74) °C at the end of the 2-hour recovery period, despite 79% of patients receiving adequate active rewarming measures, indicates that normothermia may not be achievable in all patients within the 2-hour period. Therefore, nurses must anticipate and respond to side effects associated with residual hypothermia. Shivering was a clinically significant problem in terms of occurrence (23%) and duration (X = 45, SD = 30 minutes). The data suggest that the techniques of managing shivering in this cohort may have been inadequate. Alternatively, the data concerning shivering may suggest that we currently have a poor understanding of shivering in terms of its antecedents and management.
4.2.3.4 Haemodynamic Critical Incidents during 2-hour Recovery Period

At times during the recovery period, patients experienced haemodynamic instability that was considered critical. A haemodynamic critical incident was defined as an episode of profound haemodynamic deterioration that required urgent interventions to avert further deterioration and possible death. The specific criteria included a sudden profuse haemorrhage of greater than 200 mls in the chest drains, a MAP less than 50 mmHg or systolic arterial pressure less than 80 mmHg, a lethal cardiac dysrhythmia, or an SpO₂ less than 90%. Twenty-nine percent of patients (n = 11) had at least one haemodynamic critical incident during the 2-hour recovery period. The median number of critical incidents was 1 (Q25, Q75 = 1, 2). A total of 21 critical incidents were observed and they related to profound hypotension (81%), a sudden profuse haemorrhage (5%), and an SpO₂ less than 90% (14%). No patients had a lethal cardiac dysrhythmia.

The time at which critical incidents took place after patients were admitted to critical care varied widely. The median time was 11 (Q25, Q75 = 7, 105) minutes. Seven patients displayed a haemodynamic critical incident in the first 15 minutes of the 2-hour recovery period and 3 patients deteriorated in the last half hour of the 2-hour recovery period. Patient 28, who had undergone mitral and aortic valve replacements, suffered eight critical incidents, the first of which occurred 11 minutes after admission. The cause of the incidents in patient 28, all of which presented as profound hypotension, were not determined, but cardiac tamponade or a problem with the newly replaced mitral valve was suspected. Patient 28 was returned to theatre for surgical reexploration 90 minutes into the 2-hour recovery period where it was discovered that the newly replaced mitral valve needed replacement.

4.3 Discussion

The purpose of this chapter was to present the complexity of postoperative patients in order to set the scene for, and describe the context of, haemodynamic decision making by critical care nurses. Three important findings were presented in this chapter that have clinical significance for nurses in regards to decision making. First,
haemodynamic data related to cardiovascular function, bleeding, and hypothermia clearly indicate that most patients in this study were haemodynamically unstable during the 2-hour recovery period. Significantly, 95% of patients (n = 36) experienced some form of haemodynamic instability during the recovery period. Additionally, all patients (n = 14, 37%) who received valve replacement surgery experienced haemodynamic instability. These data indicate that nurses must be adequately prepared both physically and mentally for the patient so that they can respond appropriately. That is, nurses must have equipment ready for assessment and interventional decision making as well as be mentally alert to the forms of haemodynamic instability that may be encountered. Given that 60% of patients arrived in a haemodynamically unstable state, nurses' state of readiness must be established prior to the admission of patients. The data also suggest that nurses must be goal orientated in their decision making. That is, nurses need to be making decisions based on the optimisation of cardiovascular performance, the promotion of haemostasis, and the reestablishment of normothermia in order to optimise patient recoveries.

Five percent of patients (n = 2) had a postoperative recovery devoid of any haemodynamic instability. Patients 2 and 25 did not bleed, shiver, or experience cardiovascular problems such as hypotension or myocardial dysfunction. Both patients were treated with GTN and propofol infusions that had been commenced in theatre. No other drug infusions were required.

As only 5% of patients (n = 2) experienced an uneventful 2-hour recovery period, attention is drawn to the sampling procedures used in this study. As indicated earlier, patients were not randomly selected. Patients were included in the study if their nurse was a participant. Patients 2 and 25 were recovered by an inexperienced nurse and an experienced nurse respectively. The incidence of bleeding complications (21%) were higher in this study than the average of 2% to 12% reported by Hall et al. (2001). Similarly, the incidence of low SVR syndrome was higher in this study (16%) compared to the incidence of 5% to 8% reported by Myles et al. (1997). In this study, only 16% of patients suffered low cardiac output syndrome whereas Kumon et al. (1986) reported an incidence of 22.3% in their institution. Only 24% of patients shivered in this study, whereas Spaniol et al. (1994) found 50% of patients shivered in the first 4-hour
postoperative period. The requirements for temporary pacing was higher in this group of patients (74%) than the level (47%) reported by Vitello-Cicciu and colleagues (1987). It is possible that the number of patients who experienced postoperative complications reflects the settings of this study rather than a systematic sampling bias. That is, the study was conducted in tertiary teaching hospitals which tend to attract patients with comorbidities and other factors that may be associated with complicated postoperative courses.

Second, the most common pattern to emerge from the data is that haemodynamic instability and complications associated with bleeding and hypothermia impacted upon cardiovascular performance. Therefore, nurses need to consider parameters salient to cardiovascular performance in light of patients' overall haemodynamic status when making haemodynamic decisions. In other words, parameters such as MAP, cardiac index, and SVR may provide crucial information about signs of bleeding and hypothermia as well as cardiovascular function. In order to optimise patient recoveries, nurses must repeatedly assess salient data relevant to the three goals of therapy and reflect upon the findings in a lateral and inclusive manner.

The third finding that has clinical significance for nurses is that episodes of haemodynamic instability presented in different forms and on multiple occasions in one patient. There were no clear patterns in patient presentation; but, rather, diverse permutations and combinations in the ways that haemodynamic instability presented. For instance, patient 12 shivered, was hypotensive, had a low SVR, and required urgent surgical reexploration for a sudden surgical bleed. Patient 8 had low SVR syndrome, hypotension, and a cardiac index between 2.2 L·min⁻¹·m⁻² and 2.5 L·min⁻¹·m⁻². Patient 32 had an extremely labile blood pressure requiring numerous manipulations of vasodilator therapy and despite rewarming attempts remained hypothermic throughout the recovery period (core temperature 34.6 °C on admission, 34.5 °C at 60 minutes, 34.8 °C at 120 minutes), but did not shiver.

Given that haemodynamic instability can present in such diverse ways, nurses need to anticipate, and remain vigilant to, numerous forms and causes of haemodynamic instability. To do so, nurses need to be aware of the clinical sequelae of cardiopulmonary bypass and surgery because most postoperative complications and
haemodynamic instability can be traced to those events. Combinations of subtle cues need to be closely monitored and analysed because not all postoperative complications present in overt ways. Information regarding haemodynamic problems that occurred in theatre are passed on by anaesthetists during handover and can be used to alert nurses to precarious areas of patients’ haemodynamic status. However, care must be taken not to exclude the many other potential complications than can emerge during this time. In addition to treating symptoms as they occur, nurses need to continually reflect upon emerging patterns in haemodynamic data that provide indications of underlying problems. For instance, causes of hypotension need to be explored in addition to manipulating therapies that reestablish normotension. Only by continuous appraisal, evaluation, and responsiveness to haemodynamic data can nurses optimise patient recoveries.

4.4 Conclusions

The data reported in this chapter illustrate the high acuity and unpredictable nature of cardiac surgical patients in the 2-hour recovery period. There are important implications for nurses recovering such patients. For instance, nurses need to be prepared to respond to haemodynamic instability as soon as patients are admitted. Nurses need to remain vigilant to the potential complications of cardiopulmonary bypass by repeatedly assessing and managing salient haemodynamic data in relation to cardiovascular function, bleeding, and hypothermia. Once adverse data are detected, rapid, accurate, and appropriate responses are required in order to optimise patient recoveries. In the following chapter, findings concerning nurses' decision making in response to patients' haemodynamic states will be presented.
CHAPTER 5

NURSES' HAEMODYNAMIC DECISION MAKING

The purpose of this chapter is to present the findings regarding how nurses used cues and met the physiological needs of cardiac surgical patients. The analysis of nurses' decision making regarding preparations in anticipation of haemodynamic decision making, continuous appraisal and evaluation of haemodynamic parameters, and responsiveness to those parameters are presented using three haemodynamic goals of therapy. The framework for exploring the sources of decision making variability included the complexity of haemodynamic tasks, nurses' experience, and environmental characteristics.

For cardiac surgical patients, the initial 2-hour recovery period is distinguished by potentially life-threatening haemodynamic instability. As discussed in Chapter Four, haemodynamic instability may present suddenly or gradually, in diverse permutations and combinations, and on multiple occasions. Although certain forms of haemodynamic instability and complications may be anticipated as a consequence of cardiac surgery on cardiopulmonary bypass, postoperative haemodynamic decision making remains complex. The complexity of haemodynamic decision making arises from issues of high patient acuity, haemodynamic technologies, and numerous haemodynamic data sources. To ensure optimum patient outcomes, nurses of varying experience must rapidly and accurately respond to episodes of haemodynamic instability. Previous studies have shown, however, that nurses are more hesitant (Lewis, 1997) and less consistent in their decision making (Hughes & Young, 1990) during complex rather than simple decision tasks.

Extensive research on the role of experience in decision making has shown that experience can moderate decision complexity and therefore enhance decision outcomes (Boshuizen & Schmidt, 1995; Chi et al., 1988; Devine & Kozlowski, 1995; Ellis, 1997; Shanteau, 1992). Experience has been shown to enhance nurses’ abilities to make rapid decisions (Baumann & Bourbonnais, 1982), to make goal-directed decisions (Ellis, 1997), to distinguish salient cues from non-salient cues, and to recognise and act on
patterns of information (Benner et al., 1992). By contrast, inexperienced nurses depend on nursing theory and principles of practice learnt through education to guide decision making (Benner et al., 1992), require assistance in prioritising complex decisions (Benner, 1984), and use rule based processes in complex decision tasks (Ellis, 1997). Even when making decisions that are not complex, inexperienced nurses have been shown to rely on rules, such as protocols, standards of care, and medical orders to guide clinical decision making (Benner, 1984; Benner et al., 1992).

There are few guidelines available for nurses regarding haemodynamic decision making, apart from those related to measuring pressure-based parameters. In situations where there are no decision making guidelines, the difficulty for inexperienced nurses to detect nuances or distinguish changes in cues is likely to lead to requests for decision making assistance from experienced colleagues (Benner et al., 1992). In the initial recovery period, colleagues assisted primary nurses to receive postoperative patients by providing technical support (Chase, 1995). However, nurses also make autonomous decisions as a result of the geographical layout of critical care units and lack of accessible experienced nursing colleagues (Bucknell, 1996). Currently there is little understanding of the outcomes of inexperienced nurses' complex haemodynamic decision making in the presence or absence of decision support.

Decision complexity, nurses' experience, and environmental characteristics have each been found to influence nurses' decision making in some form. However, the effect of interplay between those three influences on decision outcomes has not been investigated previously. The aim of this chapter is to report the findings in relation to the following research aim: Identify and describe the extent of variability in nurses' haemodynamic decision making during the initial 2-hour period following cardiac surgery as a function of the complexity of haemodynamic decisions, nurses' cardiac surgical intensive care experience, and environmental characteristics in relation to the following goals of therapy:

(a) optimisation of cardiovascular performance
(b) promotion of haemostasis
(c) reestablishment of normothermia.
The methodological approach, methods used to collect data about nurses' haemodynamic decision making, and methods used to recruit nurses were described in detail in Chapter Three. Specific issues regarding data collection and analysis provide a background for evaluating the strengths and limitations of the study's findings and are discussed briefly.

Data were collected through non-participant observation of nurses' clinical practice, follow-up interview of nurses, and analysis of patients' observation flow charts. Gaps in the data regarding nurses' haemodynamic decision making are due to the observation method used in Phase One of the study. Phase One was an exploration of observation as method. Observations were unstructured, which, although consistent with an exploratory design, resulted in selective attention by the observer to nurses' most common decision activities. Since selective attention posed a risk to the rigour of observation and an observation tool can reduce a selective attention bias (Polgar & Thomas, 2000), a 2-page observation checklist was developed. The observation tool provided systematic and comprehensive data collection in Phase Two.

Data from the observations, interviews, and patients' observation flow charts were analysed in four stages as outlined in Figure 3.2 in Chapter Three. Based on the organising framework for analysis developed specifically for this study, decision episodes pertaining to the three haemodynamic goals of therapy were identified. Stage three involved a frequency analysis of decision episodes and analysis of nurses' techniques of management in relation to best practice guidelines. Data were analysed in stages two and three using content analysis. This has been recommended for analysis of decision making (Carroll & Johnson, 1990) and it was considered appropriate for describing decision making variability. Previously, content analysis has been used to analyse observation data (Patel et al., 2000; Xiao, 1994) and interview data (Crandall & Getchell-Reiter, 1993) in studies based on naturalistic decision making. In stage four, a different lens was used to analyse the data and the purpose was to identify themes that transcended across decision episodes. In particular, the role of experience was contrasted across decision episodes and the roles of specific environmental characteristics were explored. Framework, an analytic process, (Ritchie & Spencer, 1994) was used to achieve this aim.
The chapter is divided into two major sections in order to present the variability and commonality of nurses’ haemodynamic decision making for each haemodynamic goal of therapy as a function of interplay between the multifactorial influences on decision making. The first section is a discussion of nurses’ anticipation of haemodynamic decision making, in which nurses’ decision making was centred on preparing the physical and mental workplace. The second section contains the analyses of nurses' decision making regarding the continuous appraisal and evaluation of salient cues and responsiveness to those cues within each goal of therapy.

5.1 Anticipation of Haemodynamic Decision Making

In anticipation of haemodynamic decision making, nurses prepared the physical and mental workspace prior to receiving patients from the operating theatre. Preparing the physical workspace and preparing the mental workspace have been previously described in anaesthetists by Xiao (1994). To prepare the physical workspace, nurses arranged patients’ cubicles and equipment in order to facilitate interactions with patients and equipment. Nurses' preparation of the physical workspace could be readily determined at the beginning of observations when the patient arrived. The information that nurses had available immediately prior to patient arrival constituted preparations for the mental workspace. Observation did not capture all decision making related to preparing the mental workspace, but interactions with the nurse before the observation period began and in follow-up interviews provided data in this regard.

5.1.1 Preparing the Physical Workspace

An important aspect of nurses' decision making concerning the reception and recovery of patients was preparation of the physical workspace. Preparations of the physical workspace provided information about whether or not nurses anticipated assessment and interventional decision making necessary to meet the haemodynamic goals of therapy in cardiac surgical patients. Most activities were related to obtaining and setting-up equipment. For instance, monitoring requirements, equipment for particular assessments, and items for interventional therapies were prepared in patients'
cubicles. Such preparations and the frequency of nurses' actions are shown in Table 5.1 and discussed in the following sections.

5.1.1.1 Optimisation of cardiovascular performance

To prepare for the optimisation of cardiovascular performance, certain equipment is gathered and assembled by nurses in relevant cubicles. As indicated in Table 5.1, all nurses placed consumable equipment in the cubicles, but none of the nurses placed an ECG machine in the cubicle. The latter action may have indicated inadequate preparation on nurses' behalf or it may have been a deliberate decision based on the intention to assess each patient's cardiac rhythm and haemodynamic status before taking an ECG. However, as the transcript excerpt from observation 13 notes, the inexperienced nurse who was in an isolated cubicle had some difficulty accessing an ECG machine during the 2-hour recovery period.

Cardiac monitors are central to assessing cardiovascular performance. In order to set up the style of monitors used, a set or rack of modules had to be inserted into a mounting bracket. None of the nurses did so prior to the admission of patients and, as a consequence, the monitor was set up while receiving the patient. Failure to prepare the monitor was not related to experience; but, rather, appeared to be related to common practice in each setting. No advantages were observed for preparing the monitor prior to the admission of patients. On the contrary, two distinct disadvantages were observed. First, nurses were focused on setting-up the monitor during the early admission period when, as noted in the previous chapter, patients were haemodynamically unstable. Second, problems with the monitor were not detected until the patient was admitted and this had the potential to delay nurses' decision making and impact negatively on patients.

In 16% of cases (n = 6), significant problems occurred with monitoring technologies. Those problems included the arterial pressure and pulmonary artery pressure trace not displaying (Observation 2); the entire monitor not working, which necessitated a cubicle change 33 minutes into the recovery period (Observation 5); incorrect configuration of the monitors (Observations 24, 31); the pulmonary artery pressures periodically disappearing off the screen (Observation 27); and the contrast and
### Table 5.1
Preparation of the Physical Workspace According to Goals of Therapy

<table>
<thead>
<tr>
<th>Decision making activity</th>
<th>Inexperienced (n = 18)</th>
<th>Experienced (n = 20)</th>
<th>Total</th>
<th>Excerpts from transcripts of observations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Optimisation of cardiovascular performance</strong></td>
<td></td>
<td></td>
<td></td>
<td>(Obs. 13) At one stage, the nurse wanted to duck out to get the ECG machine only 10 feet away, but he would lose visual contact with the patient's monitor and patient as the room he was in was walled in, so he asked on his way out if I was able to watch. I said no as I was there to research only. He said OK and asked the nurse opposite. He later admitted that if I wasn't there he would have probably ducked out quickly even if he couldn't find someone to watch the patient.</td>
</tr>
<tr>
<td>ECG machine in cubicle</td>
<td>0, 0</td>
<td>0, 0</td>
<td>0, 0</td>
<td></td>
</tr>
<tr>
<td>Set-up of cardiac monitor</td>
<td>0, 0</td>
<td>0, 0</td>
<td>0, 0</td>
<td></td>
</tr>
<tr>
<td>Charts, infusion fluids, cardiac output equipment</td>
<td>18, 100</td>
<td>20, 100</td>
<td>38,100</td>
<td></td>
</tr>
<tr>
<td><strong>Promotion of haemostasis</strong></td>
<td></td>
<td></td>
<td></td>
<td>(Obs. 33) There are a set of shelves on the left hand side, on the bottom shelf is a pillow, on the middle shelf is some sheets and some pillow cases and an adaptor for the syringe pump. On the upper shelf is some needles and syringes and on the very top shelf is the sharps bottle, colloid fluid, and some equipment for taking bloods.</td>
</tr>
<tr>
<td>Suction equipment for chest drain system</td>
<td>18, 100</td>
<td>20, 100</td>
<td>38, 100</td>
<td></td>
</tr>
<tr>
<td>Blood sampling equipment</td>
<td>18, 100</td>
<td>20, 100</td>
<td>38, 100</td>
<td></td>
</tr>
<tr>
<td><strong>Reestablishment of normothermia</strong></td>
<td></td>
<td></td>
<td></td>
<td>(Obs. 37) There is actually a warming device and blanket in the cubicle, it hasn't been applied to the patient. The patient's temperature is about 36 °C.</td>
</tr>
<tr>
<td>Rewarming device for forced-air blankets in cubicle</td>
<td>7, 38</td>
<td>6, 30</td>
<td>13, 34</td>
<td></td>
</tr>
</tbody>
</table>

*Note. Obs. = observation*
brightness set such that the screen remained blank after modules were inserted (Observation 31). An equal number of experienced and inexperienced nurses encountered problems with monitoring technologies. It was noted, however, that the inexperienced nurses called on experienced colleagues to troubleshoot the problems while they received handover. It took an average of 14 (SD = 12, min. 2, max. 37) minutes to rectify the problems in these cases. High acuity patients were not adequately monitored for a considerable period of time during a crucial stage in their recovery and unnecessary delays in assessing cardiovascular status occurred. Given the high acuity of patients in the immediate recovery phase, questions are raised about what processes can be put in place to ensure cardiac monitors are checked and set up prior to the admission of patients.

Once patients were admitted, nurses connected monitoring cables in order to display parameters derived from the PAC. However, following the establishment of such connections, it became apparent to the nurses that PACs were correctly positioned in only 60% of patients ($n = 22$). Therefore, in 40% of cases, nurses ($n = 15$) needed to reposition the PAC in preparation for assessments of PCWP and cardiac output (see Table 5.2).

<table>
<thead>
<tr>
<th></th>
<th>Nurses</th>
<th>Inexperienced ($n = 18$)</th>
<th>Experienced ($n = 20$)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catheter moved by</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary nurse</td>
<td></td>
<td>2, 14</td>
<td>4, 26</td>
<td>6, 40</td>
</tr>
<tr>
<td>Experienced nurse or/</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>and doctor</td>
<td></td>
<td>7, 50</td>
<td>2, 10</td>
<td>9, 60</td>
</tr>
</tbody>
</table>

Only 6 nurses, most of whom were experienced ($n = 4$), were prepared to reposition the PAC themselves. Nine nurses, most of whom were inexperienced ($n = 7$) deferred the decision to an experienced nurse, doctor, or both. Nurses encountered
technical difficulties when repositioning the PAC, delays in accessing experienced
colleagues to manipulate the PAC, and delays in viewing the chest x-ray to confirm the
catheter's position. These data suggest anaesthetists need to check carefully the
placement of PACs prior to leaving operating rooms so that measurements of the PCWP
and cardiac output are readily available after the admission of patients.

5.1.1.2 Promotion of haemostasis

In anticipation of promoting haemostasis, all nurses set up suction equipment in
the cubicle and laid out blood tubes, syringes, and taps required for haematological tests
(see Table 5.1). Blood sampling equipment was also used to determine serum electrolyte
levels and blood gases as part of decision making concerning the optimisation of
cardiovascular performance.

5.1.1.3 Reestablishment of normothermia

To prepare for the reestablishment of normothermia, 34% of nurses (n = 13)
placed a forced-air warming device and accompanying disposable blanket in the cubicle
(see Table 5.1). Preparation of a warming blanket and device was not associated with
experience; but, rather, hospital setting (Fischer's exact test, p = 0.01). Although 79% of
patients required rewarming with a forced-air warming blanket, most nurses were poorly
prepared for the reestablishment of normothermia. Nurses who decided to rewarm
patients, but had not prepared for rewarming either left the cubicle or asked colleagues
to obtain a device sometime during the recovery period.

One nurse mentioned that preparing the physical workspace was a safety issue.
As explained by participant 10:

My first priority was the safety of the patient. I believe in the preparation of the
bed area, in case there was an emergency situation. It is an unstable period for a
patient, the transfer from theatre and the initial admission, so I’m always aware
that there could be problems in that initial period.

In sum, nurses were fully prepared for the promotion of haemostasis, yet poorly
prepared to monitor cardiac function and rewarm patients. Common unit practices
appeared to account for variability in nurses' preparations of the physical workspace.
Given that preparation of the physical workspace plays an important role in being able to safely receive patients, the findings suggest nurses are not adequately prepared for the optimisation of cardiovascular performance and reestablishment of normothermia prior to the admission of patients.

5.1.2 Preparing the mental workspace

Activities involved in preparing the mental workspace for haemodynamic decision making centred on nurses' obtaining information about patients' haemodynamic status. The results of preparing the mental workspace can be likened to a mental state of readiness (Xiao, 1994) for receiving patients and enabling optimal decision making. As explained by Xiao, "The activities in preparing the mental workspace are not usually directly observable. The results of such activities are a mental state of readiness for responding, for making decisions and judgements, and for executing planned actions" (Xiao, 1994, p. 138). Preparations appeared to be derived from three sources. A fourth source occurred in two cases.

The first source of preparing the mental workspace was the operation list. The operation list detailed each patient's age, gender, and proposed surgical procedure. The second source of information was in the form of a telephone call from theatre nurses approximately 30 minutes prior to the admission of patients. Theatre nurses informed critical care staff of the surgical procedure performed, current vasoactive infusions, and the presence and location of pacing wires. On questioning nurses after the observation, these two sources had provided little information about patients in terms of their preoperative haemodynamic status, comorbidities, or intraoperative problems. In four observations (ID, 6, 11, 16, and 19), theatre nurses contacted critical care at the time when patients were due for admission to advise that the patients were bleeding and had been returned to cardiopulmonary bypass; no other information was provided. Hence, 4 nurses anticipated that their patients may continue to bleed in the early recovery period or require specific haemostatic measures.

It was observed that nurses had to rely heavily on the third source of information whereby data about patients' preoperative and intraoperative haemodynamic status were handed over by anaesthetists during the admission of patients to critical care. Participant 24 explained:
From the handover we got from the anaesthetist, it looked like she was quite sick. She was on noradrenaline, milronone in theatre, she had really low blood pressure. She was bleeding. A few complications.

As pointed out by participant 24, being aware of specific concerns regarding haemodynamic status such as poor left ventricular function or intraoperative bleeding enabled her to anticipate specific problems. Thus, information from handover helped to frame nurses' state of readiness and decision making priorities. Further discussion about the role of handover in framing nurses' decision making and decision priorities occurs in Chapter Seven.

In two cases, a fourth source of information was observed early in the recovery period when surgeons visited patients. Surgeons alerted nurses to particular concerns that had not been handed over by the anaesthetists. The information was potentially critical in preparing nurses' mental workspace because, in both cases, nurses were alerted to important clinical problems. Twenty-one minutes after admission, the surgeon visited patient 13 and informed the nurse of the patient's poor left ventricular function and advised the nurse to monitor it closely. During observation 7, the surgical registrar visited the patient 22 minutes after admission, but was not forthcoming with information until participant 7, an experienced nurse, repeatedly questioned his reasons for looking at the chest drains under the sheets. Participant 7 explained:

His bleeding hadn’t been too bad but, my detective cap went on when one of the registrars came back and had a sticky nose under my blanket, and I said what are you doing. He said I’m just looking at the drains. Why, is there a particular reason that you want to be looking at the drains. He’s going oh no. I go, no tell me. He said oh he’s a bit oozy. So I was a bit aware at the back of my mind that the risk of bleeding had been on his mind that it was a potential problem…I jump on things like that. Like you think right, what haven't you told me that’s happening.

In sum, the anaesthetists' handovers appeared to be an important source of information for nurses' preparation of the mental workspace because handovers
contained clinically significant information about patients such as their history and intraoperative problems.

5.1.3 Summary

In anticipation of meeting goals of therapy, nurses prepared equipment in patients' cubicles and used information primarily derived from anaesthetists' handovers to prepare mentally for recovering cardiac surgical patients. Nurses showed poor preparation for optimising cardiovascular performance because cardiac monitors were not set up and ECG machines were not placed in cubicles prior the admission of patients. All nurses prepared equipment for the promotion of haemostasis, but only 34% of nurses were prepared for the reestablishment of normothermia by placing a forced-air warming device in each cubicle. None of the nurses were fully aware of patients' haemodynamic status until the handover from anaesthetists during patient admissions. The combination of these findings suggest that some nurses are not fully prepared to receive patients because of current system processes and, seemingly, a lack of anticipation regarding the haemodynamic decision making that will be required for this cohort of patients in the recovery period.

5.2 Continuous Appraisal, Evaluation, and Responsiveness

The majority of nurses' decision making during the recovery period involved continuous appraisal and evaluation of haemodynamic parameters and responsiveness to those parameters. These processes represent nurses' techniques of managing haemodynamic cues for each goal of therapy and, therefore, are useful to describe commonality and variability in nurses' haemodynamic decision making during the recovery period. The findings are divided into three major sections, each representing nurses' haemodynamic decision making related to the three goals of therapy.

5.2.1 Optimisation of Cardiovascular Performance

Nurses' decision making regarding the goal of optimising cardiovascular performance centred around nurses' continuous appraisal and evaluation of, and responsiveness to, the salient haemodynamic parameters of heart rate and rhythm,
perfusion pressure, preload, contractility, afterload, and SpO₂ monitoring. Findings regarding nurses' decision making for these parameters are presented separately.

5.2.1.1 Heart rate and rhythm

Lowest sources of decision variability surrounding heart rate and rhythm related to decisions concerning serum electrolytes, arterial blood gas status, and continuous monitoring of cardiac rate and rhythm. Major sources of variability related to pacing and perfusion pressure. Nurses' decision making about heart rate and rhythm is illustrated in Table 5.3.

Continuous cardiac monitoring and alarm setting

All nurses continuously monitored heart rate and rhythm. Alarms for heart rate (and blood pressure) were set by 90% of nurses. In two observations, the monitor alarms were on, but the settings related to previous patients because neither nurse set the alarm limits for their patient. Participant 8 realised her omission and set the alarms 115 minutes into the recovery period, but participant 10 did not realise his omission during the 2-hour recovery period. Both nurses said that they usually set alarms when patients were received. Participant 10 explained:

I do normally set the alarms up to reasonably tight parameters. I don’t think I did it when the patient came back and I don’t think I’ve looked at them yet.

This issue raises the question about what mechanisms can be put in place to ensure that nurses review alarm limits when they set up monitors.
Table 5.3
Nurses’ Decision Making for Heart Rate and Rhythm

<table>
<thead>
<tr>
<th>Assessment / intervention</th>
<th>Inexperienced (n = 18)</th>
<th>Experienced (n = 20)</th>
<th>Total (n = 38)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous monitoring</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alarm limits on</td>
<td>18, 100</td>
<td>20, 100</td>
<td>38, 100</td>
</tr>
<tr>
<td>Alarm limits set</td>
<td>18, 100</td>
<td>18, 90</td>
<td>36, 95</td>
</tr>
<tr>
<td>Arterial blood gases</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assessed and analysed</td>
<td>18, 100</td>
<td>20, 100</td>
<td>38, 100</td>
</tr>
<tr>
<td>SpO₂ monitoring</td>
<td>18, 100</td>
<td>20, 100</td>
<td>38, 100</td>
</tr>
<tr>
<td>Serum electrolytes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assessed</td>
<td>18, 100</td>
<td>20, 100</td>
<td>38, 100</td>
</tr>
<tr>
<td>Analysed</td>
<td>18, 100</td>
<td>20, 100</td>
<td>38, 100</td>
</tr>
<tr>
<td>12-lead ECG (*n = 28)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recorded</td>
<td>11, 85</td>
<td>15, 100</td>
<td>26, 93</td>
</tr>
<tr>
<td>Analysed</td>
<td>10, 77</td>
<td>15, 100</td>
<td>25, 89</td>
</tr>
<tr>
<td>Pacemaker assessments (*n = 33)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial safety</td>
<td>17, 100</td>
<td>15, 94</td>
<td>32, 97</td>
</tr>
<tr>
<td>Complete</td>
<td>9*, 53</td>
<td>7, 46</td>
<td>16, 48</td>
</tr>
</tbody>
</table>

Excerpts from transcripts of observations and interviews
(Obs.8, 115 minute mark) Primary nurse has just altered one of the ECG alarms.
(Obs.10, 45 minute mark) Primary nurse is continuously looking at the monitor, he’s consistently looking up and watching it all the time. However he still hasn’t set the alarms.
(Obs.19) Nurse is listening to the patient’s chest, the SpO₂ is still reading 93, 94 and she tried to troubleshoot it by putting the device on another finger to get a better trace, in fact the trace is good and it’s clearly 93.
(Obs.26) A colleague has just silenced the alarms and has moved in and said that she’ll take the bloods for her.
(Obs.32) The nurse has been asked if she wants to take the ECG and she replied that she wants to wait until the patient warms up more because she is atrioventricular paced.
(Int. 2) The pacing boxes here I’m still getting used to. I just wanted to check my (pacemaker) thresholds and outputs. Yeah I explained to the experienced nurse what I was going to do first, and that was like check the heart rate, the underlying rhythm, and she said yes and we only go as far as 60 and if its still pacing at 60 we abandon the procedure, which we did.

Note. Obs. = observation. Int. = interview.
* = excludes some patients who were atrioventricular paced. b = number of patients with temporary pacemakers. c = These participants performed complete assessments under direction or supervision of experienced nurses.
Serum electrolyte analyses

All nurses assessed, analysed, and responded to patients' serum electrolytes (see Table 5.3). Nurses were particularly responsive to serum potassium levels. Nurses said that they administered intravenous potassium chloride according to protocols or medical orders that required serum potassium levels to be maintained between 4.5 mmol/L and 5.0 mmol/L. Fifty-five percent of nurses (n = 12) gave 1 g of intravenous potassium chloride and 13% (n = 21) gave 2 g of potassium chloride to treat hypokalaemia (see Figure 5.1). Thirty-two percent of patients received no supplemental intravenous potassium chloride. Nurse’ decision making regarding arterial blood gases analysis is presented in Section 5.2.1.6.

![Graph showing frequency of Grams of Potassium Chloride]

**Figure 5.1.** Intravenous potassium chloride administration during 2-hour recovery period.

12-lead Electrocardiograph

Two inexperienced nurses (ID, 21 and 22) did not take an ECG when their patients were in atrial pacing or sinus rhythm (see Table 5.3). According to protocols, ECGs were not required when patients were atrioventricular paced because such pacing precludes assessment of ischaemia.
Pacing

As 87% of patients (n = 33) had temporary epicardial pacing wires, the majority of nurses (87%) needed to make assessments of, and decisions about, pacing. Two types of pacing assessments were observed. Ninety-seven percent of nurses performed an initial assessment of the pacemakers' settings and safety features while receiving patients (see Table 5.3). The initial assessment had the potential to detect faulty pacing and protect patients from cardiac dysrhythmias and haemodynamic instability. For example, two participants (ID, 20 inexperienced and 37 experienced), found pacing wires hanging loose in bedsheets rather than being connected to pacemakers. Neither of the patients' heart rates and rhythms was adequate as a consequence of the disconnected wires. In observation 20, the atrial wires were connected, but the ventricular wires were disconnected. The resultant atrial pacing was inappropriate because the patient's underlying rhythm was a 3rd degree atrioventricular block and the MAP was 62 mmHg which indicated compromised cardiovascular performance. When participant 20 reconnected the ventricular wires and reestablished atrioventricular pacing under supervision from an experienced nurse, the MAP rose from 62 mmHg to 84 mmHg and cardiovascular stability was reestablished.

The second assessment observed was a complete pacemaker assessment. As indicated by Table 5.3, 48% of nurses performed a complete pacemaker assessment. The frequency of complete pacemaker assessments by primary nurses varied according to experience and task complexity in terms of the patient's cardiac rhythm (see Table 5.4).

Fewer nurses performed a complete pacemaker assessment when patients had atrioventricular pacing (18%) than when patients had atrial pacing (27%) (see Table 5.4). On questioning, nurses said that they did not carry out complete pacemaker assessments primarily because their patients were atrioventricular paced. In addition, nurses cited prolonged periods of cardiopulmonary bypass, haemodynamic instability, and hypothermia as reasons for not conducting a complete pacemaker assessment. Those factors all contribute to the uncertainty and risk of the task, which, in turn, contributes to task complexity. Despite the complexity of the task and provided certain processes are followed carefully, pacemakers can be checked safely while set on atrioventricular pacing (Hickey & Baas, 1991).
Table 5.4  
Frequency of Complete Assessments of Temporary Pacemakers by Primary Nurses According to Patients' Cardiac Rhythm (n = 33)  

<table>
<thead>
<tr>
<th>Patients' cardiac rhythm</th>
<th>Experienced nurse</th>
<th>Inexperienced nurse</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assessed</td>
<td>Not assessed</td>
</tr>
<tr>
<td>Sinus</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Atrial pacing</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Atrioventricular pacing</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>7</td>
<td>9</td>
</tr>
</tbody>
</table>

Nurses' level of experience and knowledge also varied decision making regarding complete pacemaker assessments. Although variability in performing complete pacemaker assessments does not appear to be sourced to nurses' experience from the information in Table 5.4, all of the inexperienced nurses who performed a complete pacemaker assessment (n = 9) were observed by an experienced nurse. Those 9 inexperienced nurses were overheard asking an experienced colleague to either instruct them through every step of the procedure or be present during the procedure for supervision and support. Nurses later confirmed in the interview that they had sought decision support to assess pacemakers in this way (see Table 5.3, Interview 2).

The decision support provided by experienced nurses facilitated the conduct of complete pacemaker assessments in situations where they would have otherwise not been carried out. Indeed, of the 8 inexperienced participants who did not assess the pacemaker, 6 participants had inexperienced colleagues helping them to recover the patient. These nurses did not seek decision support from their inexperienced peers to perform a complete pacemaker assessment. Two other inexperienced participants were assisted by experienced nurses, but the patients were atrioventricular paced.

During pacemaker assessments, it was apparent that patients were dependent on pacemakers for cardiovascular stability. As shown in Table 5.5, of the 16 pacemaker checks conducted, 14 participants found their patients had either no underlying rhythm
(44%), sinus bradycardia with associated hypotension (12%), or sinus rhythm with associated hypotension (32%). Two participants found their patients had an underlying sinus rhythm with normotension and subsequently set the pacemaker in a mode to allow the patients' own rhythm to dominate. During observation 4, the following was noted by the researcher:

Nurse has the pacemaker in her hand and she has lowered the rate and that alarm is asystole and also no blood pressure. The patient went into complete asystole and had no pulse.

It is clinically significant that only 2 of 16 patients were haemodynamically stable during complete pacemaker assessments. These data confirm the dangers involved for the patient during the procedure and the need for nurses to be knowledgeable of, and experienced with, the procedure. The number of instances where inexperienced nurses asked for assistance suggests that they were aware of the potential dangers to the patient during a complete pacemaker assessment and they were not confident to perform it alone. Participant 34, an inexperienced nurse, felt daunted by the pacemaker. She asked an experienced assistant nurse to assess the pacemaker with her in order to ensure the patient was safe. She explained:

Every intervention I have with pacing just highlights how much learning I have to do. So for me, part of me was thinking well I'll just ignore it because it was not doing anything. The other part of it was...I have to address the things that are making me feel not confident about this, so I was getting the ACN to go through it...making sure that the patient was safe.

By having an experienced colleague in attendance, inexperienced nurses were assured of support for themselves and the patient during a complex task. Experienced nurses also demonstrated that they could respond rapidly to adverse events during pacemaker checks to limit the duration and extent of haemodynamic instability. For instance, participant 3 found her patient did not have an underlying rhythm greater than 60 bpm and rapidly responded by aborting the procedure and reinstituting appropriate settings in order to reestablish cardiovascular stability.
Table 5.5

Patients' Underlying Heart Rhythm and Blood Pressure Revealed During Complete Pacemaker Assessment (n = 16)

<table>
<thead>
<tr>
<th>Rhythm and blood pressure</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>No underlying rhythm</td>
<td>7</td>
<td>44</td>
</tr>
<tr>
<td>Sinus bradycardia with hypotension</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>Sinus rhythm with hypotension</td>
<td>5</td>
<td>32</td>
</tr>
<tr>
<td>Sinus rhythm with normotension</td>
<td>2</td>
<td>12</td>
</tr>
</tbody>
</table>

Note. Hypotension = mean arterial pressure less than 70 mmHg. Normotension = mean arterial pressure greater than 70 mmHg and less than 90 mmHg.

Not all experienced nurses, however, had the confidence to perform pacemaker assessments. Participant 16, an experienced nurse, did not conduct an initial assessment nor a complete pacemaker assessment. Furthermore, participant 16 did not look to see what changes were made to the pacemaker after doctors altered the settings during the recovery period. It is possible that the nurse did not perform both pacemaker assessments because she possessed inadequate knowledge of, and experience with, the procedures. This situation suggests that experience does not always equal knowledge and confidence and that the nurse's experiences have not supported development of decision making concerning pacing.

Of the 16 nurses who assessed the pacemaker, 11 nurses made changes to the pacemaker settings in terms of mode, rate, sensitivity, output, or various combinations thereof in order to optimise cardiovascular performance through pacing-induced heart rates and rhythms. Seven nurses who found their patients did not have an underlying rhythm promptly reestablished the original settings of each pacemaker. It is not known whether the pacemaker settings were optimal for cardiovascular performance in 17 patients because the relevant nurses did not perform complete pacemaker assessments.

The significance of performing complete pacemaker assessments for optimising cardiovascular performance was highlighted when two potentially dangerous
complications related to the pacemaker, oversensing and failing to sense, were detected and averted by an experienced assistant nurse during observation 19.

In sum, the factors that led to variability of conducting complete pacemaker assessments were nurses' experience and knowledge of pacing, the complexity of the task in terms of the patient's cardiac rhythm (intrinsic or pacemaker induced), and the availability of colleagues. These findings suggest interplay between the multifactorial influences on decision making that influenced primary nurses' decisions to conduct complete pacemaker assessments and, therefore, optimise cardiovascular performance through heart rate and rhythm.

5.2.1.2 Perfusion pressure

Variability in nurses' decision making concerning perfusion pressure was sourced to frequency of physical assessments and techniques of appraising and responding to MAP. All nurses measured urine output hourly.

Physical assessment

Most nurses assessed patients' neurovascular and neurological perfusion either once or twice during the 2-hr recovery period (see Figure 5.2). Two inexperienced nurses (ID, 5 and 15) performed assessments of perfusion four times. One nurse was closely monitoring a patient's (ID, 5) extreme cardiovascular instability and nurse 15 was repeatedly trying to assess the mental state of patient 15 who awoke from the anaesthetic in a confused and agitated state.

The mean time taken for nurses to initially assess peripheral perfusion was 34 (SD = 22) minutes after admission. Although this time period may seem like nurses did not prioritise physical assessments of perfusion, several nurses assessed patients' neurological and peripheral perfusion as soon as handover was completed as indicated by the minimum time in Table 5.6. Most nurses, however, were observed to prioritise the establishment of patients' technologically-derived haemodynamic parameters on the monitor in the initial reception period. Thereafter, nurses responded to those technologically-derived parameters, especially if they indicated haemodynamic instability, prior to assessing peripheral and mental perfusion. Inexperienced nurses
Figure 5.2. Nurses' frequency of assessing perfusion through physical assessments during the 2-hour recovery period (n = 36).

Note. Inexperienced, n = 17. Experienced, n = 19.

assessed patients' peripheral perfusion earlier than experienced nurses (see Table 5.6). Earlier assessments of peripheral perfusion by inexperienced nurses may have occurred because they focused on familiar aspects of patient management. Experienced colleagues who assisted inexperienced nurses also tended to establish and assess technologically-based parameters on behalf of the primary nurses and these actions left inexperienced nurses to perform physical assessments.

Table 5.6
Mean Time in Minutes for Nurses to Assess Peripheral Perfusion According to Experience (n = 36)

<table>
<thead>
<tr>
<th>Nurses' level of experience</th>
<th>M</th>
<th>SD</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inexperienced (n = 17)</td>
<td>29</td>
<td>17</td>
<td>7</td>
<td>60</td>
</tr>
<tr>
<td>Experienced (n = 19)</td>
<td>38</td>
<td>25</td>
<td>10</td>
<td>98</td>
</tr>
</tbody>
</table>
Mean arterial pressure

Variability in nurses' decision making regarding MAP is presented in terms of nurses' methods of appraising, evaluating, and responding to, MAP as a function of experience and environmental characteristics. Analysis of decision episodes showed that nurses were frequently evaluating, and had a high level of responsiveness to, the MAP. As this assertion is difficult to quantify because MAP is a continuously measured parameter, qualitative data from the observations and interviews are presented.

Mean arterial pressure appeared to be the most important haemodynamic parameter for appraising and evaluating cardiovascular performance. Indeed, all nurses remarked in the interviews that the MAP was the most important parameter that they used to judge patients' level of haemodynamic stability. The most reliable method of continuous appraisal of perfusion pressure was achieved by setting alarm limits on the MAP derived from arterial pressure monitoring. As noted in Section 5.2.1.1, all nurses had alarms activated, but only 90% of nurses set, and therefore knew, those alarm limits for MAP. In addition to setting alarms, nurses' appraisal of MAP could be achieved by periodically looking at the monitor. A high level of monitor vigilance by primary nurses was witnessed in 9 observations. Twice as many experienced nurses (n = 6) as inexperienced nurses (n = 3) were observed to frequently look at the monitor. Precise data recording of monitor vigilance behaviour was not recorded with the aid of a checklist, so the finding cannot be quantified. However, two transcription excerpts provide support for the actions witnessed. It was noted during observation 12:

Nurse is often looking at the monitor screen whenever he’s in the middle of doing something he’s very vigilant and watching it closely. The alarms are on, but he is watching it very frequently....He goes to go to the side of the bed but stops and goes back and looks at the monitor again. As I said before he’s very monitor vigilant....He certainly has a high level of monitor vigilance compared to the other nurses that I have observed.

During observation 19, the patient was haemodynamically unstable and the nurse was frequently titrating GTN to control the patient's MAP and high SVR. The researcher recorded:
She’s very vigilant, she’s constantly looking at the monitor, she’s always looking up.

It seemed that inexperienced nurses had a high monitor vigilance in response to haemodynamic instability induced by a labile MAP. However, patients were not necessarily haemodynamically unstable when experienced nurses’ level of monitor vigilance was noticed to be high.

There were frequent deviations in MAP from evidence-based and clinically significant values that placed patients in potential or real danger (see Table 5.7). The number of patients that displayed hypotension and hypertension and the experience level of the primary nurse are shown in Table 5.7. The majority of nurses (68%) managed numerous episodes of either hypotension or hypertension during the recovery period. Two patients (ID, 17 and 27) had hypotension and hypertension at various stages during the recovery period.

Table 5.7
Frequency of Patients that Displayed Deviations in Perfusion Pressure and Experience Status of Primary Nurses (n = 26)

<table>
<thead>
<tr>
<th>Perfusion pressure</th>
<th>Inexperienced</th>
<th>Experienced</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypotension</td>
<td>12 , 46</td>
<td>9 , 34</td>
<td>21 , 80</td>
</tr>
<tr>
<td>Hypertension</td>
<td>3 , 11</td>
<td>6 , 23</td>
<td>9 , 34</td>
</tr>
</tbody>
</table>

**Note.** Hypotension = mean arterial pressure less than 70 mmHg. Hypertension = mean arterial pressure greater than 90 mmHg.

Examples of nurses’ management of hypotension will be presented to illustrate the variability and commonality in nurses' decision making of perfusion pressure. Nurses' decision making concerning hypertension is presented in Section 5.2.2.2 because those decisions were often linked to the promotion of haemostasis.
In 84% of observations (n = 32), doctors had written postoperative medical orders to guide nurses' management of MAP. Drug and colloid infusions were titrated to achieve particular MAP values. Inexperienced nurses in particular used, and relied upon, postoperative orders written by medical staff to guide their decision making. In the absence of medical orders, nurses (n = 6) said that they tried to keep the MAP greater than 70 mmHg though fluid and drug infusions.

A benefit of experienced nurses' attentive monitoring of the MAP during periods of haemodynamic stability was that they responded to haemodynamic data before alarm conditions were breached or before MAP dropped below 70 mmHg. This level of responsiveness to MAP was shown by participant 37 who was an experienced nurse. Despite setting alarm limits, she intervened prior to alarm conditions being breached so as to limit the extent and duration of haemodynamic instability caused by hypotension. The following excerpt describes her actions in response to seeing a slow drop in the MAP. Although the MAP was still above 74 at the time of her interventions, nurse 37 responded to a downward trend in the MAP thereby limiting the extent of hypotension:

Primary nurse has just disconnected the saline that was connected up to the blood line and has put up a bag, a 500 ml bottle of Haemacel and is watching the monitor and at the same time is unwinding the cardiac output coil and is connecting the syringe up to the proximal port of the PAC…blood pressure is 93/66 with a MAP of 74…Systolic blood pressure is now 87. She has turned the GTN from 120 down to 70. Systolic blood pressure remains at 85, she is taking a PCWP. She is just pumping that Haemacel in and watching the monitor constantly.

Such proactive decision making suggested that the nurse was aware of the risk to the patient from hypotension. Furthermore, although alarms were set on the monitor, the nurse watched the monitor very closely while she assessed data, manipulated therapeutic interventions, and evaluated patient responses to those interventions.

All of the experienced nurses (n = 9) whose patients had hypotension sought to identify the causes of hypotension before implementing corrective therapies. For instance, in response to hypotension, experienced nurses performed any or all of the following: evaluated doses of vasodilator and inotrope infusions, measured the PCWP
and CVP; assessed the rate and volume of chest drainage; looked for clots in the chest drains at the skin exit sites; assessed the rate of the pacemaker; assessed the current rate of colloid infusions; and performed a cardiac output.

Once experienced nurses assessed haemodynamic data, they performed a combination of the following interventions as appropriate: decreased the dose of, or ceased, vasodilator infusions; increased the dose, or suggested commencement, of inotrope infusions; increased the rate of, or commenced, colloid fluid infusions; milked or stripped the chest drains if clots were present; altered settings on the pacemaker; lowered the head of the bed until it was flat; tipped the patient head down (head of bed below 0° flat); called medical staff to attend the patient; suggested a blood transfusion; and called for the surgeon to attend the patient.

Experienced nurses often identified numerous possible causes of hypotension and, accordingly, implemented a range of therapies. For example, participant 3 was observed to respond to hypotension in the following way:

The MAP is 59. The blood pressure has just alarmed again and primary nurse has gone up and appears to be altering the dose of one of the infusions (GTN). Blood pressure is alarming again and primary nurse is still altering the dose. Silenced alarm and has turned to measure the CVP. The blood pressure is reading 118/33 with a mean of 62…now primary nurse measures CVP and she’s started pumping in some blood. Now she’s entered the PCWP procedure screen to take a PCWP.

Only one third of the inexperienced nurses whose patients had episodes of hypotension were observed trying to identify the cause or causes of hypotension prior to intervening in the same way as experienced nurses. Three nurses measured the patients' PCWP and CVP prior to colloid fluid administration and a fourth nurse mildly sedated a patient to treat coughing induced hypotension.

In 4 of the 12 cases where inexperienced nurses' patients had episodes of hypotension, either an experienced colleague or a doctor in attendance prompted the inexperienced nurses to respond. Inexperienced nurses were told what data to assess and what therapies to implement to alleviate the hypotension. In doing so, experienced colleagues assisted the nurses to optimise perfusion pressure and cardiovascular
performance. One example of this form of decision support is provided in Observation 6 in Table 5.8. In a second instance, (Observation 38), the primary nurse was observed to seek and receive decision support from an experienced colleague numerous times. However, at one stage when her colleague was absent, the patient's MAP drifted down to 63 mmHg. Less than 1 minute earlier the MAP had been 72 mmHg. In response, the nurse was observed to look at the monitor and then proceed to go behind the monitor to access a module to alter the size of the ECG trace. During this time (1 minute), the MAP dropped to 58 mmHg. On seeing the MAP of 63 mmHg, the nurse had not assessed the patient's CVP or PCWP, lowered drugs that may have been contributing to the hypotension, nor sought to determine the cause of the hypotension in any other way. At that point in time, a doctor arrived and prompted the nurse to respond to the hypotension by lowering the rate of a drug infusion, assessing for preload values, and suggesting a bolus of colloid fluid. When asked about the incident in the interview, participant 38 said that she had not responded promptly to the hypotension:

Researcher: I noticed at one stage the doctor pointed out to you there was a low blood pressure
Participant: Yep
Researcher: Had you noticed that before she said it, or did she draw your attention to it?
Participant: I think I had, I had noticed. But I hadn't actually acted as quickly as what I should have at that point.

In acutely ill patients, slow responses by nurses have the potential to place the patient at risk of cardiovascular collapse. This incident suggests that the nurse did not recognise the problem of hypotension and was unable to respond quickly. Clearly the nurse required greater decision support than was available from her colleagues at the time.

The remaining inexperienced nurses (n = 4) administered colloid infusions in response to episodes of hypotension without assessing the patients' fluid status by measuring PCWP or CVP. Although the MAP was temporarily increased by the infusions, decisions to treat hypotension with colloid fluids without establishing hypovolaemia as the antecedent have the potential to induce other complications such as
pulmonary oedema. It was apparent to the observer, and later to the nurses involved, however, that one patient was probably bleeding, the second patient was shivering and had a low SVR, the third patient was inadequately paced, and the fourth patient had undiagnosed low SVR syndrome. All of these nurses were receiving decision support from similarly inexperienced nurses. These findings suggest that inexperienced nurses find the task of managing hypotension complex and that decision support from experienced colleagues may be required to manage episodes of hypotension in an optimal manner.

It was observed that inexperienced and experienced nurses' management of hypotension could be influenced by certain environmental characteristics. Those environmental characteristics included being positioned in geographically isolated cubicles or having reduced access to experienced colleagues because of staffing levels or the staff mix. Observation and interview transcripts excerpts have been used to illustrate the potential influences on nurses' decision making arising from interplay between these factors (see Table 5.8).

As shown in Table 5.8, ready access to more experienced colleagues for decision support was not always possible. Participant 11 said she needed experienced colleagues to assist her in many aspects of haemodynamic decision making despite having medical orders for MAP and other parameters. However, working in an isolated cubicle hindered her access to social interactions and decision support from experienced colleagues (see Table 5.8). Moreover, on the previous day, she had been unable to access staff when a patient suddenly bled and dropped his blood pressure. Similarly, participant 13, received a patient in an isolated cubicle and was observed trying to access colleagues to no avail. Although participants 11 and 13 responded to deviations in the MAP by titrating fluid and vasodilator therapies, the underlying reasons for the deviations in MAP were not detected. Patient 11 was vasodilated because of a low SVR and patient 13 had signs of low SVR syndrome. These data suggest that in situations where restricted access to social interactions with experienced staff occurred due to geographical isolation, inexperienced nurses were able to maintain adequate perfusion pressures, but their decision making was not optimal for enhancing cardiovascular performance.
<table>
<thead>
<tr>
<th>Environmental characteristic</th>
<th>Management of hypotension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of cubicle</td>
<td></td>
</tr>
<tr>
<td>Geographically isolated</td>
<td>(Int. 11) I sometimes find I need to run over things with people, and sort of say to someone, oh I’ve done this because of that… I find that when you’re in a cubicle that’s away from other people I find it very isolating… It’s the atmosphere and I probably still need a little bit of guidance, and people popping by and saying are you okay… Whereas in that cubicle anything could happen and you don’t have anybody sort of able to poke their head in.</td>
</tr>
<tr>
<td>Open-plan</td>
<td>(Obs. 5) The blood pressure is reading 66 systolic. Now its reading 61. She just taking a closer look and said is that really the blood pressure. She’s saying that its causing a MAP of 40. She immediately calls the medical staff back into the cubicle and starts pumping the saline with one hand and is turning on the saline with her left hand. Dr walks back into the cubicle. Blood pressure is now 63/35 with a mean of 43.</td>
</tr>
<tr>
<td>Decision support</td>
<td></td>
</tr>
<tr>
<td>Available</td>
<td>(Obs. 6) The patient’s arterial line has just alarming its 80 on 64 (MAP). So assistant experienced nurse was on that side of the bed and just looked up and suspended it… primary nurse is picking up the pacemaker and experienced assistant nurse is explaining to her that she need to increase the rate to try and get a better MAP.</td>
</tr>
<tr>
<td>Not available due to low staffing levels</td>
<td>(Int. 11) I had a post operative patient yesterday who started dumping out of his drain tubes, dropping his blood pressure. I was in the cubicle by myself and there was not really anybody about. I found that a particularly difficult situation.</td>
</tr>
<tr>
<td>Experienced nurses</td>
<td>(Int. 38) I am quite isolated in this area here. I also know only having one person come to help me actually is good. I don’t like a lot of people coming to help me, so just having her here was fine. No one else otherwise would have known I was even here or even had a post-op back and that is because of the isolation of this actual bed area at the moment.</td>
</tr>
<tr>
<td></td>
<td>(Obs. 8) The MAP isn’t holding, the MAP was 66. Primary nurse asks for someone to mind while she goes out to the drug cupboard, gets Noradrenaline I think. It’s taken her 5 minutes to actually prepare the Noradrenaline which she’s commenced at 5 mics kg-min. The patient’s blood pressure is now 94/61 with a mean of 65… patient’s blood pressure was just alarming a mean of 64, 63 and nurse immediately goes to the Noradrenaline and increases to dose up to 8 mics kg-min.</td>
</tr>
<tr>
<td></td>
<td>(Obs. 27) The other nurse has just arrived with the Noradrenaline to draw up. Primary nurse has just finished aspirating that line and just has some saline to flush it. The other nurse is drawing up Adrenaline and the blood pressure has just hit 89 on a MAP of 59… systolic blood pressure has now hit 74, its currently, in fact its now it 70 with a MAP of 46 and primary nurse has just asked assistant nurse to turn on the Gelofusine full bore.</td>
</tr>
</tbody>
</table>

**Note:** Obs. = observation. Int. = interview
The lack of established relationships with nursing colleagues also influenced inexperienced nurses' decision making regarding MAP. When nurses did not know their colleagues very well, they were hesitant about voicing their concerns and decision making strategies. Participant 34 remarked:

The difficult thing about this situation was not knowing the people I was working with. Although there was lots of people around the bed, no one was saying anything to me and I could see the patient's blood pressure was dropping and I wasn't sure quite what my first intervention should be, and I suppose I was thinking no one else is looking at this blood pressure and I think this blood pressure is a problem.

Only 1 experienced nurse (ID 37) said that the geographical isolation of cubicles had influenced the number of colleagues assisting her, but her decision making regarding hypotension was not affected (see Table 5.8). The nurse's assertion is supported by the observation. Not one situation was observed whereby experienced nurses were unable to access staff to assist them manage patients' hypotension. Indeed, during observation 30, the nurse considered that there were too many nurses assisting her. This issue is discussed further in Chapter 6.

In combination, these data suggest that interplay between nurses' experience, the complexity of managing hypotension, and environmental characteristics had the potential to influence nurses' decision making of perfusion pressure and ultimately cardiovascular performance. When inexperienced nurses received decision making support from experienced nursing colleagues or when they were positioned in open-plan cubicles, they were able to respond appropriately to episodes of hypotension. When inexperienced primary nurses were unable to access experienced colleagues because of either the staffing mix or the isolated nature of the cubicle in which they were recovering patients, nurses had difficulty in responding to episodes of hypotension. These data suggest that social interactions with, and decision support from, experienced colleagues is critical to ensure inexperienced nurses' techniques of managing MAP are appropriate to optimise patients' recoveries. Additionally, the way in which decision support is provided may be crucial to nurses' management of MAP and the optimisation of cardiovascular performance.
5.2.1.3 Preload

Major sources of variability in nurses' decision making regarding preload were sourced to certain technical procedures related to ensuring accurate parameters, the method of monitoring CVP, and the frequency of PCWP assessments.

*Technical procedures to measure accurate PCWP and CVP*

All nurses zeroed pressure transducers in order to establish atmospheric pressure as a zero baseline (see Table 5.9). The process of levelling the pressure transducers to the phlebostatic axis with a spirit level in order to eliminate the effect of hydrostatic pressure was performed by 95% of nurses. Five percent of nurses (n = 2), did not perform levelling with a spirit level at any stage during the 2-hour period. Instead, the 2 experienced nurses levelled the transducers by estimating visually the height of the transducers in relation to the phlebostatic axis. For example, during observation 10, the researcher recorded:

> The transducers haven’t actually been levelled and I can’t see a spirit level in the room…However what the participant did was kind of stand back from bed and squat, and eyeball what he considered to be the right height for the transducers. Moved it to that position, he’s just now lifting up the patient’s blanket in order to try and see the patient's phlebostatic axis, which is not marked, and eyeball the height. He’s satisfied with that rough estimation.

Although such practices did not adhere to evidence-based guidelines, it cannot automatically be assumed that the nurses' levelling methods resulted in the measurement of inaccurate parameters. Nurses were frequently seen to estimate visually the height of the transducers to be level to the phlebostatic axis, then check the estimated height with a spirit level, and determine that the estimated height was correct. The following excerpt from observation 25 illustrates this point:

> When participant 25 laid the patient down to a slightly higher position than supine, she raised the level of the manifold holding the transducers prior to picking up the spirit level. She then checked the level to the air-fluid interface, and it was exactly right. I notice that some staff are able to guess the level fairly well.
As indicated in Table 5.9, 90% of nurses positioned patients correctly. Ten percent of patients had inaccurate pressure parameters continuously displayed on the monitor because 4 nurses in one setting complied with two surgeons' requests to position patients' heads of bed higher than 45°. Although participant 23 had positioned the head of bed at 45°, 3 minutes into the recovery period she was instructed by the surgeon to position the patient about 70° upright. Participant 23 later explained that she understood the surgeon wanted the patient sitting upright to facilitate a faster extubation time. Participant 24 indicated that she sat the patient upright to 50° because surgeons believed such positioning facilitated drainage from the chest drains.

All nurses eliminated the effects of respiratory excursions when assessing PCWP by measuring the parameter at end expiration on a PCWP procedure screen (see Table 5.9). Nurses used a technique equivalent to the stop cursor freeze screen method that conforms to evidence-based guidelines to measure PCWP at end expiration. However, only 5% (n = 2) of nurses used the stop cursor method to assess CVP at end expiration. The observed variability in nurses' assessment techniques between CVP and PCWP were attributed to monitoring technologies rather than experience. That is, 95% of nurses estimated the end expiration value of a CVP on a dynamic waveform because the monitors were not equipped with a facility for measuring CVP via a stop cursor freeze screen method. It is also possible that some participants recorded CVP from the digital display because observation did not allow for finer discrimination of nurses' decision making regarding CVP assessment technique.
Table 5.9

Nurses' Adherence to Procedures to Ensure Technical Accuracy of Preload Measurements

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Inexperienced (n = 18)</th>
<th>Experienced (n = 20)</th>
<th>Total</th>
<th>Excerpts from transcripts of observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zeroing</td>
<td>18, 100</td>
<td>20, 100</td>
<td>38, 100</td>
<td>(Obs. 2) Primary nurse has just opened all the transducers to air, the stopcocks and pressed to zero all the transducers at once and she is just replacing all of the stopcocks.</td>
</tr>
<tr>
<td>Levelling pressure transducer</td>
<td>18, 100</td>
<td>18, 90</td>
<td>36, 95</td>
<td>(Obs. 3) Assistant nurse has just walked out of the cubicle and she’s come back in about 10 seconds with a spirit level to eliminate hydrostatic pressure. She is now levelling the transducer.</td>
</tr>
<tr>
<td>Head of bed elevation less than 45°</td>
<td>17, 94</td>
<td>17, 85</td>
<td>34, 90</td>
<td>(Obs. 6) Assistant nurse elevates the head of the patient’s bed up to 30 degrees and asks for the spirit level so she can re-level it. (Obs 27) Primary nurse has decided to do a PCWP. The patient is sitting in an upright position of about 70 degrees (Obs 5) The bed has actually been tipped now, so the patient’s head is down to try and increase his blood pressure.</td>
</tr>
<tr>
<td>Elimination of respiratory excursions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCWP (stop-cursor method)</td>
<td>18, 100</td>
<td>20, 100</td>
<td>38, 100</td>
<td>(Obs. 1) Primary nurse is taking another set of observations, including the wedge pressure on the wedge function screen. On all occasions, she has taken it at end expiration. (Obs 14) I always instead of just reading the CVP number off the screen, I’ve been taught to read it at end expiration, so I was looking for the A, C, V wave.</td>
</tr>
<tr>
<td>CVP (stop-cursor method)</td>
<td>1, 5</td>
<td>1, 5</td>
<td>2, 5</td>
<td></td>
</tr>
<tr>
<td>CVP monitoring</td>
<td></td>
<td></td>
<td></td>
<td>(Obs. 24) Its not protocol (to intermittently monitor CVP) This is the only unit that does this stupid H system, where you have to turn off your mainline, and pulmonary artery diastolic so you get CVP reading. I do not know why we do it this way. Actually some times I don’t do it this way. I tell students that it isn’t our policy.</td>
</tr>
<tr>
<td>Continuous</td>
<td>18, 100</td>
<td>15, 75</td>
<td>33, 87</td>
<td></td>
</tr>
<tr>
<td>Intermittent</td>
<td>0, 0</td>
<td>5, 25</td>
<td>5, 13</td>
<td></td>
</tr>
</tbody>
</table>

Note. Obs. = observation
Continuous appraisal and evaluation of CVP

Variability in nurses’ method of monitoring CVP was observed. Eighty-seven percent of nurses continuously monitored the CVP and 13% chose to intermittently monitor the CVP (see Table 5.9). All the nurses who chose intermittent monitoring (n = 5) were from one setting and experienced. Participant 24 explained that intermittent monitoring of the CVP was not a unit protocol (see Table 5.9), but it was common practice. It is highly likely that the practice originated 15 to 20 years ago when it was only possible to monitor two pressures simultaneously on a cardiac monitor. On seeing a change in practice by some nurses, participant 26 asked a senior colleague if it was right to display three pressures (the blood pressure, PCWP, and CVP) on the monitor screen, that is, allow continuous monitoring of the CVP. The reply was no and the nurse continued to monitor the CVP intermittently rather than continuously.

The problems with intermittent monitoring of CVP observed by the researcher and perceived by some nurses, were temporary loss of the pulmonary artery waveform display and pauses in the main intravenous infusion each time a CVP was measured (see explanation by participant 24 in see Table 5.9). These consequences of intermittent CVP monitoring are neither desirable in high acuity patients, nor necessary because PACs have multiple ports especially designed to provide continuous pressure monitoring and continuous infusions.

The following instance observed during observation 19 supports the notion that best practice regarding appraisal of CVP involves continuous monitoring so that trends in CVP can be readily ascertained. Participant 19, an inexperienced nurse, decided to continuously monitor the CVP and by doing so, a rising CVP was detected. Further assessments by nurses and doctors subsequently diagnosed a cardiac tamponade. Participant 19 explained why she chose to monitor the CVP continuously and how it helped to detect cardiac tamponade in her patient:

That’s actually my personal preference, because I’ve seen people do it in other hospitals and I like doing it because we don’t have it as a standard practice…(I noticed) his blood pressure dropped and I wasn’t needing anymore GTN and his CVP went up as well as his PCWP. They had been close together all the
the CVP was slightly higher than the PCWP. Considering that he had bled, I decided to check his cardiac output and see if he’s not tamponading.

Although an inexperienced nurse, participant 19 said that she used a combination of her previous clinical experiences, theoretical knowledge of cardiac tamponade, and ipsative changes in numerous patient data to detect cardiac tamponade. Nurse 19 said that she thought the patient may have a cardiac tamponade because she noticed that the PCWP and CVP had trended in adverse directions, the MAP had dropped to the point that she had to cease the GTN infusion, and the rate of bleeding had slowed. Such decision making enabled prompt responses by medical staff and the subsequent return of patient 19 to theatre for corrective surgery.

*Continuous appraisal and evaluation of PCWP*

The majority (71%) of nurses assessed the PCWP at least three times during the 2-hour period (see Figure 5.3). At least five assessments of the PCWP were made by 24% of nurses, two-thirds were experienced. Frequency of assessment was noted to be higher in haemodynamically unstable patients because nurses evaluated therapeutic interventions on an ongoing basis.

*Nurses' responsiveness to PCWP and CVP*

Variability in nurses' responsiveness to PCWP and CVP is difficult to quantify and, therefore, findings are presented using qualitative data. Nurses said they managed preload by assessing the PCWP and CVP, often in combination with the MAP, to quantify the fluid status of patients and to determine the need for, and rate of, intravenous colloid fluids. The type of fluids used to manage patients' hypovolaemia was based on unit specific standing orders. To guide nurses' decision making regarding preload management, doctors wrote orders on patients' observation flow charts in the form of aims for the PCWP or CVP, for example, PCWP 12 - 15 mmHg. Medical orders for preload values were written in 68% of observations (n = 26). There were no medical orders written in 32% of observations which involved 8 experienced nurses and 4 inexperienced nurses. Although none of the experienced nurses made comments about
the lack of medical orders, one of the inexperienced nurses (ID, 34) remarked that she would have liked medical orders to guide fluid management:

I would have liked an aim for the PCWP. Sort of about 15 mmHg was where we were headed for. That was my impression.

All of the inexperienced nurses who had postoperative medical orders said that they used those orders to manage patients' preload. For example, participant 9 remarked:

One of the registrars wanted me to fill the patient, (so I did so until) the PCWP and the CVP were stable and within the parameters that she'd written.
By contrast, one experienced nurse (ID, 4) said that she tended to ignore medical orders for achieving certain preload values with colloid fluids because she considered that such orders were rarely individualised to patients. Instead of relying on medical orders that she perceived to be routine, she used numerous haemodynamic data relevant to her patient to guide preload management decisions. Such data included preoperative and postoperative MAP, cardiac index, SVR, comments about the patient's cardiac function from surgeons and anaesthetists during handover, the grade of the left ventricle, and patients' responses to colloid fluids. A further 13 experienced nurses (65%) and 3 inexperienced nurses (17%) also mentioned that they used these numerous sources of data to guide their preload management decisions.

All experienced nurses assessed the PCWP or CVP prior to administering fluid therapies and repeated assessments to evaluate patient responses to therapies. Participant 22, an inexperienced nurse, was observed to administer boluses of pump blood when the patient had an elevated PCWP and normal CVP. When questioned about that decision, she replied:

The CVP was about 9 or 10 and the PCWP was quite high...I just always pump it in, if the pump blood comes back from theatre and he has a low blood pressure I’ll pump it in and see if that does anything. Because often they come back so under filled. That’s the only reason I did that.

In that instance, the preload values were normal to high for a cardiac patient and the low MAP was due to low SVR syndrome, not hypovolaemia. As a result of that fluid bolus, the patient may have developed acute pulmonary oedema. However, the patient did not develop pulmonary oedema because changes in patient management occurred not long afterward when a doctor reviewed the patient. Nevertheless, concerns are raised about how often inexperienced nurses make decisions based on expectations about patients rather than on the presenting haemodynamic data of individual patients.

In sum, variability of nurses' decision making regarding preload occurred as a function of experience, haemodynamic instability, common practices in one setting, the capacity of monitors, and accommodation of surgeon's requests.
5.2.1.4 Contractility

The highest sources of variability related to nurses' frequency of assessing cardiac index and four specific technical aspects of cardiac output and cardiac index measurement. Findings for decisionmaking surrounding contractility refer to 37 participants because one patient did not have a PAC.

Technical procedures to measure accurate cardiac output

The commonality and variability of nurses' decisions related to technical procedures associated with measuring an accurate cardiac output are shown in Table 5.10. In terms of preparation procedures, all participants adhered to evidence-based guidelines with the exceptions of ensuring a 12 °C temperature differential and positioning the patient correctly. As shown in Table 5.10, 24% of nurses did not ensure a 12 °C temperature difference between the injectate temperature and blood temperature and 30% of nurses elevated the head of bed greater than 20°.

Nurses' years of experience did not appear to account for nurses' decisions regarding the establishment of a 12 °C temperature differential. As noted in the excerpt from the transcription of observation 13, monitors displayed a flashing temperature to alert nurses to an incorrect temperature differential, but none of the nurses (n = 9) responded. The nurses involved may not have had the theoretical knowledge regarding this issue to realise the significance of the flashing temperature.

In regard to positioning the patient's head of bed greater than 20°, accommodation of surgeons' preferences rather than inexperience accounted for nurses' lack of adherence to guidelines. As indicated in Section 5.2.1.3, two surgeons wanted the head of their patients' beds elevated to facilitate faster extubation times and chest drainage. None of the nurses refused to elevate the head of bed to about a position between 45° and 80°.
Table 5.10
Nurses' Adherence to Procedures to Ensure Technical Accuracy of Cardiac Output Measurements (\(^n = 37\))

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Inexperienced ((n = 18))</th>
<th>Experienced ((n = 19))</th>
<th>Total ((n = 37))</th>
<th>Excerpts from transcripts of observations and interviews</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation</td>
<td></td>
<td></td>
<td></td>
<td>(Obs. 13) He’s just gone to do a cardiac output and waited for end expiration. The patient is sitting at a 45 degree position. The patient’s blood temperature is flashing 35.4 which means that the cardiac output won’t be accurate because there’s not a 12 degree difference, but he didn’t take note of that, or just went ahead and did it because he’s not sure, I don’t know. After doing the fourth cardiac output, he has deleted the first and taken an average of those three.</td>
</tr>
<tr>
<td>Correct position of PAC</td>
<td>18, 100</td>
<td>19, 100</td>
<td>37, 100</td>
<td></td>
</tr>
<tr>
<td>10 mls room temperature injectate</td>
<td>18, 100</td>
<td>19, 100</td>
<td>37, 100</td>
<td></td>
</tr>
<tr>
<td>Computer constant correct</td>
<td>18, 100</td>
<td>19, 100</td>
<td>37, 100</td>
<td></td>
</tr>
<tr>
<td>No concurrent fluid boluses</td>
<td>18, 100</td>
<td>19, 100</td>
<td>37, 100</td>
<td></td>
</tr>
<tr>
<td>12 °C temperature differential</td>
<td>13, 72</td>
<td>15, 79</td>
<td>28, 76</td>
<td></td>
</tr>
<tr>
<td>Head of bed elevation less than 20°</td>
<td>12, 72</td>
<td>14, 74</td>
<td>26, 70</td>
<td></td>
</tr>
<tr>
<td>Operator technique</td>
<td></td>
<td></td>
<td></td>
<td>(Int. 8) I know that you’re supposed to inject…at end expiration…but I just usually do it whenever. (Int. 18) We have had lecturers saying that as long as you do it from the same point in the cycle it doesn’t really matter.</td>
</tr>
<tr>
<td>Inject injectate over 4 seconds</td>
<td>18, 100</td>
<td>19, 100</td>
<td>37, 100</td>
<td></td>
</tr>
<tr>
<td>Inject injectate evenly throughout respiratory cycle</td>
<td>0, 0</td>
<td>0, 0</td>
<td>0, 0</td>
<td></td>
</tr>
<tr>
<td>Calculation of average</td>
<td></td>
<td></td>
<td></td>
<td>(Int. 9) Make sure that the first curve is usually discarded or if it seems to be similar to the other traces I would keep it in. Make sure they were in 10% of each other and make sure that my data input, like the wedge, CVP, PAD and all that are accurate… I’d make sure all of my curves are the same.</td>
</tr>
<tr>
<td>Minimum of 3 cardiac outputs</td>
<td>18, 100</td>
<td>19, 100</td>
<td>37, 100</td>
<td></td>
</tr>
<tr>
<td>Accept cardiac outputs within 10% range of median cardiac output</td>
<td>0, 0</td>
<td>0, 0</td>
<td>0, 0</td>
<td></td>
</tr>
</tbody>
</table>

Note. Obs. = observation. Int. = interview.
\(^n = 37\) patients with pulmonary artery catheters for cardiac output measurement
In terms of operator technique, all nurses (n = 37) appeared to inject the injectate over the required time span, but none of the participants evenly spaced the injection of injectate across the respiratory cycle as per guidelines (see Table 5.10). As illustrated in Table 5.10, one experienced nurse (ID, 8) thought that the correct stage for injecting injectate was end expiration, but she had not put that incorrect knowledge into practice and, as a result, may have timed the injections according to guidelines unintentionally. An inexperienced nurse (ID, 18) had been taught in her critical care program to inject at the same stage of each respiratory cycle. Nurses' answers to questions about their method for measuring cardiac output highlights the confusion that nurses have about the timing of injecting injectate in relation to the respiratory cycle (see Table 5.11). As illustrated in Table 5.11, 44% of participants (n = 14) injected the injectate randomly across the respiratory cycle whereas 56% of participants (n = 18) did so during expiration. There are missing data for 13% of nurses (n = 5) because these nurses were participants in Phase One of the study where a structured observation tool was not used.

The data in Table 5.11 suggest just over half of the nurses were unaware of current guidelines because 56% of nurses believed that expiration was the correct phase for injecting injectate. Early research had suggested injecting injectate during expiration. A lack of clarity regarding current literature may have also been perpetuated in clinical practice through preceptorship. An inexperienced participant 14 explained:

I’ve been told so many mixed things that I just do it whenever now. A couple have said do it at end expiration, but other people said it doesn’t matter, so I’ve gone with the it doesn’t matter.

The third and final stage of accurate cardiac output measurement requires the nurse to calculate the average cardiac output. As shown in Table 5.10, none of the 37 participants adhered strictly to all the guidelines which direct nurses to identify the median cardiac output from at least three measurements, delete cardiac outputs outside a 10% range from the median value, and calculate the mean of the remaining cardiac outputs. All participants took an average from three cardiac output measurements, but
Table 5.11

Nurses' Timing of Injecting Injectate During Cardiac Output According to Experience \((n = 32)\)

<table>
<thead>
<tr>
<th>Stage of respiratory cycle timed to injection</th>
<th>Inexperienced ((n = 15))</th>
<th>Experienced ((n = 17))</th>
<th>Total (n, %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random</td>
<td>5, 33</td>
<td>9, 50</td>
<td>14, 44</td>
</tr>
<tr>
<td>Expiration</td>
<td>10, 67</td>
<td>8, 44</td>
<td>18, 56</td>
</tr>
</tbody>
</table>

there was wide variability in the method used by nurses to calculate the average cardiac output (see Table 5.12). The majority of nurses accepted 3 cardiac outputs within a 10\% range of each other (36\%) or that appeared similar in shape to each other (34\%). The remaining nurses used other methods (see Table 5.12). There is missing data for 7 participants. Before calculating the average cardiac output, 13\% of nurses \((n = 5,\) inexperienced \(n = 2,\) experienced \(n = 3)\) were observed to, and confirmed that they, routinely discarded the first cardiac output, a practice deemed unnecessary in current guidelines.

Table 5.12

Nurses' Method of Averaging Cardiac Output According to Experience \((n = 30)\)

<table>
<thead>
<tr>
<th>Method</th>
<th>Inexperienced ((n = 14))</th>
<th>Experienced ((n = 16))</th>
<th>Total (n, %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within 10% of each other</td>
<td>7, 50</td>
<td>4, 25</td>
<td>11, 36</td>
</tr>
<tr>
<td>Similar shape waveform</td>
<td>2, 14</td>
<td>8, 50</td>
<td>10, 34</td>
</tr>
<tr>
<td>Within 25% of each other</td>
<td>1, 7</td>
<td>0, 0</td>
<td>1, 3</td>
</tr>
<tr>
<td>Within 50% of each other</td>
<td>0, 0</td>
<td>1, 6</td>
<td>1, 3</td>
</tr>
<tr>
<td>Within 0.5 L of each other</td>
<td>4, 29</td>
<td>3, 19</td>
<td>7, 24</td>
</tr>
</tbody>
</table>
**Frequency of assessing cardiac output and cardiac index**

The frequency of assessing cardiac index through cardiac output measurements varied between one and three times in the 2-hour recovery period (see Figure 5.4). Experienced nurses assessed the cardiac index more frequently than inexperienced nurses. As illustrated in Figure 5.4, only experienced nurses assessed the cardiac index three times. Although, 36% of experienced nurses (n = 13) and 32% of inexperienced nurses (n = 12) assessed the cardiac index twice, 5 of those inexperienced nurses were prompted by experienced colleagues to perform the second assessment. For example, participant 34 said that she was prompted by an experienced nurse to assess the cardiac index the second time. She said:

The first one was because I knew you had to do a cardiac output postoperatively and I wanted a baseline and then later, because he seemed to be dropping his MAP, I did one again which was partly the prompting of the nurse in charge and to see if, which he was, starting to dilate a little bit.

![Graph](image-url)

*Figure 5.4. Frequency of assessing contractility by nurses during 2-hour recovery period (n = 37).*
All nurses (n = 37) assessed the cardiac index more frequently in patients who had hypotension or a low cardiac index on the first assessment. This finding, in combination with experienced nurses assessing and prompting more frequent assessments of cardiac output, suggests that experienced nurses evaluated the effectiveness of interventions for hypotension and poor cardiac contractility more often than inexperienced nurses.

Two experienced nurses (ID, 10 and 23) assessed the cardiac index only once because they both believed that the cardiac index was of limited value in assessing and managing cardiovascular performance. Both said that they formed that view during their nursing education and experience in the United Kingdom. The researcher noted 1 hour into observation 10 that the patient's MAP was less than 70 mmHg. The experienced nurse was prompted to measure the cardiac index by a doctor. As indicated by participant 10 later, he had little intention of performing a cardiac output:

I would have been quite happy not to do them for a while, until she’s settled in and warmed up a little bit, and then I would really only do them for the fact that people like to see cardiac outputs.

Similarly, participant 23 did not prioritise an assessment of cardiac index because she did not regard it as important unless other parameters indicated haemodynamic instability:

My priority isn't to do a set of studies (cardiac outputs) because...to my mind, its almost like, I always think it’s a potential habit, rather than, clinically if something is going on then definitely because they’re going to treat it, but otherwise just see what’s going on, I just think...

Participant 23 did not finish the sentence, but her argument about not assessing a cardiac output unless other parameters indicate haemodynamic instability are at odds with data reported in Chapter 4 regarding the complexity of haemodynamic presentations in this cohort. It is also worth noting that one patient's (ID, 4) continuously monitored parameters indicated haemodynamic stability, yet the nurse detected low
cardiac output syndrome on measuring the cardiac output. The beliefs held by nurses 10 and 23 regarding the limited value of cardiac index in managing patients' cardiovascular status are at odds with literature that indicates a morbidity and mortality associated with low cardiac output syndrome (Kumon et al., 1986).

Nurses' responsiveness to cardiac index

Once cardiac index was assessed, nurses manipulated inotrope and colloid fluids to establish or maintain the cardiac index at values that varied slightly according to medical orders. Medical orders were written on patients' observation flow charts in 49% of observations (n = 18). There were no medical orders written for 35% of patients (n = 13) and there is missing data for 16% (n = 6). Of those nurses (n = 18) with medical orders, most (55%) required nurses to keep the cardiac index greater than 2.2 L·min·m⁻² with appropriate therapies. Although 1 medical order (6%) required the cardiac index to be greater than 2.0 L·min·m⁻², the remainder of the orders were for cardiac index values to be greater than 2.3 L·min·m⁻² (22%), greater than 2.4 L·min·m⁻² (11%) and greater than 2.5 L·min·m⁻² (6%). Nurses without medical orders (n = 13) said that they used a cardiac index value of 2.2 L·min·m⁻² to guide their decision making.

As noted in Chapter 4, 16% of patients (n = 6) had low cardiac output syndrome (cardiac index less than 2.2 L·min·m⁻²) and a further 16% of patients (n = 6) had a cardiac index between 2.2 L·min·m⁻² and 2.5 L·min·m⁻². In all these cases (n = 12), experienced nurses (n = 8) were responsive to the low cardiac index values with appropriate interventions. However, immediately after measuring the cardiac output, one inexperienced nurse (ID, 38) whose patient had low cardiac output syndrome asked an experienced colleague what interventions to take in order to raise the cardiac output value. The experienced nurses sought additional patient parameters from the inexperienced nurse and then suggested appropriate therapies. One other inexperienced nurse (ID, 19) who had a patient with low cardiac output syndrome and 2 nurses (ID, 15 and 18) whose patients had cardiac index values between 2.2 L·min·m⁻² and 2.5 L·min·m⁻² were observed to manage the patients autonomously and appropriately.
5.2.1.5 Afterload

Highest sources of variability in nurses' management of SVR occurred in the frequency with which SVR was assessed and in nurses' responsiveness to low SVR.

Appraisal of SVR

As the SVR is derived from the cardiac output, participants assessed SVR between one and three times during the recovery period as per the frequency of cardiac output assessments (see Figure 5.4).

Nurses' responsiveness to SVR

As discussed in Chapter Four, 16% of patients (n = 6) displayed low SVR syndrome. The nurses who detected and appropriately responded to low SVR syndrome included experienced nurses (n = 3) and inexperienced nurses (n = 3) receiving decision support from experienced colleagues or doctors. These findings suggest experienced decision support enabled inexperienced nurses to manage low SVR syndrome in order to optimise cardiovascular performance. An example of how an experienced nurse guided an inexperienced nurses' decision making about low SVR syndrome is taken from observation 6. An experienced nurse assisted the primary nurse to recover patient 6 by prompting specific assessments and interventions and explaining the rationales and actions of those interventions. On seeing a MAP of 64 mmHg, the experienced nurse assessed the level of the transducers to confirm that the MAP was accurate and then the following was observed:

Experienced assistant nurse has actually been guiding primary nurse...just said to her she needs to do an output to be able to check to see how dilated the patient is and needs to increase the pacing to try and get a higher output as well...experienced assistant nurse is just pointing out that the patient has low SVR syndrome. She’s pointing out the haemodynamic effects of that and that noradrenaline is required so that the heart doesn’t have to work so hard...and it is a syndrome that one needs to respond to.

There were 5 patients who displayed an SVR less than 800 dynes·sec·cm⁻². In the first case, an experienced nurse said to an assistant nurse that he was about to commence noradrenaline infusion, but the patient suddenly haemorrhaged and was returned to
theatre immediately without the infusion being commenced. In four observations, the inexperienced nurses involved did not respond to the lower than normal SVR in terms of altering therapeutic interventions or bringing the potential problem to the attention of experienced colleagues. These data suggest that inexperienced nurses may be unaware of potential problems for patients from a lower than normal SVR and that decision support from an experienced colleague may be required to ensure the problem is identified and responded to as necessary.

In contrast to findings regarding a low SVR, nurses who had patients with an elevated afterload \((n = 10)\) showed that they were skilled at managing it. That is, both inexperienced \((n = 3)\) and experienced nurses \((n = 7)\) were observed to respond to a higher than normal SVR by increasing the rate of current vasodilator infusions or consulting doctors to commence a vasodilator infusion to maintain the SVR below 1200 dynes-sec-cm\(^{-5}\). It is likely that these nurses were familiar and experienced with titrating vasodilator infusions because they are commonplace in cardiac surgical patients. It is further suggested that such familiarity may have accounted for nurses' rapid responsiveness to high SVR.

It was observed that experienced and inexperienced nurses autonomously titrated vasodilator infusions according to patients' MAP once the high SVR was detected. For instance, participant 19 administered a litre of colloid fluid and manipulated the vasodilator infusion 27 times to keep the patient's MAP between 70 mmHg and 80 mmHg during the last 90 minutes of the 2-hour recovery period. As she explained:

> When I did the first set of cardiac outputs his SVR was very high and index low. I thought that the low index was a consequence of high SVR so I tried to get that down and went up on GTN as much as his blood pressure allowed me. Then went up and down accordingly. Yeah I was titrating it to the MAP. Basically I would go up as much as I can, in view of the high SVR but at the same time trying to keep his MAP above 70 at least.

Participant 19's comments about titrating vasodilator drug to lower the SVR whilst simultaneously ensuring the MAP was greater than 70 mmHg on a minute by minute basis reflected the actions of the 27% of nurses \((n = 10)\) who had patients with high
SVR. Since vasodilator drugs can induce hypotension, decision making of that kind was appropriate for optimising cardiovascular performance.

5.2.1.6 Arterial oxygen saturation

All nurses monitored arterial oxygen saturation via continuous pulse oximetry and at least one arterial blood gas analysis during the 2-hour recovery period (see Table 5.3). Nurses (n = 7) showed commonality in responsiveness to an \( \text{SpO}_2 \) less than 95% by rapidly assessing for a cause and by increasing the percentage of oxygen on the ventilator to protect the patient from hypoxaemia in the meantime. The nurses demonstrated that they considered the patient's medical history, current physiological state, speed of deterioration, and mechanical issues when assessing and managing oxygen saturation. Many nurses (n = 14, 37%) had difficulty in maintaining continuous \( \text{SpO}_2 \) monitoring due to hypothermia. In response, these nurses changed monitoring sites and monitoring devices until continuous readings were achieved.

5.2.1.7 Summary

Experienced nurses assessed haemodynamic data (heart rate and rhythm through pacemaker assessments, PCWP, cardiac index, and SVR) more frequently than inexperienced nurses. This suggests experienced nurses appraised and evaluated patients' responses to therapeutic interventions more often than inexperienced nurses. Experienced nurses demonstrated an enhanced ability to integrate data from numerous sources more readily than inexperienced nurses. For instance, experienced nurses used more cues when managing preload and hypotension than inexperienced nurses. Experienced nurses also showed that they were particularly vigilant of, and responsive to, hypotension. One inexperienced nurse (ID, 19) showed all these characteristics attributed to experienced nurses. Both experienced and inexperienced nurses were skilled at managing patients with high SVR. The finding that inexperienced nurses carried out physical assessments more often and more quickly than experienced nurses may indicate that inexperienced nurses were more familiar with data from physical assessments than technologically-derived parameters and prioritised decisions that were within their capabilities. Moreover, this finding suggests experienced nurses may not have placed a high priority on data derived from physical assessments.
Some nurses, most of whom were experienced, did not implement all relevant evidence-based guidelines to ensure technical accuracy when measuring the haemodynamic parameters of PCWP, CVP, and cardiac output. These findings suggest that some nurses' knowledge of current research about haemodynamic monitoring practices may be incomplete. The capabilities of monitoring systems impeded the ability of nurses to measure CVP at end expiration according to evidence-based guidelines.

Some inexperienced nurses received decision support from experienced colleagues to carry out complete pacemaker assessments (n = 9) and manage cardiovascular instability in the forms of hypotension (n = 4), low cardiac index (n = 1), and low SVR syndrome (n = 3). At times, however, other inexperienced nurses had limited access to decision support for haemodynamic decision making. Factors that combined to limit nurses' access to more experienced staff included recovering patients in isolated cubicles, being assisted by inexperienced nurses, or having few experienced nurses available.

The culmination of these findings suggest that the level of experience of both primary nurses and nurses who provided assistance to the primary nurse during the recovery period influenced how primary nurses appraised, evaluated, and responded to haemodynamic parameters. In doing so, the role of experience had the potential to impact on nurses' abilities to optimise cardiovascular performance. Decision making surrounding the management of pacemakers, hypotension, and low SVR syndrome appeared to be particularly complex for inexperienced nurses. Inexperienced nurses' access to experienced colleagues for decision support during the recovery period could be hampered by the geographical isolation of cubicles and the staffing mix. Ultimately, interplay between decision complexity, nurses' experience, and environmental characteristics had the potential to affect whether or not nurses' decision making was directed toward the goal of optimising cardiovascular performance.

5.2.2 Promotion of Haemostasis

For the promotion of haemostasis, nurses appraised, evaluated, and responded to the salient cues of haematological status, perfusion pressure, chest drains, and surgical wounds. Nurses' decision making surrounding those cues is discussed in the following sections.
5.2.2.1 Haematological status

All nurses assessed haemoglobin status at least once via the arterial blood gas sample. Twenty-four percent of nurses (n = 9) assessed activated clotting time and 50% of nurses (n = 19) performed a full clotting profile. Tests for activated clotting times were routinely performed on admission in one setting in accordance with unit protocol. In all settings, full clotting profiles were measured at the request of anaesthetists or surgeons in response to significant bleeding or abnormal clotting profiles during surgery.

In conjunction with medical staff, 63% of participants (n = 24) actively managed patients' haematological status by administering a combination of haemostatic agents to promote haemostasis. However, 2 nurses, participants 3 (experienced) and 34 (inexperienced) infused pump blood to patients who were being treated with haemostatic agents for a coagulopathy, despite the issues with pump blood in terms of its content and side-effects.

5.2.2.2 Perfusion pressure

Episodes of hypertension were observed in 24% of patients (n = 9). The management of hypertension was carried out in the same way by experienced (n = 6) and inexperienced (n = 3) nurses. First, as all the patients involved had a current GTN infusion, the rate was increased in an attempt to lower the MAP below 90 mmHg in 6 patients and below 80 mmHg in 3 patients. When the GTN infusion reached 200 mcg/min and the MAP was still higher than desired or if the patient had a high SVR, 4 nurses, 1 of whom was inexperienced, suggested to doctors that sodium nitroprusside should be commenced. Such suggestions were met with agreement in three observations. In the fourth observation (ID, 31), the doctor ordered milronone instead of sodium nitroprusside because of the surgeon's preference. In addition to titrating vasoactive therapies to reestablish normotension, nurses infused colloid fluids (n = 9), actively warmed patients (n = 8), and sedated patients with propofol (n = 6).

Nurses' management of hypertension was proactive. For example, 15 minutes into observation 37, the experienced nurse increased the GTN infusion from 20 mcg/min to 120 mcg/min to lessen the hypertension. Nurse 37 said that she was mindful that the patient had bled in theatre and was concerned that his hypertension (MAP = 100 mmHg) would cause further bleeding. She wanted the MAP to be lower than 90 mmHg as soon
as possible. When the patient did not respond to a gentle rise in the GTN dose, the nurse increased the dose markedly. Participant 37 remarked:

> He was so hypertensive, his MAP was up around 90 to 100, I did want to get that down quite quickly…I was actually expecting a quicker response to the GTN, I thought that with me going up by 20 or 30 or even 40 that I would have seen a much quicker drop in blood pressure and when that didn't happen, that was when I kept going up… he actually doesn’t have the normal quick effect from the GTN.

Participant 37 continuously looked at the monitor and did not move away from watching the monitor until the hypertension was under control. Additionally, to prevent the possibility of hypotension from the increase in GTN dose, nurse 37 immediately began infusing colloid fluids. This situation illustrates the advantage of nurses' knowledge of, and familiarity with, hypertension, actions of vasodilator drugs, and usual physiological responses to vasodilator drugs in the context of postoperative cardiac patients at risk of bleeding.

None of the patients who bled (n = 8) suffered hypertension, they all, however, had episodes of hypotension. One inexperienced nurse (ID, 5) who was receiving help from similarly inexperienced nurses, did not appear to recognise a labile MAP and three intermittent, profound episodes of hypotension (MAP of 60 mmHg, 45 mmHg, and 29 mmHg) as signs of bleeding. The patient was hypotensive and unable to maintain a normal PCWP despite receiving 1.5 L of blood products. The patient had slowly lost 255 mls of clotty blood and was peripherally cold and shutdown. The nurses' inexperience probably impeded her ability to integrate these numerous haemodynamic cues and recognise that the patient may be bleeding. However, nurse 5 had responded appropriately to individual parameters. For instance, the patient was given colloid fluid for a low preload, inotropes for a low cardiac index and hypotension, and procoagulant therapies to normalise the clotting profile. Deeper investigations into the cause of the hypotension and a reflection on the patients' whole haemodynamic status were not carried out until an experienced nurse assisted the primary nurse during the third episode of profound hypotension. Following discussions, the experienced colleague told the primary nurse that the patient was most likely bleeding. Subsequently, medical staff
were alerted and investigations were carried out that led to the patient's return to theatre for surgical reexploration.

5.2.2.3 Chest drains

Nurses' management of chest drains in the initial 2-hour period involved establishing the chest drainage system, maintaining tube patency, and assessing chest drainage. The frequency of nurses' decision making regarding these procedures is shown in Table 5.13.

Establishing chest drainage systems

While primary nurses received the patient, colleagues usually took responsibility for establishing the chest drainage system. However, once patients were settled, all primary nurses looked at the drainage receptacle and the tubes where they exited the chest wall.

The majority of nurses (76%) forcefully pushed each chest tube and the extension tubing into the Y connection to ensure that connections were secure (see Table 5.13). The higher frequency in securing connections by inexperienced nurses was due to experienced assistant nurses and inexperienced primary nurses performing this function during the admission of patients. Twenty-four percent of nurses (n = 9) placed pieces of opaque tape longitudinally on the Y connection according to a unit-based protocol (see Table 5.13). When asked if she considered the protocol necessary to ensure integrity of the connections, participant 23, who had complied with the protocol, replied no and added:

In fact it can actually cause more harm. I took over someone the other day and they actually taped it completely and it had a clot in it.

This practice had the potential to be dangerous because, if the tape was not carefully placed longitudinally, it could obscure clots which may impede chest drainage.

Maintaining chest tube patency

All nurses kept chest tubes free of kinks (see Table 5.13), but dependent loops could form in the tubing because of the length of the extension tubing and poor
<table>
<thead>
<tr>
<th>Procedure</th>
<th>Inexperienced (n = 18)</th>
<th>Experienced (n = 20)</th>
<th>Total (n, %)</th>
<th>Excerpts form transcripts of observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest drainage system</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Establish 20 cm H₂O suction</td>
<td>18, 100</td>
<td>20, 100</td>
<td>38, 100</td>
<td>(Obs. 1) Primary nurse looks at the chest drains, she has turned on the suction. Assistant nurse connected the chest drains, but I don't think she turned on the suction as I can now hear bubbling. There was no bubbling sound before. I can also see an air leak in the drainage tubes.</td>
</tr>
<tr>
<td>Ensure secure connections</td>
<td>17, 94</td>
<td>12, 60</td>
<td>29, 76</td>
<td>(Obs 31.) She is taping the chest drains, taping the chest tube connections so that they are, I presume, so that they don't disconnect.</td>
</tr>
<tr>
<td>Opaque tape along connections</td>
<td>1, 6</td>
<td>8, 40</td>
<td>9, 24</td>
<td></td>
</tr>
<tr>
<td>Chest drain patency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tubes free of kinks</td>
<td>18, 100</td>
<td>20, 100</td>
<td>38, 100</td>
<td>(Obs. 15) Primary nurse is lifting the chest drains and moving the tubes into a position for them to freely drain.</td>
</tr>
<tr>
<td>Manipulation with fingers</td>
<td>5, 27</td>
<td>5, 25</td>
<td>10, 26</td>
<td>(Obs. 33) She is now milking the chest drains with a pair of milkers.</td>
</tr>
<tr>
<td>Milked chest tubes</td>
<td>3, 17</td>
<td>3, 15</td>
<td>6, 16</td>
<td>(Obs. 30) They just explain to the patient that they’re going to roll him over to the other side in order to see if the drains anything out the other side as well. There is 195ml in the drains after 1¼ of a hour. The registrar asks if blood dumped out of the drains, nurse replies no.</td>
</tr>
<tr>
<td>Assess for collection in chest</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roll patient</td>
<td>4, 22</td>
<td>4, 20</td>
<td>8, 21</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Obs. = observation.
placement of both the chest tubes and collection receptacle. Nurses drained any fluid that had accumulated in a dependent loop into the collection receptacle between three and nine times in the recovery period.

To aid tube patency, 26% of participants (n = 10) manipulated the chest tubes with their fingers and 16% of participants (n = 6) milked the chest tubes (see Table 5.13). It was observed that those practices were only used when nurses saw clots in the tubes or there was a sudden slowing of drainage in patients known to be bleeding. Both experienced and inexperienced nurses manipulated the chest drains to free clots and help maintain tube patency.

Assessments of chest drainage

All nurses made at least three assessments of chest drainage volume. A higher frequency of drainage assessments were performed in patients who bled. It is not possible to provide more precise data regarding chest drain assessments because colleagues who assisted primary nurses often called out information about chest drainage or documented their findings on patients' observation flow charts, and these events could not be observed.

Of the 8 patients who bled due to surgical or medical reasons, all showed signs of excessive drainage and clots in the drain tubes. However, two inexperienced nurses (ID, 5 and 34), did not appear to recognise the significance of those cues because they did not initiate milking of the tubes to clear the clots, nor assess patient data for signs of bleeding. Two other inexperienced nurses (ID, 6 and 11) received advice from experienced colleagues about the potential significance of clots in the chest tubes and responded by milking the tubes to clear the clots and assessing for, and responding to, patient data indicative of bleeding. One inexperienced nurse (ID, 19) and three experienced nurses (ID, 3, 12, and 31) made rapid responses to the levels and type of drainage. Those responses included assessments of other patient data, milking chest drains, and initiating conversations with medical staff regarding haematological tests, procoagulant drugs, and blood product infusions. These data suggest that in some instances, inexperienced nurses can require decision support to detect and respond to bleeding in a timely manner.
Twenty-one percent of nurses (n = 8) rolled patients from side to side to assess for a collection of blood in the chest. One experienced participant (7) was unable to roll her patient because she said she was in a geographically isolated cubicle and did not have ready access to colleagues. Participant 7 explained:

The drains seemed to be still draining okay, and they didn’t stop, but they also weren’t flowing for somebody who was suppose to be oozy as well. So that’s why I would have liked to have rolled this patient and made sure there wasn’t pooling blood in his chest or anything like that but…this unit is quite different, its layout, people can’t see you to help you as readily.

Nurse 7 believed that being located in an isolated cubicle impeded her ability to fully assess the patients' bleeding status. Participant 34, an inexperienced nurse, who rolled her patient argued that the procedure needed to be prioritised within the first few hours after surgery:

Probably the most important thing was that I wanted to roll him to see if he dumped any blood from his chest tubes and I wanted to get that done before the end of my shift…he did move some blood. Not a lot, but a couple of hundred mls.

Participant 34's comments indicate that she was unaware that the volume of blood that drained as a result of rolling the patient probably indicated that he was bleeding. The patient also had abnormal clotting results. An experienced nurse in attendance saw the drainage and called medical staff to review the patient.

5.2.2.4 Surgical wounds

All participants assessed surgical wounds. Nurses looked to see if dressings were intact, dry, and secure. In patients with radial artery graft sites, nurses performed neurovascular observations of the relevant hand. Two nurses responded to minor problems. Participant 34 elevated the patient's left arm that had been used to procure the radial artery because the hand was swollen and cool to touch. Participant 8 reinforced the radial artery donor site because blood had oozed through the bandage.
5.2.2.5 Summary

Both experienced and inexperienced nurses assessed and managed patients’ haematological status in combination with medical staff according to unit-based protocols and patients' clinical data. Similarly, experienced and inexperienced nurses continuously appraised, evaluated, and responded to, data indicative of hypertension. Nurses skilfully implemented a combination of therapies that included titrating vasoactive infusions, infusing colloid fluids, rewarming, and sedation in order to promptly reestablish normotension and reduce the risk of bleeding from hypertension. None of the patients who had hypertension bled during the recovery period.

Experience influenced nurses' management of bleeding. Three experienced nurses, 2 inexperienced nurses who received decision support from experienced nurses, and 1 inexperienced nurse, recognised complex sets haemodynamic data suggestive of bleeding and responded to such data appropriately in order to promote haemostasis. A further 2 inexperienced nurses neither detected bleeding in their patients, nor responded in a timely manner until experienced nurses provided decision support. Thus, experience enhanced nurses' abilities to evaluate, and respond to, data suggestive of bleeding.

Variability in nurses' management of chest drains and chest drainage systems occurred due to unit-based protocols, patients' level of haemostasis, and evidence-based practices. Although 26% of participants manipulated chest tubes with their fingers and 16% of participants milked the chest tubes when clots were present, the majority of nurses (58%) who did not manipulate the tubes in the absence of clots also adhered to evidence-based practices. That is, current evidence suggests that the manipulation of chest tubes does not enhance tube patency over nonmanipulation of tubes in the absence of clots (Charnock & Evans, 2001). It is not known, however, if any or all of these nurses' actions were coincidental or deliberate. An equal number of experienced and inexperienced nurses rolled patients in order to see if blood was collecting in the chest. This practice is not supported by research, however, one patient's bleeding was detected as a result of this procedure. Further research is required to validate or refute the practice.

The culmination of these findings suggests that experience can influence the ability of nurses to interpret complex sets of data suggestive of bleeding, but not the
ability of nurses to manage hypertension, chest drainage systems, or haematological status.

5.2.3 Reestablishment of Normothermia

The reestablishment of normothermia involved monitoring core and body shell temperatures and rewarming patients with hypothermia. The reestablishment of normothermia also involved preventing the onset of shivering and, in the event of its occurrence, promptly responding to limit its extent and duration. Commonality and variability in nurses’ decision making regarding these issues are presented in this section.

5.2.3.1 Core temperature

The majority of nurses (97%) assessed core temperature continuously via a PAC. Participant 30 assessed core temperature intermittently with a tympanic membrane thermometer because patient 30 did not have a PAC. All nurses assessed body shell temperature during physical assessments of perfusion as described in Section 5.2.1.2.

The mean core temperature of patients on admission was 35.6 (SD = .85, min. = 32.6, max. = 37.3) °C. In response, 79% of nurses (n = 30) actively rewarmed patients (see Table 5.14). Ten patients had received rewarming via forced-air blankets during surgery because the disposable blankets were in place on admission. Eight nurses (21%) continued this method of rewarming. A decision was made by 21% of nurses (n = 8) not to actively rewarmed patients. The reasons for not commencing active rewarming included: 

- core temperatures greater than 36 °C (n = 6) and body shell temperatures feeling warm to touch despite core temperatures below 36 °C (n = 2). For example, one experienced nurse (ID, 37) placed a warming blanket on the patient in response to an admission core temperature of 35.9 °C, but did not turn on the blanket because she said the patient had rewarmed to 36 °C and felt warm to touch within 30 minutes. Another experienced nurse (ID, 28) said the patient felt warm to touch, even though core temperature was below 36 °C for the duration of the observation (see Table 5.14). A rewarming blanket was in place, but not turned on. As noted by the nurse, she was preoccupied trying to control recurrent episodes of profound hypotension and reestablish haemodynamic stability.
<table>
<thead>
<tr>
<th>Decision to rewarm patient</th>
<th>Inexperienced (n = 18)</th>
<th>Experienced (n = 20)</th>
<th>Total (n = 38)</th>
<th>Excerpts from transcripts of observations and interviews</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continued</td>
<td>6, 33</td>
<td>2, 10</td>
<td>8, 21</td>
<td>(Int. 28) I probably would have started (rewarming) a lot sooner, but there was so much else happening and she felt warm. So the priority was the MAP at that stage. Because things seemed to happen quite quickly, she had no blood pressure. So I probably would have had a warming blanket on a lot sooner, but just didn’t.</td>
</tr>
<tr>
<td>Commenced</td>
<td>10, 55</td>
<td>12, 60</td>
<td>22, 58</td>
<td>(Obs. 3) Nurse is lifting up the patient’s blanket and tubes and putting the warming blanket on the patient. The patient currently has a warmed green cotton blanket on which was doubled, she’s lifting that off and putting a forced-air warming blanket on.</td>
</tr>
<tr>
<td>Not initiated</td>
<td>2, 11</td>
<td>6, 30</td>
<td>8, 21</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of rewarming blanket used</th>
<th>Inexperienced (n = 18)</th>
<th>Experienced (n = 20)</th>
<th>Total (n = 38)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forced-air warming blanket</td>
<td>11, 68</td>
<td>13, 86</td>
<td>24, 78</td>
</tr>
<tr>
<td>Warmed cotton blankets</td>
<td>5, 32</td>
<td>1, 7</td>
<td>6, 19</td>
</tr>
<tr>
<td>Reflective metallic blanket</td>
<td>0, 0</td>
<td>1, 7</td>
<td>1, 3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Temperature setting of forced-air device (n = 24)</th>
<th>Inexperienced (n = 18)</th>
<th>Experienced (n = 20)</th>
<th>Total (n = 38)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>7, 64</td>
<td>10, 77</td>
<td>17, 71</td>
</tr>
<tr>
<td>Medium</td>
<td>1, 9</td>
<td>2, 15</td>
<td>3, 13</td>
</tr>
<tr>
<td>Missing data</td>
<td>3, 27</td>
<td>1, 8</td>
<td>4, 16</td>
</tr>
</tbody>
</table>

*Note.* Obs. = observation. Int. = interview. *n = 24 nurses who used forced-air warming blanket.*
(see Table 5.14). These two situations suggest experienced nurses prioritise decisions according to patient acuity and use combinations of cues to initiate active rewarming.

Active rewarming was initiated slightly more frequently by inexperienced nurses than experienced nurses, but 25% of inexperienced nurses (n = 4) did so on the advice of experienced colleagues. Methods of active rewarming included forced-air warming blankets (79%), warmed cotton blankets (19%), and reflective metallic blankets (3%).

The average temperature at which participants said they commenced active rewarming was 35.5 (SD = .76) °C. As Table 5.15 shows, the mean temperature used by nurses to initiate rewarming did not differ greatly according to experience. Active rewarming measures were discontinued by 26% of nurses (n = 10) during the 2-hour recovery period. The mean core temperature in those patients (n = 10) had reached 36.9 (SD = 0.5) °C when rewarming was ceased. As only 10 nurses were observed to discontinue rewarming, participants in Phase Two were asked what temperature reading they used in their usual practice to discontinue rewarming. The average core temperature that nurses (n = 31) said they used to discontinue rewarming was 36.7 (SD = 0.3) °C. As illustrated in Table 5.15, experienced and inexperienced nurses used a similar core temperature to discontinue rewarming.

| Table 5.15 |
| Mean Core Temperature Used by Nurses to Initiate and Discontinue Active Rewarming (n = 31) |
| Rewarming decision | M | SD |
| Mean Temperature (°C) for initiation | | |
| Experienced nurses | 35.1 | 0.9 |
| Inexperienced nurses | 35.7 | 0.5 |
| Mean temperature (°C) for discontinuation | | |
| Experienced nurses | 36.8 | 0.3 |
| Inexperienced nurses | 36.7 | 0.4 |

The majority of nurses (71%) set a high temperature setting on the forced-air rewarming devices in accordance with unit-based protocols and 13% of nurses set a medium temperature setting (see Table 5.14). Two experienced participants deliberately
lowered the temperature setting to medium when they saw it had been set on high by inexperienced colleagues. When asked, participant 10 explained that he had seen patients vasodilate too quickly when warmed too rapidly:

I’ve seen it before where you warm a patient quite aggressively and they basically dilate very quickly and that’s when you have problems trying to keep the blood pressure up. That was the reason why I turned the temperature down. I don’t like to have it set hyperthermic, I prefer to just warm them up to a normal temperature…(otherwise) you are meeting problems and you need noradrenaline.

Participant 10 postulated that aggressive rewarming creates a rapid rise in temperature over a short period of time which causes rapid peripheral vasodilation, that is, a low SVR. Similarly, participant 25, an experienced nurse, lowered the warming device to medium which had been set by an inexperienced nurse. Nurse 25 said that she did so:

Just because he had warmed up a little, and so I turned it down so that he didn’t warm up too quickly and over warm and dilate up and drop his blood pressure.

In this study, 11 patients had an SVR lower than normal (800 to 1200 dynes·sec·cm⁻⁵). As shown in Figure 5.5, the rise in mean temperature of patients with an SVR less than 800 dynes·sec·cm⁻⁵ was 0.8 °C over 75 minutes. That compares with a 1 °C temperature rise in patients over the 2-hour recovery period (see Table 4.5). A rise of 1 °C over 2 hours falls within the generally accepted practice for safely rewarming hypothermic patients. These data suggest that patients who had a lower than normal SVR may have been warmed too rapidly. No conclusions can be drawn about the role of the temperature setting on the device or the rise in mean temperature in the development of a low SVR because there is missing data about the temperature settings used by nurses and the study was not designed to investigate such relationships. Nevertheless, these data suggest that patients who had a low SVR experienced a faster rise in temperature than is generally accepted for safely rewarming hypothermic patients.

Although participants 10 and 25 provided reasons for lowering the temperature setting on the device, they may not have needed to do so because the device
automatically changed from a high temperature setting to a medium temperature setting after a certain time period. Only one nurse said that he realised the device automatically changed its temperature setting, but his knowledge of the device's operation was not complete. Participant 12 said:

Well those (warming devices) default after a period of time from your high setting to your middle. Which I don’t remember from memory them doing that in (previous unit named)...Because you push 40, 36 to 40 or like the high setting and you go back, 5 or 10 minutes later and its back down. It must go, it drops down.

Similarly, nurses did not know how long the device warmed at the highest temperature setting before it changed to the medium setting. In sum, many nurses' knowledge of, and familiarity with, the functioning of the forced-air warming devices was limited despite the frequent practice of rewarming this cohort of patients.

![Graph showing temperature over time](image)

**Figure 5.5.** Mean temperature in degrees Celsius over 2-hour recovery period in patients with systemic vascular resistance less than 800 dynes·sec·cm⁻⁵ (n = 11).
It was observed that the rewarming devices were poorly designed and maintained and these factors had the potential to impact upon patient management. There were eight instances in five observations where the hose that transferred the warmed air from the device to the actual blanket disconnected at the blanket end. Disconnections occurred because the clip connecting the hose to the blanket was too flimsy for the weight of the hose, clips were broken, or nurses accidentally brushed against the hose as they walked past. As a result, warm air blew into the surrounding atmosphere rather than into the blanket. Unless the nurse heard the hose fall to the floor or periodically performed a thorough assessment by looking under all the sheets and blankets on top of the patient, the disconnection was not detected. An example of how the state of forced-air warming devices could impact on patients was observed during observation 32. The patient was received with a core temperature of 34.7 °C. Despite the application of a forced-air warming blanket on the highest temperature setting, the patient's core temperature reached only 34.8 °C by the end of the 2-hour recovery period probably because there had been an accidental disconnection of the hose for 68 of the 120 minutes. It is likely that hypothermia contributed to the patient's high level of haemodynamic instability which manifested as an extremely labile MAP despite numerous manipulations of the sodium nitroprusside infusion and the administration of 1275 mls of colloid fluid.

The decisions made by nurses to reestablish normothermia adhered to best practices in terms of the temperature at which rewarming was initiated and discontinued. Although the majority of nurses (71%) initiated rewarming, 9 patients shivered during the 2-hour recovery period. Variability in nurses' management of shivering is presented in the next section.

5.2.3.2 Shivering.

As described in Chapter 4, 24% of patients (n = 9) shivered during the recovery period. Two of those 9 patients shivered on two or more separate occasions. All of the patients who shivered were being warmed with either a forced-air warming blanket (n = 8) or warmed cotton blankets (n = 1). The latter patient was normothermic on admission (37.3 °C), so the nurse used warmed blankets to maintain his temperature. These data suggest that nurses had made attempts to prevent the onset of shivering by trying to reestablish or maintain normothermia through rewarming measures.
Four experienced nurses and 1 inexperienced nurse detected shivering. Shivering was not detected by 4 inexperienced nurses, (ID, 18, 21, 34 and 35). However, during two of these observations (ID, 21 and 35), experienced colleagues who were assisting the nurses detected the patients' shivering and immediately informed the primary nurses.

The time taken by participants to respond to shivering once it was detected is shown in Table 5.16. Response times varied between less than 1 minute and 75 minutes. In observations 21 and 35, the response times of less than 1 minute were due to the experienced nurses' actions of immediately alerting the inexperienced primary nurses and doctors to the problem and rapidly responding with drug therapies. In cases where shivering was recognised and reported to medical staff, it was controlled by pharmacological means. As illustrated in Table 5.16, there appeared to be little consistency in either drugs used or the doses of those drugs to control shivering.

Despite the active rewarming measures taken by nurses to prevent shivering and the pharmacological responses by 7 nurses to stop shivering, the mean duration of shivering was 42 (SD = 30) minutes. Patients of experienced nurses shivered for less time (X = 35, SD = 23 minutes) than those of inexperienced nurses (X = 49, SD = 36 minutes). Patient 35 demonstrated a short duration (less than 4 min) of shivering. The prolonged duration of shivering in most patients, and the finding that only participant 33 responded twice to a single episode of shivering, suggest that few nurses evaluated the effectiveness of drug therapies following administration. Although experienced nurses' responses to shivering were faster than those of inexperienced nurses, in light of the deleterious effects of shivering for the cardiovascular system and the potential adverse impact upon patient outcomes, most of the nurses involved demonstrated poor responsiveness to shivering.
### Table 5.16

**Duration of Patient Shivering, Nurses' Response Times, and Nurses' Interventional Responses to Shivering**

<table>
<thead>
<tr>
<th>Nurses' level of experience</th>
<th>Participant number</th>
<th>Response time (mins)</th>
<th>Shivering duration (mins)</th>
<th>Therapeutic response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experienced</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>68</td>
<td></td>
<td>Propofol infusion commenced</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Warm blankets</td>
</tr>
<tr>
<td>8</td>
<td>25</td>
<td>27</td>
<td></td>
<td>Pethidine 25mg</td>
</tr>
<tr>
<td>12</td>
<td>5</td>
<td>16</td>
<td></td>
<td>Pethidine 25 mg</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>14</td>
<td></td>
<td>Pethidine 25 mg</td>
</tr>
<tr>
<td>33</td>
<td>25</td>
<td>50</td>
<td></td>
<td>Propofol bolus x 2</td>
</tr>
<tr>
<td>Inexperienced</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>7</td>
<td>97</td>
<td></td>
<td>Pethidine 50 mg</td>
</tr>
<tr>
<td>18</td>
<td>31</td>
<td>31</td>
<td></td>
<td>No response</td>
</tr>
<tr>
<td>21</td>
<td>&lt; 1</td>
<td>40</td>
<td></td>
<td>Propofol bolus</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td></td>
<td></td>
<td>Pethidine 25 mg</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td></td>
<td></td>
<td>Pethidine 25mg</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Warmed blankets</td>
</tr>
<tr>
<td>34</td>
<td>75</td>
<td>75</td>
<td></td>
<td>No response</td>
</tr>
<tr>
<td>35</td>
<td>&lt; 1</td>
<td>4</td>
<td></td>
<td>Propofol infusion commenced</td>
</tr>
</tbody>
</table>

**Note.** < = less than.
5.2.3.3 Summary

All nurses appraised and evaluated core temperature and body shell temperature. Variability in responses to hypothermia were sourced to the methods used to rewarm patients and the temperature setting of rewarming devices. In accordance with unit-based protocols, 71% of nurses set the temperature of forced-air rewarming devices on high. The medium temperature setting was chosen by 13% of nurses. There was a trend toward experience influencing the decision to commence rewarming, but experience did not appear to influence nurses’ decisions to discontinue rewarming. Two experienced nurses believed that there were potential adverse effects from too rapid rewarming on patients' haemodynamic status.

Responding to shivering appeared to be a particularly complex task for the nurses involved, however, experienced nurses showed slightly better techniques of managing shivering in terms of detection and responsiveness than inexperienced nurses. As a result, patients of experienced nurses shivered for a shorter duration than patients of inexperienced nurses. Different drugs were used to treat shivering which may reflect a lack of clear guidelines regarding the treatment of shivering in cardiac surgical patients.

5.3 Discussion

The purpose of this chapter was to describe the variability in nurses' haemodynamic decision making during the initial 2-hour period following cardiac surgery, as a function of the complexity of haemodynamic decisions, nurses' cardiac surgical intensive care experience, and environmental factors. Haemodynamic decision making was analysed in relation to the following goals of therapy: (a) optimisation of cardiovascular performance; (b) promotion of haemostasis; and (c) reestablishment of normothermia. This was done in order to explore the proposition that interplay between the multifactorial influences on decision making would lead to clinically significant variability of nurses' haemodynamic decision making in relation to the three goals of therapy. Where possible, nurses' decision making was analysed in terms of best practice management. The findings suggest that the major influence on nurses' interactions with
patients and therapeutic decision making was experience. The experience of primary nurses and the experience of assistant nurses who provided decision support to inexperienced nurses influenced nurses' appraisal and evaluation of haemodynamic data concerning the three goals of therapy, and nurses' responsiveness to those data. Environmental characteristics also played a part in variability of nurses' haemodynamic decision making. In particular, geographical isolation and system factors influenced nurses' decision making regarding the three goals of therapy.

5.3.1 Commonality and Variability in Haemodynamic Decision Making

For the optimisation of cardiovascular performance, all nurses assessed salient parameters, arterial blood gases, and serum electrolytes. However, there was variability between nurses in recording a 12-lead ECG and checking the settings and function of pacemakers. It is common practice in the postoperative period to assess for cardiac ischaemia and conduction disturbances via a 12-lead ECG and to assess the appropriateness of pacemaker settings (Finkelmeier, 2000). Sixteen of 33 nurses checked the pacemaker and it is clinically significant that the majority of these nurses (69%) subsequently altered settings in order to improve cardiovascular performance through heart rate and rhythm. This suggests that the pacemaker settings chosen at the end of surgery may not be appropriate for the patient's cardiovascular state in the initial 2-hour recovery period. Although pacing assessments for appropriate settings and function have been recommended to be carried out every 8 to 24 hours in general critical care or coronary care patients (Hickey & Baas, 1991; Mansfield, 2000), findings from this study suggest assessments of this kind are required in the immediate 2-hour recovery period in this cohort of patients. The frequency of cardiac output assessments varied between nurses according to the credence given to the value of assessing cardiac index when other parameters indicated haemodynamic stability. This finding suggests that some nurses lack knowledge about the significance of cardiac index for patient outcomes in terms of lengths of stay (Christakis et al., 1996; Miller, 1998) and mortality (Dietzman et al., 1969; Kumon et al., 1986; Yau et al., 1999).

Throughout the 2-hour recovery period, nurses deviated from certain evidence-based techniques for assessing accurate cardiovascular data. Evidence-based guidelines that were poorly adhered to included patient positioning during pressure and cardiac
output measurements, ensuring a 12 °C temperature differential between the injectate temperature and blood temperature during cardiac output measurement, timing the injection of cardiac output injectate solution throughout the respiratory cycle, using the correct method to calculate the average cardiac output, and levelling transducers to the phlebotastic axis. The scope of this study precludes conclusions about the effects, if any, on patient outcomes as a result of nurses' decision making in this regard. However, these data suggest there is a research-practice gap that has the potential to result in inaccurate measurements of cardiovascular parameters. These findings support findings from questionnaire-based studies (Bridges, 1991; lberti et al., 1994; McGhee & Woods, 2001; Straw, 1986) that found nurses' theoretical and clinical knowledge of the principles of haemodynamic monitoring to be low. These data are also consistent with a previous study (Grap, Pettrey, & Thornby, 1997) that found evidence based practices surrounding haemodynamic parameters are not implemented consistently or completely at the bedside by critical care nurses.

In relation to the promotion of haemostasis, nurses assessed haemoglobin in all patients and measured full clotting profiles in patients who showed signs of bleeding. All patients had a chest x-ray taken. Patients were closely monitored for signs of hypertension and nurses were very responsive with therapeutic interventions to reestablish normotension when patients became hypertensive. For chest tube management, all nurses applied suction, ensured chest tubes were not kinked, and milked or manipulated chest tubes to ensure continuous patency (Charnock & Evans, 2001; Symbas, 1989), however, variability in securing connections and positioning patients for chest drainage occurred. Nurses' actions of siting patients upright continuously, that is, beyond 45° head of bed elevation, at the request of surgeons for the purpose of facilitating chest drainage had the potential to lead to inaccurate recording of parameters and inappropriate therapeutic interventions. Pressure-based parameters are accurate to a head of bed elevation of 45° (Chulay & Miller, 1984; Dobbin et al., 1992; Wilson et al., 1996) and cardiac outputs are accurate to a head of bed elevation of 20° (Grose et al., 1981; Kleven, 1984). It is not known if lack of knowledge regarding relevant research or nurses' lack of authority led to their acquiescence to such requests. Nurses have previously reported a lack of control over their practice and a lack of support from physicians regarding the implementation of evidence-based practices
regarding haemodynamic monitoring (Grap et al., 1997). Whatever the reason for nurses' decisions, it raises questions about measures that can be put in place to educate both nurses and surgeons about current literature regarding patient positioning for recording accurate haemodynamic data.

In relation to the reestablishment of normothermia, nurses commonly monitored patients' core and body shell temperatures and rewarmed patients who were hypothermic. Nurses' actions adhered to best practices regarding temperature monitoring and rewarmed (Giuffre et al., 1994; Harrison & Ponte, 1996; Morley-Forster, 1986; Mort et al., 1996). The temperature recordings used by nurses to initiate and discontinue active rewarmed approximated those recommended in the literature (Phillips & Skov, 1988). Many nurses deviated from recommendations for a medium temperature setting of forced-air rewarmed devices in patients, such as postoperative cardiac patients, who are unconscious and have poor perfusion (Moors et al., 1994). The majority of nurses (71%) set forced-air rewarmed devices on high according to unit-based protocols. This finding suggests a review of the processes surrounding the basis for unit-based protocols may be required. Nurses were also found to have a poor understanding of mechanisms of forced-air warming devices, despite using them frequently. For nurses to use technology fully, they must have skills and knowledge related to the equipment. Past reports have noted that nurses find it difficult to learn and develop familiarity with every device in critical care (Bucknall & Thomas, 1997; Morrison, Beckmann, Durie, Carless, & Gillies, 2001). If technology is not used to its fullest potential, its utilisation is questionable. These data suggest nurses require more education about the function and use of rewarmed equipment in the recovery of cardiac patients.

The finding that shivering occurred in 9 patients and continued for prolonged periods in 8 of these patients suggests that current guidelines for managing shivering may be inadequate and that nurses lack sufficient knowledge and skills regarding detection and treatments. Shivering must be promptly detected and stopped because prolonged shivering is an ineffective means of rewarmed and can lead to haemodynamic instability through a marked increase in oxygen consumption, metabolic rate, carbon dioxide production (Holtzclaw, 1986; Mort et al., 1996). Most nurses detected the onset of shivering by sight. None of the nurses palpated patients' mandibles to detect low grade shivering as suggested by Holtzclaw (1986), although one nurse
palpated a patient's forehead. The observed variability in methods of detection and responses suggest that nurses require greater knowledge about managing shivering in order to prevent prolonged episodes of shivering and associated haemodynamic instability.

Experienced-based practices were observed that have not been explored in the literature. The majority (95%) of nurses assessed CVP on a dynamic waveform because the monitors did not provide for the stop-cursor method of assessing CVP in the same way as they did for PCWP. Some nurses also lay patients' heads below 0° flat during episodes of profound hypotension, however, the accuracy of pressure-based parameters in this position has not been established.

Twenty-one percent of nurses rolled patients to assess chest tube patency and to see if blood had collected in the chest. The practice was performed in all settings by experienced nurses and inexperienced nurses who had been taught to do so by experienced nurses. This practice is not supported by evidence, but one patient's bleeding was detected as a consequence of the procedure. Another practice not supported by current evidence related to too rapid rewarming and low SVR syndrome. Two experienced nurses made sure that the forced-air rewarming devices were not set on high because they believed that a high setting had the potential to warm patients too quickly, cause peripheral vasodilation, a low SVR, and hypotension. Patients with a low SVR in this study had a faster rate of rewarming than patients who did not have a low SVR. No claims are being made that rapid rewarming caused patients to have a low SVR; but, rather, that the phenomenon has not been reported in the literature to date. It is possible that clinical knowledge of chest drain management and rewarming is held by experienced nurses and used in everyday practice to guide their decision making. Previously, Crandall and Getchell-Reiter (1993), reported that experienced nurses held intuitive knowledge about cues to detect sepsis in babies that was not part of mainstream literature. Yet that knowledge contributed positively to patient outcomes. It is possible that nurses' clinical knowledge of chest tube management and rewarming may also have an important role to play in the recovery of cardiac patients. Further research is required to validate these nurses' actions.
5.3.2 The role of experience

Experienced primary nurses assessed and evaluated most haemodynamic data more frequently than inexperienced nurses. A higher assessment frequency suggests experienced nurses monitored patients' haemodynamic status closely, looked for antecedents of haemodynamic instability prior to intervening, and evaluated patients' responses to therapeutic interventions. Experienced nurses detected, and responded to, signs of haemodynamic instability and complications such as hypotension, bleeding, and shivering more rapidly than inexperienced nurses. Experienced nurses demonstrated an ability to combine complex, subtle combinations of cues in their decision making and this skill enabled rapid recognition of postoperative problems and responses in order to reestablish haemodynamic stability potentially contributing to optimum patient outcomes. The decision strategies used by experienced nurses are consistent with those described by Benner and colleagues (1984; 1992) who found that nurses with more than 3 years experience showed a mastery of nursing skill and used previous experiences to make decisions. The skills and abilities of experienced nurses in this study to recognise subtle ipsative changes in certain haemodynamic data, integrate combinations of numerous cues, accurately interpret data, and respond rapidly with therapeutic interventions to both maintain and reestablish haemodynamic stability are skills associated with experience (Baumann & Bourbonnais, 1982, 1983; Benner, 1984; Benner et al., 1992; Bourbonnais & Baumann, 1986; Chi et al., 1988; Crandall & Getchell-Reiter, 1993; Elstein et al., 1978; Shanteau, 1992; Thompson & Sutton, 1985). One inexperienced nurse also demonstrated rapid decision making skills and an ability to integrate complex sets of data to determine the significance of those data.

The outcomes of inexperienced primary nurses' decision making was on a par with experienced primary nurses' decision making when they received decision support from experienced nurses. Experienced nurses assisted inexperienced nurses to identify and integrate complex, often subtle, combinations of salient cues and choose appropriate interventions in order to reestablish haemodynamic stability. In particular, experienced nurses assisted inexperienced nurses to detect and respond to hypotension, low cardiac output syndrome, low SVR syndrome, bleeding, and shivering. An example of this situation was during observation 6 when an experienced nurse assisted the inexperienced
primary nurse to alleviate hypotension by changing the settings on the pacemaker, identify and respond to bleeding caused by a coagulopathy, and respond to the emergence of low SVR syndrome with the commencement of a noradrenaline infusion. In doing so, optimal decision making took place and patient outcomes had the potential to be optimised.

The findings suggest that experienced nurses, one inexperienced nurse, and inexperienced nurses who received decision support from experienced nurses demonstrated optimal decision making. Optimal decision making aimed to prevent or alleviate haemodynamic instability or potential complications in relation to the three goals of therapy. The definition of optimal decision making was based on a description of goal-directed decision making by Ellis (1997) whereby nurses acted to solve problems or made progress toward solving problems that were known to exist or had the potential to exist. The findings that experienced nurses made optimal decisions for each goal of therapy in this study support those of Ellis (1997) who found that nurses with more than 3 years specialty experience made goal-directed decisions. Ultimately, experience moderated the difficulty of complex tasks because experienced nurses were able to manage all forms of haemodynamic instability.

The outcomes for nurses' decision making as a result of receiving decision support from experienced colleagues has not been well understood from previous studies. The findings of this study suggest that the outcomes of inexperienced nurses' decision making can benefit when these nurses request, or are provided with, decision advice and support from experienced colleagues. Since nurses' haemodynamic decision making concerning the three goals of therapy has the potential to optimise patients recoveries through the prevention of haemodynamic instability and potential complications, the findings suggest decision support for inexperienced nurses may be crucial to optimising patient recoveries in the 2-hour recovery period.

5.3.3 The role of environment

During the recovery period, there were times when inexperienced nurses' access to experienced decision support was limited because inexperienced nurses were recovering patients in isolated cubicles and had little access to roving staff. Alternatively, there may have been few experienced nurses available due to the staffing
mix or workload issues within the unit at the time. There were also situations where inexperienced nurses provided decision support to inexperienced primary nurses. In these situations, autonomous decision making by inexperienced nurses took place. Inexperienced nurses relied upon medical orders, unit protocols, or their limited experience to make autonomous decisions; they did not seek decision advice from their inexperienced peers. Findings suggest the quality of nurses' management of haemodynamic instability and postoperative complications in the absence of decision support due to environmental characteristics could vary. For instance, inexperienced nurses' autonomous decision making regarding hypertension, cardiac tamponade, hypoxaemia, and hypothermia were managed well. These findings suggest most nurses were familiar with, and confident of, managing such forms of haemodynamic instability.

In the absence of decision support from more experienced colleagues, some inexperienced nurses appeared to have difficulty managing hypotension, low SVR syndrome, bleeding, and shivering. In these circumstances, inexperienced nurses responded with interventions to treat individual parameters that had deviated, but the underlying causes of haemodynamic stability were not detected or optimally managed. An example of this situation occurred during observation 5 when the inexperienced nurse was unable to integrate periodic, complex, and seemingly diverse presentations of haemodynamic instability. However, once an experienced nurse began to work with participant 5 and assist her to reflect on the patient's whole haemodynamic state, it was clear that internal bleeding was most likely the cause of the patient's instability. Although therapies for alleviating haemodynamic instability had been instituted by participant 5 and the patient was not placed in danger, she did not appear able to integrate, appraise, and evaluate subtle salient data related to surgical bleeding. As a result, it is possible that the patient experienced a longer duration and greater depth of haemodynamic instability. It is possible that the patients' bleeding may have been detected earlier if experienced nurses had provided assistance to the inexperienced primary nurses from the time of admission because much decision making knowledge is embedded in clinical practice (Benner, 1984; Benner et al., 1992; Crandall & Getchell Reiter, 1993). Familiarity with case types in a specific clinical context has been found to impact on nurses' abilities to deliver a high standard of care (Fisher & Fonteyn, 1994, 1995). As suggested by Fisher and Fonteyn (1994; 1995), inexperienced nurses' lack of
familiarity with complex patient situations can be addressed by having experienced nurses instruct and direct inexperienced nurses about patient care during clinical practice. This situation highlights the crucial role played by experienced nurses in terms of providing decision support to inexperienced nurses during the initial recovery period. It also highlights the role of environmental characteristics in inexperienced nurses' decision making.

During autonomous decision making, it also appeared that some inexperienced nurses did not recognise key patient cues that indicated haemodynamic instability and therefore did not respond appropriately to alleviate the problem. For example, 2 inexperienced nurses neither detected nor responded to the onset of shivering. In other instances, some inexperienced nurses recognised deviations in salient parameters, but responded to those parameters with therapeutic interventions without determining why the data had deviated. For example, 4 inexperienced nurses responded to hypotension with colloid fluid infusions without establishing the existence of hypovolaemia. In these situations, the inexperienced nurses were working at the edge of their knowledge and safety and were unable to prioritise decisions appropriately. Decision making of that kind has been previously reported (Benner, 1984; Benner et al., 1992) and has the potential to impede patients' recoveries. A lack of time for nurses to reflect on the whole haemodynamic status of patients may have also contributed to delays in detecting and responding to complex episodes of haemodynamic instability. Additionally, it may be that inexperienced nurses are not adequately prepared to manage complex forms of haemodynamic instability because there are few guidelines available in this regard.

The benefits to inexperienced nurses' decision making and professional development as a result of recovering patients in open-plan cubicles and having access to available experienced nurses was shown during nurses' assessments of pacemakers. Only inexperienced nurses who had decision support from experienced nurses (and experienced primary nurses themselves) checked the pacemakers for correct settings and function in order to optimise heart rate and rhythm and cardiovascular performance. All the inexperienced nurses involved (n = 9) asked experienced colleagues for instruction and supervision through each part of the procedure. Decision support provided three benefits. First, problems with malfunctioning or inappropriately set pacemakers were detected and corrected, which, in turn, allowed patients' heart rate and rhythm to be
optimised. Second, decision support ensured that the procedures were conducted in a safe manner in patients who were dependent upon the pacemaker for haemodynamic stability (n = 14). Third, the directions and theoretical explanations given by experienced nurses provided inexperienced nurses with either new knowledge and practical skills or consolidation of recently learnt pacing theory and practical skills. By performing the complex assessment with support, inexperienced nurses said that they gained more confidence about pacing. Hence, experienced decision support had the potential to impact upon inexperienced nurses' decision making concerning complete pacemaker assessments at the time and in the future.

There were no findings to suggest that environmental characteristics influenced experienced nurses' decision making in relation to continuous appraisal and evaluation of patient data, and responsiveness to those data. That is, experienced nurses were able to detect and respond rapidly to haemodynamic instability for each goal of therapy, regardless of their geographical location or level of social interactions with colleagues.

In addition to geographical isolation and availability of colleagues, system processes appeared to influence nurses' decision making, particularly in relation to anticipation of haemodynamic decision making. System processes were common processes and procedures that took place during the recovery of cardiac patients and, as such, were characteristics of the critical care environment. Variability in decision making concerning preparations for haemodynamic decision making was sourced to system processes and an apparent lack of anticipation by nurses regarding decision making practices common to immediate postoperative cardiac patients. All nurses were ill-prepared to optimise cardiovascular performance and reestablish normothermia because cardiac monitors were not set up for pressure, cardiac rhythm, or SpO2 monitoring; ECG machines were not placed in cubicles; and only 34% of nurses had obtained a rewarming device. As a result, all nurses spent valuable time setting-up monitors while receiving patients and 16% also had to troubleshoot monitoring problems. Additionally, all nurses had to find colleagues or leave the cubicle themselves to bring equipment to the cubicle during the recovery period. Although nurses' decision making related to preparing equipment in anticipation of haemodynamic decision making was consistent with Xiao's (1994) findings that anaesthetists prepared equipment and materials needed for anaesthesia, nurses in this study did not comprehensively
prepare equipment for haemodynamic decision making. The lack of comprehensive preparation of cardiac monitors prior to the admission of patients may have influenced the finding concerning 2 experienced nurses' failure to set alarm limits for MAP and heart rate and rhythm for virtually the entire recovery period. By neglecting to set the alarm limits on monitors, there was a potential risk for haemodynamic instability to go unnoticed by nurses. These data suggest a review of processes that will encourage nurses to be more methodical in the set up of equipment required for haemodynamic decision making is warranted.

The way in which nurses received information about patients' haemodynamic status also appeared to influence their preparedness for haemodynamic decision making. Nurses did not receive detailed information about patients' preoperative and intraoperative haemodynamic status until the anaesthetist's handover during the admission phase. Moreover, in 40% of cases, nurses could not immediately assess PAC-derived data because PACs were incorrectly positioned in 15 patients. As described in Chapter 4, 60% of patients were admitted in a haemodynamically unstable state. However, current handover processes appeared to place pressure on nurses to respond rapidly to episodes of haemodynamic instability while receiving information about patients' haemodynamic status for the first time and, in 40% of cases, trying to reposition PACs. To be able to respond to haemodynamically unstable patients immediately on admission, it is important that nurses fully prepare cubicles to receive patients and receive patient-specific information prior to patient admissions. These findings suggest managers and nurses need to consider changes to system processes to allow greater preparation of nurses' mental and physical workspace before patient admissions.

5.4 Conclusions

The variability and commonality of nurses' decision making about patients' haemodynamic status have been reported and discussed in relation to the three goals of therapy and, as a function of interplay between haemodynamic decision complexity, nurses' level of experience, and environmental characteristics. In the main, experienced nurses and inexperienced nurses who received decision support from experienced
colleagues demonstrated rapid and responsive haemodynamic decision making. Decision making of this kind had the potential to optimise patient outcomes through early detection of, and rapid responses to, haemodynamic instability and postoperative complications. Inexperienced nurses had difficulty responding to complex tasks when experienced nurses were unavailable due to staffing or geographical limitations. Ultimately, interplay between decision complexity, nurses' experience, and environmental characteristics had the potential to affect whether or not nurses' decision making was optimal for each goal of therapy, and, therefore, the potential outcomes of those decisions. Variability of nurses' decision making due to the social context that surrounds the reception and recovery of cardiac surgical patients in the initial 2-hour recovery period will be presented in the following chapter.
CHAPTER 6

THE SOCIAL CONTEXT OF DECISION MAKING

The purpose of this chapter is to describe the social context that surrounds the reception and recovery of cardiac patients by critical care nurses during the initial 2-hour recovery period and the influences of this context on nurses' haemodynamic decision making.

Chase (1995), Jenks (1993), and Bucknall (1996) have found that colleagues can influence nurses' haemodynamic decision making in various ways. In previous research, the geographical layout of critical care and the one nurse to one patient ratio meant that nurses have been seen to make individual decisions in isolated cubicles. The study by Chase (1995) showed, however, that team decision making may eventuate while patients are admitted to critical care because of the informal arrangement of receiving assistance from colleagues during that time.

Data from the observations and interviews were analysed in four stages as outlined in Figure 3.2 of Chapter Three. Using the Framework approach described by Ritchie and Spencer (1994), a model of team decision making (TDM) in the initial 2-hour recovery period was developed. The model is grounded in data and was developed through careful analyses of data. The researcher observed two types of TDM that were labelled integrated TDM and non-integrated TDM. A second model, TDM in crisis, that demonstrates a shifting dynamic in team function, is also described.

The discussion of the findings is divided into five sections. In the first section, TDM is described. In the second and third sections integrated TDM and non-integrated TDM are described in terms of their characteristics, nurses' emotional and action-based responses, implications for nursing practice, and the potential implications for patient outcomes. The fourth section of this chapter contains the findings regarding the negative cases in relation to TDM. That is, some nurses received a postoperative patient without

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3 Elements of this chapter have been published in:

other nurses immediately available to provide assistance. The experience of receiving patients from surgery alone and the implications for nurses and their practice is described. In the final section of this chapter, the model of TDM in crisis is described.

6.1 Team Decision Making

In critical care, the one nurse to one patient ratio infers a high level of individual decision making. The timing of the observations in the initial 2-hour period following cardiac surgery revealed that individual decision making was strongly influenced by a team of nurses that comprised the primary nurse and assistant nurses.

Once the anaesthetist's handover was completed, assistant nurses did not simply offer technical support to the primary nurse as described by Chase (1995); rather, they formed a team with the primary nurse to make decisions regarding the patient’s recovery from surgery. Although TDM may be expected during the patient's immediate arrival to critical care, TDM occurred well beyond this period. The mean duration of TDM in this study was 55 ($SD = 31$) minutes and consequently accounted for a high level of decision making. Five (13%) primary nurses received help for the entire 2-hour period from at least one assistant nurse. Individual decision making by primary nurses occurred when assistant nurses departed the room; however, TDM resumed periodically throughout the entire observation period when assistant nurses returned.

Distinctions between a team, teamwork, and TDM are important to understand. A team is "a small number of people with complementary skills who are committed to a common purpose, performance goals, and approach for which they hold themselves mutually accountable" (Katzenbach & Smith, 1993, p.45). Teamwork, on the other hand, describes performance and how to achieve the primary objective (Katzenbach & Smith, 1993). Teamwork can be measured by outcomes or processes and one team process is that of decision making (Mickan & Rodger, 2000). Team decision making is the process by which interdependent individuals make decisions to achieve a common goal (Orasanu & Salas, 1993). The common goal in this study was the immediate recovery of the patient from cardiac surgery and subsequent discharge from critical care and hospital. As distinct from individual decision making, TDM involves members having differing
agendas, motives, perceptions, and opinions that influence decision activities (Orasanu & Salas, 1993).

In this study, TDM manifested in either an integrated or non-integrated form. The two forms of TDM were distinguished by the nurses who directed and made most haemodynamic patient management decisions, the communication processes between team members, and the number of assistant nurses (see Table 6.1). The forms of TDM could alter within one observation because both forms of TDM occurred for certain time periods within a given observation rather than for an entire observation.

<table>
<thead>
<tr>
<th>Table 6.1</th>
<th>Characteristics of Integrated Team Decision Making and Non-integrated Team Decision Making</th>
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<tr>
<td>Characteristics</td>
<td>Integrated team decision making</td>
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<tr>
<td>Patient management decisions</td>
<td>Directed by primary nurses</td>
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<td></td>
<td>Performed by primary nurses</td>
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<tr>
<td>Communication</td>
<td>Continuous referral to primary nurses</td>
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<tr>
<td>Number of assistant nurses</td>
<td>1 or 2</td>
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The model of TDM is illustrated in Figure 6.1. As shown in Figure 6.1, both forms of TDM influenced nurses and decision making practices. There was also a potential for TDM to influence patient outcomes.
Figure 6.1. Model of team decision making.
Decision making can be thought of as a problem solving process whereby the solution is in the form of a decision which usually leads to an action (Newell, 1980). As haemodynamic decision making involves a problem solving process whereby critical care nurses assess patient data and then make decisions in the forms of interventions, nurses' actions result from decisions. Therefore, in this chapter, actions by nurses such as implementing or changing therapies are referred to as decisions.

6.2 Integrated Team Decision Making

In this section, integrated TDM is described first in terms of its distinguishing characteristics and incidence. Second, the outcomes for nurses and their responses to integrated TDM are discussed. Third, the outcomes of integrated TDM for nurses' clinical practice and the potential outcomes for patients are described.

As Table 6.1 shows, integrated TDM was distinguished by primary nurses directing and making most haemodynamic patient management decisions, continuous referral to primary nurses by assistant nurses, and only one or two assistant nurses helping the primary nurse to admit and recover the patient.

The haemodynamic patient management decisions that were directed or made by primary nurses involved establishing haemodynamic monitoring, assessing and interpreting haemodynamic data, responding to data with appropriate interventions, and evaluating patients' responses to those interventions. In doing so, primary nurses had a grasp of patients' overall haemodynamic status and were immediately aware of interventional decisions needed to maintain or reestablish haemodynamic stability. Primary nurses often directed assistant nurses who had offered support to perform specific tasks such as documenting data measured by primary nurses or checking the volume of chest drainage. By delegating assessments and interventions, primary nurses gathered more haemodynamic data in a short time frame and quickly determined decision priorities.

The second feature of integrated TDM was continuous referral to the primary nurse from assistant nurses. The outcomes of assessments made by assistant nurses at the request of primary nurses were relayed promptly to primary nurses. If assistant
nurses did not report their findings, primary nurses asked for the findings. Furthermore, if primary nurses saw or heard assistant nurses spontaneously involving themselves in aspects of patient management, the assistants were asked what they were doing. In the main, however, assistant nurses voluntarily told the primary nurse about their actions. Primary nurses also initiated or directly conversed with medical staff regarding the haemodynamic status of patients and prospective interventions.

The third distinguishing feature of integrated TDM was that only one or two nurses provided assistance. Integrated TDM occurred for a mean time of $46 \pm 24$ minutes. If other nurses offered assistance, primary nurses declined these offers.

Integrated TDM occurred in 24 (63%) of the 38 observations. Integrated TDM was observed more often when the primary nurse was experienced ($n = 17$) than when the primary nurse was inexperienced ($n = 7$). In 2 of the 7 observations where integrated TDM occurred with inexperienced nurses, the assistant nurses were experienced. Data were collected about the experience status of assistant nurses when participants reflected on their 2-hour experience of recovering patients during the interview. Participants referred to nurses being experienced or inexperienced in cardiothoracic intensive care which equates to cardiac surgical intensive care experience.

In sum, integrated TDM occurred more frequently when the primary nurses were experienced. Integrated TDM was characterised by primary nurses making most haemodynamic decisions and the presence of one or two assistant nurses who continuously communicated with the primary nurse. Primary nurses' emotional and action-based responses to integrated TDM, along with their awareness of patient care during integrated TDM are discussed in the next sections.

6.2.1 Nurse Outcomes

6.2.1.1 Aware of Colleagues' Actions

Primary nurses involved in integrated TDM remained aware of assistant nurses' actions and patients' haemodynamic status because they had often delegated assessments to the assistant nurses who, in turn, provided continuous referral to the primary nurse. Continuous referral was appreciated by primary nurses because it kept them abreast of the patient's haemodynamic status. Participant 2 explained:
It was just the assistant nurse and myself...the assistant nurse was telling me what he was doing, and I knew what he was doing and it was great just the two of us.

Previous experiences with certain colleagues created and consolidated working relationships that contributed to primary nurses' high levels of awareness. Primary nurses held expectations of certain assistant nurses' activities as a result of such relationships. Participant 26 explained why she was aware of the assistant nurses' actions:

Well they told me beforehand what they were going to be doing, so I sort of knew. Also I think working with especially the Associate Charge Nurse, I've worked with her for all these years so I just know her level of competence...I just had a quick glance every now and then.

In sum, primary nurses were aware of patients' haemodynamic status because of continuous referral from one or two assistant nurses and the delegation of tasks or decisions to those assistant nurses. For some primary nurses, busy periods meant that it was difficult to remain aware of the activities of two nurses. In those circumstances, primary nurses also watched assistants' actions.

6.2.2 Nurse Responses: Action

6.2.2.1 Keeping Watch

Primary nurses watched assistant nurses' actions to keep abreast of patients' haemodynamic status and ultimately maintain control of patient management. Two characteristics of integrated TDM, continuous communication and one or two assistant nurses rather than many accounted for primary nurses having a good understanding of patients' haemodynamic status. Nevertheless, several participants mentioned that they watched assistant nurses intermittently during the recovery period to be sure that they knew exactly what the assistants were doing. Primary nurses especially watched assistant nurses who self-selected a decision task. It was not too difficult for primary
nurses to watch assistant nurses' actions because there were only one or two nurses assisting them in the small cubicles. For example, participant 7 said:

First of all I felt that the person that helped me… was very helpful because she was self directed, and there was only…one other person helping me so I could keep an eye on exactly what was going on and I still could feel like I had control of the situation.

Primary nurses not only watched assistant nurses' actions, they also asked them questions to keep up to date with assistant nurses' actions and, in turn, maintain control of patient management decisions.

6.2.2.2 Staying Informed

There were periods during integrated TDM when primary nurses were engrossed with recovering patients and unaware of assistant nurses' activities. There were also some situations when assistant nurses did not tell primary nurses about an assessment finding or intervention. In these circumstances, primary nurses asked assistant nurses about their actions. For instance, participant 9 said:

I just look around and ask people what they are doing and look to see if jobs are being done and if they had or hadn't, I would ask people.

Primary nurses watched and asked questions of their colleagues in order to keep up to date and remain in control of patient management. Although primary nurses watched assistant nurses, it could not replace verbal communication because primary nurses could not always visualise the outcomes of assistant nurses' decisions. Primary nurses also had emotional responses to integrated TDM and these are presented in the next section.
6.2.3 Nurse Responses: Emotional

6.2.3.1 Grateful for Colleagues' Support

Primary nurses indicated that they felt grateful for the support provided by their colleagues. There were two forms of support. The first form of support related to the physical presence of other nurses because it eased workload issues. The second form of support was decision support regarding patient management. In other words, assistant nurses provided physiological rationales, theoretical explanations, and practical advice regarding patient management to primary nurses.

Due to the sheer number of physical tasks that need to be completed by nurses at this crucial stage, primary nurses appreciated the presence of, and assistance provided by, assistant nurses. In referring to assistance received by one other nurse, participant 2 stated:

Brilliant. It was really good. I had a nurse straight away as soon as the patient came around the corner I had an extra pair of hands.

If there were more than one assistant nurse, procedures associated with receiving patients were completed more rapidly. Primary nurses expressed feelings of support when they had colleagues that reliably and competently completed procedures associated with receiving patients.

Both experienced and inexperienced primary nurses expressed their gratitude for advice about patient management decisions provided by experienced assistant nurses. One experienced nurse felt particularly supported because he received both physical assistance and decision making backup from an experienced nurse. Nurse 10 explained:

She’s looked after cardiothoracic patients for many years and so I’m very happy just to let her get on with things. I don’t need to ask her to do things, I don’t need to check what she’s doing either…In that initial period there’s a lot of set jobs to do…she can do a lot of things and take some of the load off me basically. See I know she’s had similar kind of experience to me so I’m happy that I’ve got somebody else there to back me up if anything went wrong…yeah she knows subtle signs as well that you have to look for in a postoperative cardiac patient.
Nurses were grateful for their colleagues' support because patients were settled faster and it benefited patient care. While assistant nurses focused on removing transportable equipment from cubicles or sourcing equipment and drug infusions, primary nurses focused on decision making concerning patients' haemodynamic status. Nurses who were involved in integrated TDM also felt in control of patient management.

6.2.3.2 Being In Control

The theme of being in control describes an emotional response by nurses to receiving assistance in the form of integrated TDM and refers to nurses feeling like they have a good understanding of their patients' haemodynamic status. Nurses felt organised during integrated TDM, which, in turn, led to a feeling of being in control. Nurses who voiced feelings of being in control all had assistant nurses who were experienced.

Primary nurses expressed a sense of organisation when their assistant nurses knew intuitively what tasks to perform, carried out actions competently and thoroughly, and conveyed the outcomes of their actions. Participant 7 summed up feeling in control:

I felt that the person that helped me prepare the patient for being in the unit was very helpful because she was self directed, and there was only…one other person helping me so I could keep an eye on exactly what was going on and I still could feel like I had control of the situation.

The time taken to establish the haemodynamic status of patients via a baseline set of assessments was an important component of nurses feeling organised and in control. Rapid settling and assessment of patients provided nurses with a sense of being ready to deal with any potential episodes of haemodynamic instability in the ensuing hours.

Nurses felt in control when experienced nurses provided decision support rather than taking over decision making. Inexperienced primary nurses in particular felt in control when assistant nurses prompted them to make patient management decisions. They said that assistance of that kind boosted their decision making confidence. Participant 6, in reference to two experienced nurses who assisted her, said:
They’re very good at what they do, but they’re also very conscious of not stepping on your toes. So they were very good, they prompt you in the right areas but allow you to work within your realm of what you can do, but, very helpful. But not overbearing or make you feel like you missed this, you should have known this.

Nurses needed to be making decisions in order to feel in control. Nurses felt in control because they knew trends in patients’ haemodynamic data, understood patients' responses to interventions, and could anticipate the most likely responses by patients to prospective interventions. Feeling in control was also a key aspect of nurses' abilities to make optimal decisions. Participant 7 explained:

As you do things you’re sort of taking notes yourself unconsciously I think…so that when something happens you go, oh, and you can tell somebody that’s where it sort of started off, even though it's not documented, you know where you started off. And then you get a feel for the patient, you get a feel for how they go with a bit of filling and different sorts of ways that parameters change on the patient.

When integrated TDM occurred during the recovery period, both inexperienced and experienced nurses felt organised and in control of patient management. Integrated TDM also influenced nursing practice and this is the focus of the next section.

6.2.4 Practice Outcomes

When integrated TDM occurred, clinical practice was coordinated and perceived by nurses to be smooth and easy. In turn, patient outcomes had the potential to be optimised.

6.2.4.1 Coordinated Clinical Practice

When coordinated clinical practice was observed or described by nurses, primary nurses had usually delegated decisions, there were few assistant nurses present, and continuous referral to the primary nurse occurred. Other factors central to coordinated clinical practice were that assistant nurses were experienced, nurses had clearly defined roles, and nurses knew the routine procedures associated with receiving postoperative patients.
Inexperienced and experienced primary nurses appreciated having experienced assistant nurses. Experienced nurses knew the procedures associated with receiving patients and were able to provide advice regarding decision priorities, both of which led to coordinated practice. In circumstances where assistant nurses were experienced, clinical practice was well coordinated as noted by participant 29:

I mean if you are working with really experienced people like we are today, they just know what to do and they just do it.

Coordinated clinical practice was also characterised by primary nurses delegating roles and responsibilities to assistant nurses in order to ascertain the current haemodynamic status of patients as quickly as possible. Primary nurses focused on decisions central to haemodynamic management. With decision support from experienced assistant nurses, inexperienced primary nurses displayed coordinated practice and they said that such experiences boosted their confidence. Participant 11 described her nursing practice as well coordinated:

I felt very good that I was able to take responsibility for the patient and also ask people to do things, and feeling comfortable with doing that. I felt that people were also prompting me as well, you know, do you want me to start this. So obviously if that was a priority, or if I felt that was important I said yes do, start this or no would you mind doing this instead. So that was good. The roles were pretty much well defined who was starting to do what. So…it was well co-ordinated.

During coordinated care, primary nurses remained focused on the patient. Responsibilities that took primary nurses out of cubicles or took a great deal of time to complete were delegated to assistant nurses so that primary nurses attended to patients. For example, during observation 24, the cardiac monitor was not functioning correctly and needed to be altered to show a particular pressure waveform. It was a time consuming job, so it was delegated by the primary nurse to an assistant nurse.

In sum, coordinated clinical practice was enabled by characteristics of integrated TDM, the delegation of tasks to assistant nurses, clearly defined roles and
responsibilities for all nurses involved, and experienced assistant nurses. Primary nurses also considered their practice smooth and easy during integrated TDM.

6.2.4.2 Smooth and Easy Clinical Practice

When the researcher observed decision making practices that flowed in a seemingly effortlessly way, such instances were labelled smooth and easy the researcher. Primary nurses moved seamlessly through numerous decisions, changed priorities as the haemodynamic status of patients required, and responded to haemodynamic critical incidents in a composed manner. As smooth and easy clinical practice was associated with both haemodynamically stable and unstable patients, such practice resulted from integrated TDM rather than from patients' level of haemodynamic stability. Some experienced nurses, such as participant 25, also perceived their practice to be smooth and easy:

Fine, it went very smooth and not too many problems, it went really smoothly basically.

The absence of haemodynamic complications was a feature of smooth and easy for some nurses. For instance, participant 9 stated:

Satisfactory. I didn't think there were any major complications and it went quite smoothly.

However, as mentioned earlier, smooth and easy clinical practice also occurred when patients had serious haemodynamic complications. In Observation 12 when the patient suddenly haemorrhaged, smooth and easy clinical practice was observed by the researcher. Later, the experienced nurse, participant 12, said:

It was bleeding badly, bleeding too bad, it wasn’t a medical bleed it was a surgical bleed and basically we can’t fix a surgical bleed, the surgeon needs to take them back to theatre…although he was quite unwell…there wasn’t a big panic…it was good. It went well. It went well.
Nurses referred to their practice as being smooth and easy because they had met the haemodynamic decision challenges encountered during the 2-hour recovery period and continued to work towards meeting each goal of therapy.

As a consequence of primary nurses being involved in integrated TDM, coordinated, smooth, and easy clinical practice occurred. As a result of such clinical practice, there was the potential to optimise patient outcomes during the 2-hour recovery period.

6.2.5 Potential for Optimised Patient Outcomes

In order for nurses’ decision making to have the potential to optimise patient outcomes, it is important that nurses respond to adverse data rapidly and accurately so that the extent and duration of haemodynamic instability is limited. It was observed by the researcher that the decision making of nurses involved in integrated TDM had the potential to optimise patient outcomes in the initial 2-hour recovery period. Additionally, participants said whether or not they considered their decisions had the potential to optimise patient outcomes.

Some nurses believed, and the researcher observed, that haemodynamically stable patients were due to decision making practices that were later described by the researcher as coordinated and smooth and easy and associated with integrated TDM. However, some nurses considered that smooth and easy or coordinated clinical practice resulted from haemodynamically stable patients. The following two transcript excerpts provide an example of each perspective. The first transcript supports some nurses' views that a haemodynamically stable patient enabled smooth decision making. The second transcript supports the assertion that a haemodynamically stable patient resulted from clinical practices associated with integrated TDM. First, participant 17 remarked:

Yes he was very stable, so that’s why things ran smoothly because he was stable.

In this second excerpt, participant 7, gives herself the credit for the patient remaining haemodynamically stable during the 2-hour recovery period. She said:
I felt that they (the 2 hours) went beautifully because my patient didn’t present himself with any problems that I didn’t feel like I could solve.

The distinguishing characteristics of integrated TDM created decision making practices that assisted nurses in their efforts to keep patients haemodynamically stable. For instance, primary nurses could make decisions promptly because of continuous referral from assistants. The longer the duration of haemodynamic stability, the greater the potential for optimised patient outcomes. An example of integrated TDM that led to optimised patient outcomes occurred when patient 12 suddenly bled 300 mls within 2 minutes into the chest drainage receptacle after several coughs. As noted by the researcher during observation 12:

A bit of blood has come out of the chest drains…but he’s settled again and he got a lot of sputum in the suction catheter. The patient seems to have settled now and the assistant nurse has just come to review the patient with the primary nurse…assistant nurse is manipulating the chest drains and the blood is coming out of those and assistant nurse is getting a fair amount of blood coming out of the chest drains so is showing primary nurse. Its well over 200 mls now and primary nurse gets a bit closer. The patient's coughing seems to have initiated this. Quite clotty as well. Primary nurse taken over milking it a little bit…so 180 to 500, so its dopped 300 mls in 2 minutes.

The primary nurse responded by coordinating investigations of coagulation status, maintaining the patency of the chest drains, alerting doctors to the problem, implementing therapeutic interventions to prevent cardiovascular collapse, and organising the patient's return to theatre. This incident was an example of the complex haemodynamic decision making that must be performed rapidly and accurately by nurses within the first 2-hour period. Within 12 minutes of the patient's first cough, the patient had been returned to theatre. It took the primary nurse only 3 minutes from the time that the surgeon arrived in the unit and announced that the patient warranted surgical reexploration to transfer the patient to theatre. Such rapid decision making by the primary nurse gave the patient the best possible chance of surviving the haemorrhage without sustaining permanent injuries.
Integrated TDM resulted in coordinated, smooth and easy clinical practice, which, in turn, primary nurse 12 believed would prove beneficial to the patient's outcome. Initially, the primary nurse sought help from two assistant nurses. Another two nurses provided assistance in the last minute before the patient was transferred. The primary nurse indicated that he felt in control of the situation. The patient's systolic blood pressure was maintained at 69 mmHg. No inotropic drugs were administered, the GTN infusion rate remained constant, and the chest drains remained patent. The primary nurse had responded rapidly in order to keep the patient in the best haemodynamic state possible in the circumstances. Participant 12 said:

You would be quite optimistic (for their survival) in getting somebody around to theatre without opening his chest and starting on inotropes…I thought that situation was handled very well by all the staff involved which will impact on the patient's prognosis. It was handled very well.

Surgical reexploration revealed a bleeding anastomosis site which was oversewn and the patient returned to critical care later that day in a stable state.

In sum, integrated TDM was distinguished by primary nurses making patient management decisions, continuous referral from assistant nurses, and one or two assistant nurses. Integrated TDM occurred more frequently when primary nurses were experienced. As a result of nurses being aware of colleagues' decision making and patients' haemodynamic status either by continuous referral or watching colleagues' activities, nurses felt in control of their practice, perceived their practice to be coordinated and smooth and easy, and said that they were grateful for such collegial support. Ultimately, it was observed that the characteristics of integrated TDM had the potential to optimise patient outcomes.
6.3 Non-integrated Team Decision Making

In this section, the characteristics and incidence of non-integrated TDM are presented. Nurse outcomes and responses to non-integrated TDM are described, along with the outcomes for nurses' clinical practice. Finally, the potential implications for patient outcomes from non-integrated TDM are presented.

As shown in Table 6.1, there were three distinguishing characteristics of non-integrated TDM. First, assistant nurses directed and made many haemodynamic patient management decisions. Second, there was a lack of communication to primary nurses from the assistant nurses about their decisions and actions. Third, three or more assistant nurses helped primary nurses to receive and recover patients. These three characteristics are discussed in detail.

In observations where non-integrated TDM took place, assistant nurses, rather than primary nurses, directed and made many haemodynamic patient management decisions. Those decisions involved establishing haemodynamic monitoring, assessing and interpreting haemodynamic data, responding to data with appropriate interventions, and evaluating patients' responses to those interventions. In some instances, assistant nurses sought to establish haemodynamic monitoring. Although actions such as levelling the transducers or choosing the cardiac monitoring lead may not have concerned primary nurses or impacted on their level of awareness of the patients' haemodynamic status, other actions by assistant nurses had the potential to impact on practice or the primary nurses' sense of control of patient management. For instance, assistant nurses set alarm limits on haemodynamic parameters and responded to those alarm settings with therapeutic interventions and other troubleshooting measures without informing the primary nurses.

A lack of communication between nurses was frequently observed when situations labelled as non-integrated TDM took place. When patients were admitted, usually primary nurses or assistant nurses looked to see what catheters and pacing equipment were in place. However, during the initial period of observation 22, the primary nurse and assistant nurses failed to realise that the patient had a pacemaker as a result of inadequate communication and poor role delineation between team members.
Each nurse in the team thought that another nurse had checked for a pacemaker, but none of the nurses spoke about such expectations. The primary nurse was alerted to the fact that her patient had a pacemaker 29 minutes into the recovery period when an Associate Charge Nurse, who was passing the cubicle, pointed out pacing wires hanging out below the blankets.

During non-integrated TDM, assistant nurses were observed to self-select decisions. At times, the assistant nurses did not complete their self-selected decisions and therefore did not fulfil their responsibilities to the primary nurses and patients. Compounding the self-selection of decisions was a lack of referral to the primary nurses about the outcomes of those decisions. Thus, primary nurses had an incomplete understanding of patients' haemodynamic status that hindered their abilities to prioritise further assessments and interventions.

An example of self-selected decision making occurred when an assistant nurse increased the rate of the atrial pacemaker without informing the primary nurse in observation 34. The primary nurse did not know about this change until the interview, when the researcher sought clarification of the assistant nurse's actions. Other decisions performed by assistants and not communicated to the primary nurse included altering the mode of ventilation, altering vasoactive drug infusions, and initiating or discontinuing rewarming measures.

During non-integrated TDM, there was generally three or more assistant nurses. In three observations, there were 6, 10, and 13 assistant nurses present. There seemed little justification for so many nurses. As noted by participant 22, too many assistants did not benefit patient care:

There’s always too much help, I think when the patient comes back after CABGS, you probably only need one other person to help you, and I think I had about four. So it’s hard to keep track of what’s happened and happening…So I just sort of try and do what I can to make sure what’s happening and just get my priorities and see if it’s been done or not…you don’t get to go near the patient for quite some time, you’ve got all these people setting-up your outputs, doing outputs, getting the temperature probe connected, getting the fluids running, gases, changing the monitors over, and people sort of tend to run ahead and do stuff… that’s probably the thing I find the hardest when they come back, all the people that are in there.
Non-integrated TDM was observed in 14 (37%) of the 38 observations. Non-integrated TDM occurred on eleven occasions with inexperienced primary nurses and on three occasions when the primary nurse was experienced. Non-integrated TDM was more likely to occur when primary nurses were inexperienced. The mean duration of assistance for nurses involved in non-integrated TDM was 70 (SD = 36) minutes.

In sum, non-integrated TDM was characterised by poor communication between team members, patient management decisions being directed by assistant nurses, and three or more assistant nurses. The focus of the next section is the impact of non-integrated TDM upon nurses and their practice.

6.3.1 Nurse Outcomes

6.3.1.1 Unaware of Colleagues' Actions

Primary nurses involved in non-integrated TDM were unaware of all the actions carried out by assistant nurses and consequently were not fully informed about patients' haemodynamic status. Primary nurses were unable to keep track of colleagues' actions because there too many assistant nurses who self-selected decisions and a lack of referral to primary nurses. It was impossible for primary nurses during non-integrated TDM to be able to watch three or more assistants' actions simultaneously while carrying out their own decision making responsibilities.

As highlighted by participant 22 in the interview excerpt included in the previous section (6.3), the presence of four assistant nurses left her unaware of certain patient events. Assistant nurses were observed to self-select patient assessments or other decisions. They did not convey the findings of their assessments to the primary nurses either verbally or through documentation on patients' charts. Primary nurses tended not to ask about assistants' actions and were unable to keep watch over so many assistants at one time. As a result, primary nurses were unaware of what had taken place. If primary nurses saw some of assistant nurses' actions, then they asked the assistant nurses to explain or clarify their actions; however, during non-integrated TDM, the latter course of events rarely took place. Participant 27 related in the interview how she found out that a colleague had stopped the active rewarming measures that she had instituted for her patient. She said:
Someone else had stopped it, someone else stopped it, and I think it was the assistant nurse that stopped it because she said he’s toasty now; but, I have no idea…when I got to it, it was off.

Assistant nurses also failed to inform primary nurses about laboratory investigations they had performed. Participant 4 was unaware of laboratory investigations initiated for her patient and considered it problematic:

It’s more of a problem when they’re doing things spontaneously without you knowing what they’re up to. You go to do something and its already done, or you check the chart and find something done that you didn’t know was happening.

It was acknowledged by participant 4 that, at times, some assistant nurses documented the outcomes from their self-selected decisions on patients' observation flow charts. However, informing primary nurses through patients' charts was not necessarily immediately helpful because primary nurses were often delayed in reading the charts. The mean time taken for primary nurses to first read patients' charts, usually to document assessment findings, was 29 (SD = 17) minutes. The mean time for the nurses to consult and review the charts in detail extended to 45 (SD = 20) minutes. Such delays in finding out patient information had the potential to impact upon nurses' decision making and, potentially, patient outcomes.

One primary nurse considered that assistant nurses had an obligation to verbally communicate any acquired patient details to him. Indeed, participant 13 believed that passing on information to primary nurses was one of assistant nurses' key responsibilities. He said:

I feel that anything that’s taken should be reported back to me, so I don’t feel left out. But I feel they’re not taking responsibility for that. To finish off that responsibility is to report it back to me. It's not something I should have to chase up, that information should be given freely to me.
In non-integrated TDM, having three or more assistant nurses meant that nurses could not keep track of the actions of every assistant nor the implications of those actions for patients' haemodynamic status. However, despite primary nurses' thinking that assistant nurses had an obligation to pass on their assessment findings, that did not always occur.

In sum, the characteristics of non-integrated TDM such as a lack of referral to primary nurses regarding assistant nurses' activities, three or more nurses assisting, and the self-selection of assessments and interventional decisions contributed to nurses being unaware of certain aspects of their patients' management. Nurses' responses to non-integrated TDM are described in the next section.

6.3.2 Nurse Responses: Action

6.3.2.1 Silence

Primary nurses were often silent in situations that were described as non-integrated TDM. For participant 27, the decision to remain silent was a deliberate choice. When she confronted assistant nurses in the past, she had encountered what she described as combative behaviours. Now, nurse 27 was silent and vigilant:

I’ve been there and done that (confronted colleagues) before. It's too much energy expenditure for me to be fighting everyone all the time. So if I just watch them carefully, and know what they’re doing and if it matches where I want the patient to be, then that’s, I’m fine, that’s okay.

Primary nurses also remained silent when they perceived their patients were haemodynamically stable. They said they would have only spoken up if they thought their patients were being adversely affected. However, primary nurses involved in non-integrated TDM were not necessarily in the best position to judge the haemodynamic stability of patients because they were often unaware of certain patient details. Without all relevant patient information, an accurate judgement of patient's haemodynamic stability was difficult to make. It is more likely that the nurses were disinclined or disempowered to speak. For instance, participant 21 was silent in dealing with assistant nurses who were making patient care decisions:
I always feel like this, its like I look at them, and I think that they are so experienced and so good at what they do, and for myself I find, that if they want to take control of the situation I sometimes let them, and that’s a bad thing on my part.

It should be noted that participant 21 was a critical care course student and an inexperienced nurse. As a result of her student status, she described a self-perceived lower rank in the nursing hierarchy and less knowledge that prompted her silence. Also, she said she deferred decision making to the assistant nurses because they were experienced and therefore more skilled decision makers. Participant 20, who held critical care qualifications, partially attributed her silence to being recently employed in that setting:

I probably could have been a bit more vocal. But I find that a little bit difficult sometimes because I’m like the newest staff member there and they’re experienced cardiothoracic nurses…perhaps I find that a little bit difficult just to speak up and say, well could you do this for me, could you do that.

There were primary nurses who responded to non-integrated TDM by speaking up. For instance, primary nurses initiated discussions with assistant nurses about the assessments that they were carrying out. That action alone, could shift the dynamic of TDM from non-integrated TDM to integrated TDM. Furthermore, in doing so, nurses became aware of patients' haemodynamic status and had the potential to gain control of patient management decisions. Not all nurses responded to non-integrated TDM behaviours with silence, some were vigilant to assistant nurses' activities.

6.3.2.2 Maintaining Vigilance

In an attempt to keep abreast of assistant nurses' self-selected decision making, primary nurses were vigilant to assistant nurses' activities. In three observations, where non-integrated TDM occurred, assistant nurses performed cardiac output measurements. Each of the 3 participants said in the interview that they preferred to measure the cardiac output themselves, but none informed the assistant nurses at the time. Instead, the
primary nurses were vigilant to the assistants' techniques. Participant 11 admitted to being vigilant to the cardiac output curves on the monitor screen as a way of monitoring the assistant nurses' technique of performing the cardiac output. Participant 11 was also vigilant to other activities of the assistant nurse:

By observing what they’re doing, so watching what they’re up to and where they’re located, will also give me an idea about where we’re up to and what’s been done. I think I mainly observe what they’re doing and where they’re situated.

Although it was possible for some primary nurses to be vigilant of two assistant nurses, it was not possible for primary nurses to be vigilant of numerous assistant nurses at once. As participant 25 confirmed:

You might not be able to keep an eye on two or three people at once…you may not be able to keep up with what's going on

Despite primary nurses' vigilance of assistants' actions, primary nurses did not know all the assistant nurses' activities because they could not be vigilant to three or more nurses at once in addition to performing their own decision tasks. In response, some primary nurses consulted the chart to keep up to date and gain a sense of control.

6.3.2.3 Consulted the Chart

Nurses involved in both forms of TDM had a strategy of consulting the patient's observation flow chart in order to keep abreast of patients' haemodynamic status, the decision activities carried out by assistant nurses, and to reflect upon the haemodynamic status of patients. However, the strategy was used more often by primary nurses involved in non-integrated TDM than integrated TDM because continuous referral was absent. Primary nurses consulted the chart in an attempt to keep up to date with the haemodynamic status of patients and gain a sense of control. As explained by participant 22:
You haven’t really got an idea of what’s happened and you’ve got to stand back again and read your chart and have a look…so it’s just a matter of having to run back to your chart.

Participant 34 regularly consulted the chart, even during the early stages of the 2-hour period. The chart acted as a prompt for assessment and interventional decisions for the inexperienced nurse:

I use my chart as a centring thing. It's like okay, what haven’t I done. I go through my observations and go ah, you haven’t written this in, that means you haven’t thought about it. Now, take note of what it is, think through the implications of this for you. Is it something you need to do now, is it something you should have done five minutes ago or is it something you can delegate to someone else. It is my way of making sure that I have done everything.

Even if communication between team members was adequate during non-integrated TDM, primary nurses simply could not process all the information given to them at once by so many colleagues. By consulting the chart, primary nurses could gain an overall perspective of patients' haemodynamic status. Participant 6 explained how the strategy of consulting the chart enabled her to keep up to date with, and reflect upon, her patient's condition:

When a patient comes in its all new, and you get so much information shouted at you and you’re trying to store it and it's not until you put it on paper that you can actually see yeah okay, that’s what your blood pressure is, that's how much blood you’ve got in your drains, that’s how much urine output you’ve got. That’s where you get a baseline of what they’re like when they come out and it changes as they progress.

When assistant nurses communicated assessment findings or patient management decisions to primary nurses via patients' charts, it was crucial that primary nurses consulted the charts regularly to reflect upon the progress of patients. It was also crucial that assistant nurses progressively documented everything they did. In addition to the action responses discussed in this section, nurses responded emotionally to non-integrated TDM.
6.3.3 Nurse Responses: Emotional

Nurses displayed and recounted a range of emotional reactions to being involved in non-integrated TDM. Nurses indicated that they felt irritated, angry, disempowered, and out of control. The more that nurses perceived that non-integrated TDM impacted upon their patients, the stronger the feelings expressed by the nurses.

6.3.3.1 Irritation

Some nurses felt irritated particularly by having three or more assistant nurses. As explained by participant 9:

Nurses do have to cope with a lot of various staff members coming in and… that can be quite, not stressful, it is just irritating and it leaves the nurse to have to cope with another area when she or he should be focused on the patient.

Participant 9 felt irritated because too many nurses distracted her from what she considered to be her decision priorities. Participant 20 was assisted by nurses who she believed were prioritising aspects of patient management that she considered were not pressing at the time. The primary nurse's priority was to listen to handover, whereas the assistant nurses were already making assessments of the patient and moving equipment. Participant 20 felt irritated by the assistant nurses' behaviours. She said:

I personally don’t feel the need to be…fiddling with lines and things like that. Just listening to hand over, the patient was stable and there was no need to be getting in there.

The assistant nurses' behaviours were a source of distraction for primary nurses during non-integrated TDM. While some primary nurses were irritated by assistant nurses' actions, other primary nurses felt angry.

6.3.3.2 Feeling Angry

When primary nurses believed that assistant nurses' actions had impacted on patients, primary nurses expressed feelings of anger. There were occasions when primary nurses perceived that the assistant nurses' actions had placed patients at risk and,
in response, primary nurses felt angry. In one incident, an assistant nurse had not connected the underwater seal chest drainage system to suction while receiving the patient. Participant 27 related the situation saying:

I went around the other side the suction hadn’t been connected. Who didn't connect it?! At that point I was getting annoyed and grumpy because little things weren’t done and you sort of have to be everywhere all at once and you can’t.

Primary nurses felt angry when they believed that assistant nurses had failed to carry out actions that they had self-selected and when they thought there were too many assistant nurses. Participant 28 was the primary nurse for a patient who returned to theatre during the observation period because of persistent profound hypotension that was unresponsive to potent vasoconstricting drugs. After the surgeon made the decision to return the patient to theatre, nine staff came into the small cubicle to assist the primary nurse who could not keep up to date with their actions. In notes taken after the observation, the researcher wrote:

The primary nurse was really angry about the sheer number of people who came to help, but, in her words 'hinder' the process of returning the patient to theatre. She was still agitated and angry about it in the interview and that was conducted after she had already debriefed to other staff in the unit between the time of the observation ceasing and the interview commencing which was about 25 minutes. She had fed back to some of the staff that she did not think that their behaviour was helpful and some apologised, others intimated that she was being ungrateful and that they were helping.

During the interview, participant 28 related that she was really angry about the sheer number of colleagues that came to assist her and how it hindered her decision making and the transfer of the patient to theatre:

Well at one stage when I was getting really pissed off. I was thinking to myself can anyone else see the chaos here. Or is it just me….Some of them acknowledged it and said yes, and some of them apologised to me, but some of them didn’t. Some of them looked at me as if maybe you know, oh we were only
trying to help. But I think the help becomes a hindrance. They need to be aware of that. Because its not good.

Participant 28 was angry because she believed that patient care had been affected. During the turmoil, cardiac monitoring did not occur for about 5 minutes and so she did not know the patient's heart rate or rhythm. Nurses exhibited some tolerance to characteristics of non-integrated TDM, but not when they felt that situations impacted upon patients. None of the nurses who expressed anger were observed to address the problems associated with non-integrated TDM at the time. Furthermore, aside from participant 28, no other nurse involved in non-integrated TDM told colleagues of their displeasure regarding the number of staff assisting or their colleagues' lack of referral. This situation raises questions about whose responsibility it is to ask excess staff to leave and the reasons why primary nurses do not speak up.

6.3.3.3 Disempowered

Nurses expressed feelings of disempowerment and displayed disempowered behaviours during non-integrated TDM. For instance, primary nurses silently tolerated non integrated TDM and explained how they considered themselves junior in the unit's hierarchy. Experienced nurses who were new to the unit or worked part time also displayed disempowered demeanours. Participant 21, an inexperienced nurse said that she remained silent about assistant nurses making decisions that she would have rather made herself. Moreover, she said that she never asked her colleagues directly to stop whatever they were doing. Instead, she preferred to repeat those actions herself after her colleagues left the cubicle.

Being inexperienced influenced nurses' level of assertiveness and communication to more experienced staff. Nurses who perceived themselves as junior thought that their opinions and decisions were not as valid as those of their experienced colleagues. Indeed, some nurses behaved like they were stigmatised. In other words, the nurses acted as though they were disqualified from full social acceptance (Goffman, 1968). For example, when asked about a particular activity that was observed during the observation period, participant 14 replied:
I’m a junior I don’t what happened there…The registrar was discussing it with the assistant nurse not me, which sometimes happens as well when you haven’t been working here for very long…medical staff tend to liaise with the senior staff rather than (me, even) if its my patient…I guess I’m used to somebody just coming in and doing whatever.

Clearly, some nurses were not happy with the actions of assistant nurses, but, as noted earlier, they did not confront the assistant nurses at the time. Moreover, primary nurses rationalised their lack of action by saying that they were easy going. It did seem, however, that they were simply avoiding conflict with assistant nurses because they did not feel empowered to deal with the situation. Participant 14 said that being involved in situations that have been described as non-integrated TDM reduced her confidence and left her feeling disempowered, incompetent, and like she was not coping. In the interview, she explained how she found communication difficult with the assistant nurses:

I just didn’t feel confident enough to take control and say, okay please may you do this, please may you do that. I tried…Like I thought hell I don’t know what to do, I didn’t know who to ask or anything…I don’t know it was just awful.

Participant 34, an inexperienced nurse, explained that she felt disempowered while recovering her patient as a result of situations that have been described as non-integrated TDM:

They come in and help, they come in and do things and go away and they don’t always, they can leave the person looking after the patient feeling disempowered. There were a couple of occasions early on that I just thought talk to me, just tell me what you're thinking, liaise with me, work with me because I have no idea (about) the things that I have to do. Maybe you've done them. Maybe you are doing them because you think that is what you do, or maybe because you are thinking God, I've been standing here for 5 minutes expecting her to do something and she hasn't done it.
Not only did that situation leave the nurse feeling disempowered, but inadequate communication also had the potential to impact on patient outcomes. The same nurse said:

Although there was lots of people around the bed, no one was saying anything to me and I could see the patient’s blood pressure was dropping and I wasn’t sure quite what my first intervention should be, and I suppose I was thinking no one else is looking at this blood pressure and I think this blood pressure is a problem. Are they not doing anything because they don’t think it’s a problem or because they think I should be doing it and they don’t want to step on my toes?

In this instance, the team’s behaviour impacted on an inexperienced nurse to the point that she did not confront the team about the patient’s possible deterioration. Nor did team members engage with the primary nurse about the situation, perhaps because she was an experienced nurse in general critical care who held a senior appointment. This nurse's comment regarding stepping on toes suggests that she believed her level of experience or senior position in general critical care may have acted as a deterrent to interactive communication which, in turn, could have had the potential to negatively influence patient outcomes. This primary nurse’s general critical care experience, however, directed her to observe other monitored parameters and to feel for the patient’s carotid pulse to confirm he had a cardiac output. The nurse also noted that not knowing her colleagues was a factor in the incident, remarking:

I suppose the thing for me, the difficult thing about this situation, was not knowing the people I was working with.

This data shows that relationships with colleagues and the form that those relationships take can influence nurses' haemodynamic decision making. Nurses' behaviours and comments about how they felt during non-integrated TDM indicated that they were disempowered. Nurses also expressed feelings of being out of control.
6.3.3.4 Being Out of Control

Primary nurses described a feeling of being out of control as a consequence of the characteristics of non-integrated TDM. Out of control referred to being unaware of patients’ current haemodynamic status. Poor communication was identified as a key source of feeling out of control. For instance, participant 3 remarked:

I’d rather not have help than have people help me who don’t tell me what they’re doing because it makes me feel completely out of control. Like I’d just rather know what’s going on. You just sort of feel like you’re missing out on what’s happening with the patient.

The issue of too many nurses assisting the primary nurse was also a key factor that led to nurses feeling out of control. Participant 20 revealed:

I just feel anything more than two, I just felt like I lost control of it a little bit and it was just like everything was being done and I kind of felt like I was pushed to the background a little bit….I almost felt in there, like it wasn’t my patient, I had lost direction.

Characteristics of non-integrated TDM such as having too many assistant nurses and a lack of referral led to nurses feeling out of control. The effect of non-integrated TDM on practice and the potential implications for patient outcomes is the focus of the next section.

6.3.4 Practice Outcomes

Certain practice outcomes associated with non-integrated TDM had the potential to impact upon patient outcomes. Non-integrated TDM resulted in nurses having to repeat assessments and other decisions, delayed decision making, and uncoordinated practice.

6.3.4.1 Repetition of Assessments and Decisions

Primary nurses repeated assessments of patients and of equipment because they were unaware that assistant nurses had already done so. Primary nurses said that they
repeated decisions or assessments made by assistant nurses because primary nurses
considered such activities to be their responsibility. Nurses acknowledged that repeating
assessments was not productive in terms of time management in the short term, but, in
the long term, nurses believed patients benefited from having one nurse track the
progress of patients. For instance, primary nurses always acquired physical assessment
data first hand, even if it meant repetition, because they considered it a safety issue.
Nurse 3 explained:

I mean most of the time then I’d have to go and repeat things that have already
been done, because I want to know what they are myself. So it’s unproductive
that things get done again but it’s better to be unproductive at that point and get
familiar with where they are and then I can go ahead and plan and assess and
intervene and things like that from that point on.

Similarly, nurses considered setting alarm limits on haemodynamic parameters
their responsibility and preferred to do it themselves. For safety reasons, most primary
nurses reviewed alarms limits that had been set by assistant nurses. Participant 13
watched a colleague set the alarm limits on the monitor. Although nurse 13 did not think
the assistant was compromising his patient by setting the alarm limits, partly because he
was able to see what she selected, he revised the alarm settings after the assistant left the
cubicle. The alarms settings were altered because he did not consider those selected by
the assistant to be appropriate for his patient. Participant 13 said that he did not talk
about the settings with the assistant nurse at the time because she was more experienced
than him and held a senior appointment. However, nurses felt that they were accountable
for patient management and, as a result, expressed a preference to set alarm limits
themselves. Participant 12 summed up the importance of setting alarms:

You’d be crazy in this sort of situation to not look at checking your own alarm
limits. Because your heart rate could be set at, low heart rate could be set at 20.
You go away to grab something, some fluid and they’ve got a bradycardiac pulse
for 2 or 3 minutes. Little things like that, they’re important things that need to be
set, and you need to check, it’s a safety issue.
At times primary nurses said that they were dissatisfied with the standard of nursing care by assistants and so repeated particular assessments or procedures. There were incidents where assistant nurses did not complete tasks, so the primary nurses repeated those tasks to ensure patient safety. For instance, participants 1 and 27 found that their respective assistant nurses had connected the underwater-seal chest drainage system to suction, but failed to activate the negative pressure. Hence, participants 1 and 27 believed that important aspects of patient management that assistant nurses had self-selected were not completed in a timely, correct, and safe manner. Patient care had the potential to be compromised by nurses failing to complete tasks and repetition by the primary nurses in such circumstances was essential to ensure patient safety.

6.3.4.2 Delayed Decision Making

As a consequence of poor communication and repeating assessments, both the observer and participants noted that haemodynamic interventional decisions were delayed. When asked what the effect on decision making was from not getting information promptly, participant 13 simply said:

It can delay the decision making definitely.

During a haemodynamic critical incident, the participant attributed her confusion about the patient's haemodynamic status to having 10 colleagues assist her and a lack of referral from those colleagues about their actions. Non-integrated TDM was observed to delay decision making and the transfer of the patient to the operating theatre at a time when the patient was dangerously ill. Participant 28 said:

I feel what delayed it (the transfer to theatre) even more was because of the confusion around the bed area.

In circumstances of acute haemodynamic instability, time is of the essence to ensure that patients' outcomes are optimised. Delays in decision making when patients are acutely unstable have the potential to impact adversely on patient outcomes.
6.3.4.3 Uncoordinated Clinical Practice

Nursing practice related to receiving and recovering patients was performed in an uncoordinated manner during non-integrated TDM. When asked about the impact on her ability to plan patient care during a situation where there were numerous assistant nurses present, participant 23 replied:

Oh you can’t, you just can’t plan care. Because you’re about to do something and somebody else has already halfway done it, and they don’t necessarily do it thoroughly because they’re rushing, they’re not efficient, they haven’t listened to the whole story.

Participant 23 was referring to the anaesthetist's handover when she used the term the whole story. In doing so, she was pointing out the importance of listening to handover in order to know decision priorities for patients during the recovery period and therefore what actions are required. The issue of handover is further discussed in Chapter Seven.

Uncoordinated practice also arose from assistant nurses coming and going as they pleased. So, not only was there the problem of having three or more assistant nurses, but those nurses assisted the primary nurse for various time periods in between attending to other responsibilities out of the participant's cubicle. Nurses wanted fewer colleagues in attendance at the time of receiving patients and for those colleagues to remain in attendance in order to minimise uncoordinated practice. Nurse 14 explained why so many nurses led to uncoordinated practice:

If there was just one person to assist throughout, well for the first half an hour until you sort of get settled. Rather than four different people or whatever coming in and out. Because then you’re able to communicate with that person, if there’s only two people doing things as opposed to four or whatever, and things get missed because you’re not sure what’s been done, no communication at all.

In circumstances of uncoordinated practice, poor communication, three or more assistant nurses, and a continuous change in personnel was observed by the researcher and experienced by primary nurses.
6.3.5 Potential for Compromised Patient Outcomes

In order for nurses' decision making concerning the three goals of therapy to have the potential to optimise patient outcomes, nurses have to respond to adverse haemodynamic data rapidly and accurately. The decision making of nurses involved in non integrated TDM had the potential to compromise patient outcomes in the initial 2-hour recovery period.

An incident where a haemodynamically unstable patient was returned to theatre urgently will be used to illustrate how non-integrated TDM had the potential to compromise patient outcomes. In Section 6.2.5, an incident where a haemodynamically unstable patient was returned to theatre urgently was used to illustrate how integrated TDM had the potential to optimise patient outcomes. By using similar incidents, comparisons and contrasts can be made about how each form of TDM had the potential to influence patient outcomes.

The haemodynamic status of patient 28 was extremely unstable. He had an average MAP of 62 mmHg throughout the recovery period. As the MAP had not responded to numerous bolus doses and continuous infusions of potent vasoconstricting drugs, the surgeon was notified. The patient had been in the unit for 75 minutes and integrated TDM had been taking place. Once the surgeon announced that he wanted the patient returned to theatre for reexploration, nine colleagues came to assist the primary nurse and the dynamic of TDM changed to non-integrated TDM. A lack of communication between team members, uncoordinated decision making, and delayed decision making was observed. Specifically, a lack of cardiac monitoring and a prolonged time period to prepare the patient for theatre had the potential to compromise patient outcomes.

Despite the presence of three cardiac monitors in the patient's cubicle, the wall monitor, transport monitor, and the emergency trolley's defibrillator and monitor, the patient's cardiac rate and rhythm were not monitored for about 3 to 5 minutes. At this stage, the patient was profoundly hypotensive (MAP 35 mmHg) and receiving external chest compressions. In the interview, participant 28 was angry with her colleagues for actions that she believed placed the patient at risk:
On top of all the confusion there was probably a 3 minute period where that patient did not have a, in an ICU, didn’t have a heart rate being monitored anywhere….Well the patient is not being monitored, they’ve come to an ICU for 24 hour monitoring, especially a postoperative patient, and if you can’t provide that because of confusion created by too many people in the work environment in that little cubicle, well that’s poor because you are not doing what you should be doing for the patient, and that’s monitoring. There was a period there that it wasn't happening. Especially when they are critically unwell with low blood pressure…so its not good enough…it shouldn’t have happened. It was all about 5 minutes by the time we got it reestablished. Shocking that.

During observation 28, nurses had rapidly responded to the hypotension with vasoactive drugs, but the drugs failed to reestablish haemodynamic stability and so urgent surgical reexploration was warranted. On visiting the patient, the surgeon indicated that he thought that the patient was in imminent danger of a cardiac arrest and that he wanted the patient sent to theatre immediately. The patient was demonstrating haemodynamic parameters that were life-threatening and time was of the essence. However, due to non-integrated TDM, it took 11 minutes from the time the surgeon asked for the patient to be returned to theatre to the time that the patient left critical care. The time of 11 minutes to return patient 28 to theatre compares with 3 minutes taken by the nurses involved in integrated TDM to return patient 12 to theatre (see Section 6.2.5). The prolonged time was particularly concerning because patient 28 was more haemodynamically unstable than patient 12 and at greater risk. Due to non-integrated TDM, nurses took nearly four times longer to prepare the patient for transportation to theatre. Non-integrated TDM had the potential to compromise the patient's immediate and long term outcomes. Patient 28 had a mitral valve replaced in theatre and the longer term outcomes are unknown.

In sum, non-integrated TDM was distinguished by assistant nurses directing and making patient management decisions, a lack of continuous referral to primary nurses, and generally three or more assistant nurses. Non-integrated TDM occurred more frequently when the primary nurse was inexperienced. In situations that the researcher later labelled non-integrated TDM, primary nurses remained silent and tried to be vigilant of colleagues actions. Despite trying to be vigilant, many primary nurses were unaware of assistant nurses' decision activities and so repeated assessments and decisions. The characteristics of non-integrated TDM led to uncoordinated nursing
practice and had potential to compromise patient outcomes. In the next section of this chapter, nurses' experiences of receiving a patient alone are described.

6.4 Receiving Patients Alone

In this section, the negative cases where TDM was not observed during the initial reception period are described. There were situations when primary nurses received no assistance from colleagues during the admission of patients. Primary nurses said that they did not realise that they had to receive patients alone until after the patient was admitted. The reasons why nurses received patients without assistant nurses are presented. Nurses' emotional responses and the outcomes for practice and patients are described briefly.

6.4.1 Nurse Outcomes

6.4.1.1 Going It Alone

Three inexperienced nurses received a postoperative cardiac patient alone. Those 3 nurses did not receive assistance from colleagues and, consequently, were not involved in TDM. The nurses were alone for periods ranging from 5 to 10 minutes. Although that time period may seem short, as outlined in Chapter Four, 60% of patients were admitted in a haemodynamically unstable state and the median time at which a haemodynamic critical incident took place was 11 (Q25, Q75 = 7, 105) minutes. Moreover, until primary nurses heard the anaesthetist's handover during the reception phase, nurses lacked formal knowledge of the patient's past or current history. Nurses received patients alone because of the way nurses were allocated to receive patients, concurrent events in the unit, and the geographical layout of the unit. In some instances, a combination of all three factors was observed.

Despite nursing management's knowledge of the imminent arrival of postoperative patients, no formal arrangements were in place in any of the research settings whereby an assistant nurse was allocated to receive patients with primary nurses, even if those primary nurses were inexperienced. Primary nurses said that they were not aware that they were going to receive patients alone until it actually happened.
Poor communication between management and primary nurses contributed to nurses receiving patients alone. As recounted by participant 14:

The Associate Charge Nurse came over and said there are staff shortages. I just think maybe before even I’d taken the postoperative patient, if someone had said we’ve got a staff shortage today, there’s not going to be anyone in particular to help you, how do you think you’ll cope with that? Will you be okay? I would have said, oh I’m not happy…but no one said anything. So then I was just going, oh my gosh where is everyone? Someone always helps when you get a postop back, even experienced people have help.

Nurses also received a patient alone because concurrent events in the unit occupied all the rostered nursing staff or primary nurses were positioned in isolated cubicles and, as a result, had limited access to roving colleagues. In all the settings of this research, at least one nurse per shift was unassigned to a specific patient so that he or she was available to help primary nurses as needed. Despite the provision of one unassigned nurse each shift, nurses received patients alone because either two patients arrived back from theatre at once, other patients were being discharged from the unit simultaneously, or other patients were experiencing a critical incident. These situations suggest that the admission of patients was poorly coordinated. Participant 17 summed up why she thought she received a patient alone:

That really depends on what else is happening in the ward at the time. Also different staffing levels and where you are actually positioned in the ward, I was in a room which is very secluded and you sort of can’t see what’s happening.

Participant 13 also received a patient alone due to the geographical layout of the unit. That is, participant 13 was positioned in an isolated cubicle which prevented him easily accessing colleagues in neighbouring cubicles or the nurse who was not assigned to a specific patient. He explained the difficulty of recruiting assistant nurses when postoperative patients are placed in isolated cubicles:

In the beginning I was looking around for people because there was nobody around. So I was hoping somebody was going to wander by because they
obviously knew that patient had had a 5 minute call and usually many other people come to help. But no one came…at one stage I was looking for people, and you can’t wave out to anyone because you’ve got four walls around you, it does make it a little bit difficult in terms of getting attention from people.

Nurses did not seek to receive patients' alone. In one instance, a nurse called for assistance using a telephone in the cubicle, but was informed that no nurses were free at that point in time to assist. The other nurses periodically looked outside their cubicle in order to call for collegial assistance. When primary nurses received patients alone during the immediate recovery period, they felt unsupported.

6.4.2 Nurse Responses: Emotional

6.4.2.1 Unsupported by Colleagues

Nurses felt unsupported by their colleagues when they received patients alone. In the transcript excerpts in the previous section, both participants 13 and 14 indicated that they felt unsupported. Participant 14 later confirmed that feeling:

I didn’t feel very supported today… I just felt that there were not enough senior staff around…Normally when I take a post op CABG patient I can always say (to an assistant nurse), listen how do you do this, or just a brief reminder…I felt a little bit on my guard, if something is going to happen I’m responsible kind of thing.

Nurses felt unsupported both emotionally and practically. The effect of receiving a patient alone for nursing practice and the potential implications for patient outcomes are described in the next section.

6.4.3 Practice and Patient Outcomes

Despite the brief time frame of receiving patients alone, nurses believed that the lack of assistance led to delays in haemodynamic decision making and other nursing practices. Participant 17 was delayed in documenting the patient's haemodynamic parameters and that hindered her ability to reflect on the progress of the patient's haemodynamic state. Furthermore, despite the patient being hypothermic, she was
delayed in instituting rewarming measures for the patient because she did not have an assistant nurse to share the workload. Participant 17 explained:

I didn’t get my obs., down till later. Like sort of 15, 20 minutes down the track. Where its nice to have a first set of obs., when they get back, and to see which way they’ve gone in 15, 20 minutes…if I had more people helping, that (warming blanket) would have been on and actively warming. He was 35.8 ºC.

Despite delays in completing certain aspects of patient management from receiving patient's alone, it was difficult to judge whether patients suffered in any way from delayed nursing assessments. That said, the nurses involved certainly felt concerned for patient outcomes as a consequence of receiving patients alone. Nurses said that they felt concerned because they were inexperienced and felt ill prepared to detect postoperative complications and to appropriately respond to haemodynamic instability without decision support. Nurses also said that they were concerned because they knew they were accountable for their decision making and the impact of such on patient outcomes.

In sum, three inexperienced nurses received an immediate postoperative patient alone for up to 10 minutes. In response, nurses felt unsupported by their colleagues. Some delays in decision making practices were observed as a consequence of not receiving assistance from colleagues. Being alone also had practical implications in that some crucial tasks were not completed. The nurses involved wanted decision support from an experienced colleague and were concerned about the quality of their decision making and the potential impact upon patient outcomes by receiving patients alone.

6.5 Team Decision Making in Crisis

Team decision making was observed during patient crises. Patient crises included intermittent unpredictable episodes of profound haemodynamic instability caused by sudden or slow haemorrhaging and periods of sustained profound hypotension requiring external chest compressions. The form of TDM was not necessarily constant between reception of the patient and the patient's crisis. That is, a patient crisis could shift the
dynamic of TDM from integrated TDM to non-integrated TDM. Moreover, when certain nurses moved in to or out of the team, the dynamic shifted between non-integrated TDM and integrated TDM or vice versa. Hence, individual nurses had either a stabilising or destabilising effect on the team. The model of TDM in crisis is shown in Figure 6.2.

![Diagram](Figure 6.2 Model of team decision making in crisis.)

In most patient crises, the characteristics of non-integrated TDM were evident. That is, there was a lack of referral to the primary nurse, assistant nurses directed patient care by making most haemodynamic patient management decisions, and there were three or more assistant nurses present. During patient crises in observations 5 and 28, there were 13 and 10 staff, most of whom were nurses, in the cubicles. For primary nurses who had been involved in integrated TDM during the reception of patients, the
sudden shift in dynamic to non-integrated TDM seemed to be an unpleasant experience. The sheer number of staff, most of whom were assistant nurses, overwhelmed the primary nurse. Participant 28 explained:

There were just too many people around. That’s just something that happens sometimes in ICU. People need to be aware. I know people try and help, but I think there were just too many people there…Yeah and there were just too many people doing the one thing…You couldn’t move. It was just ridiculous…I do think nurses really need to learn, realise that they need to stand back. I really do.

Participant 28’s comments suggests that nurses have an entrenched response of attending patient crises in large numbers. Participant 28 indicated in the interview that she intended to raise the issue of too many colleagues assisting primary nurses during patient crises for discussion at the next unit meeting of nurses. It is not known if participant 28 did so.

As the model in Figure 6.2 indicates, the presence of individual nurses during crises could shift the dynamic between non-integrated TDM to integrated TDM. Individual assistant nurses shifted non-integrated TDM to integrated TDM by empowering primary nurses to be in control of patient management decisions, asking fellow assistant nurses to leave the cubicle, and promoting continuous referral to primary nurses. In observation 5, non-integrated TDM was evident during two patient crises until a particular assistant nurse shifted the dynamic to integrated TDM. First, an excerpt from observation 5 is provided to set the scene:

The blood pressure is now 39 (systolic)…Primary nurse has just pressed the button for an emergency arrest…The patient is head down again and assistant nurse is back in the cubicle so now there’s five nurses in the cubicle. More nurses, a doctor and another registrar arrives and intensivist…so now there are 13 people in the cubicle.

The experienced assistant nurse worked alongside the inexperienced primary nurse to reestablish the patient's haemodynamic stability, remove excess nurses from the room, and impart specific cardiac surgical knowledge pertinent to the patient's condition. Also, the primary nurse began telling the doctors about the patient's condition. The
action of the experienced nurse created a sense of calm in the cubicle. It was clear from the comments of participant 5, that the experienced assistant nurse had made a difference to her decision making and confidence related to managing patient crises:

I had one person in particular who was quite experienced in cardiothoracics and (she) is very calm in situations and we work well together...The assistant nurse was very clear, and she was fantastic, she always said are you happy for me to do that? Do you want me to do that? What would you like to do?

It was also observed that primary nurses could maintain integrated TDM during patient crises. The primary nurse in observation 12 was observed to accept assistance from a few colleagues when his patient suddenly haemorrhaged. The nurse was also observed to decline further offers of help that he considered superfluous. In doing so, it was observed that he was able to remain in control of patient management. As noted by the researcher in observation 12:

The patient suddenly coughed and basically just kept pouring blood out. Primary nurse is in control of the situation directing staff, informing medical staff.

When the patient haemorrhaged during observation 12, integrated TDM took place. As a result of non-integrated TDM, the primary nurse was not surrounded by too many staff, he could keep track of assistant nurses' decisions, he knew the patient's haemodynamic state, and he was able to rapidly coordinate the patient's return to theatre. Arguably, it is during patient crises that rapid, accurate decision making by primary nurses is most crucial to patient outcomes. During patient crises, TDM needs to be in the form of integrated TDM in order to enhance primary nurses' decision making and, potentially, optimise patient outcomes.

6.6 Discussion

The goal of this chapter was to describe the social context that surrounds the reception and recovery of cardiac patients by critical care nurses during the initial 2-hour
recovery period and the influences of this context on nurses' haemodynamic decision making. The timing of the observations in the initial 2-hour period following surgery revealed that individual decision making was strongly influenced by a team of nurses that comprised the primary nurse and assistant nurse. Two forms of TDM were observed.

Team decision making is a previously unexplored area of critical care nursing research, probably due to the preponderance of simulation-based decision making studies, which neglect crucial contextual factors such as the presence of colleagues. In this study, integrated TDM occurred more frequently when primary nurses were experienced. However, it also occurred when the primary nurse was inexperienced. In those instances primary nurses benefited from the integrated approach because they were assisted in recognising critical assessment cues that may have prevented an adverse event and given advice regarding decision priorities. In contrast, when inexperienced nurses were involved in non-integrated TDM, a situation that occurred more frequently in this study, the potential for adverse patient outcomes was higher. If primary nurses are unaware of essential aspects of patient management, such as a pacemaker setting, there are implications for those nurses' abilities to direct further haemodynamic assessments and subsequent interventions. As pointed out by Benner and colleagues (1992), inexperienced nurses can lack the ability to distinguish salient cues. The potential for inexperienced primary nurses to remain unaware of salient cues was compounded during non-integrated TDM by a lack of referral from assistant nurses in relation to assessment findings. Consequently, primary nurses involved in non-integrated TDM had an incomplete assessment base and therefore an inability to plan care in a comprehensive manner.

The finding that decision making was influenced by colleagues supports Jenks' (1993) finding that colleagues contributed to patient management decisions. The high value placed on maintaining positive relationships with colleagues reported in Jenks' study perhaps, in part, explains why inexperienced primary nurses were observed to remain silent when assistant nurses directed and performed haemodynamic management decisions. Some participants said that they remained silent in order to avoid what they described as combative behaviours and that suggests nurses were trying to maintain positive relationships with colleagues. Silence on the part of inexperienced nurses was
also attributable to some nurses not having well-formed relationships with certain colleagues. Some inexperienced primary nurses said that they lacked a level of comfort to express their feelings regarding assistant nurses' behaviours during non-integrated TDM. It is further suggested that, since some inexperienced nurses expressed a self-perception of being junior in the nursing hierarchy, they may not have considered their opinions as valid as those of their more senior colleagues and, on this basis, remained silent. Bucknall (1996) found that less experienced nurses were less confrontational than experienced nurses and respected existing professional hierarchies.

One participant who was experienced in general critical care nursing, although inexperienced in cardiac surgical intensive care nursing, admitted to remaining silent during a period of patient deterioration. Her silence may be indicative of a wider, cultural problem that all critical care nurses need to address. Open communication is especially important for less experienced nurses because inexperienced nurses seek guidance from experienced nurses to help them prioritise decisions and organise patient care (Aitken, 1997; Benner et al., 1996; Bucknall, 1996; Chase, 1995).

Non-integrated TDM had the effect of leaving some nurses feeling disempowered and out of control. Interestingly, primary nurses helped to maintain control of patient care by using the patient’s chart as a centering tool. By consulting documentation, which had been completed by primary or assistant nurses, assessments and interventions were prompted. The action of consulting patients’ observation flow charts supports O’Connell’s findings that nurses inspected and reviewed patients’ charts as a means of both checking and integrating information prior to making decisions in uncertain and dynamic environments (O’Connell, 2000). The observation flow chart provides structure to seemingly disparate and complex decision activities and enables a comprehensive perspective of the situation (Chase, 1995). But a patient’s chart does not provide a comprehensive record of all decisions (Christensen & Abbott, 2000), nor does it offer rationales for decisions. As such, charts do not replace continuous referral between team members.

For TDM to be effective, it is not sufficient that each individual possesses skills and knowledge; rather, success depends upon such information being communicated between members (Orasanu & Salas, 1993). As noted earlier, integrated TDM featured continuous referral between team members. Orasanu and Salas (1993) pointed out that
team members with a high appointed position status strongly influence the performance of the team, mostly positively. In this study, integrated TDM was demonstrated more often by teams led by primary nurses who were experienced nurses and who held the senior position of Clinical Nurse Specialist. This finding supports Chase's (1995) finding that nurses' appointed positions influenced decision making.

The finding that some nurses received patients alone due to competing demands in the unit for staff, the method used to allocate staff to receive patients, and the geographical isolation of certain cubicles has not been reported previously. By receiving patients alone, those inexperienced nurses made more autonomous decisions than they perhaps would have if a team of nurses were present. Bucknall (1996) also found that inexperienced nurses tended to make more autonomous decisions when they were situated in isolated cubicles and had reduced access to roving senior staff.

Both integrated and non-integrated TDM occurred during patient crises, but, in this study, non-integrated TDM was more common. It was also observed that certain nurses could shift the dynamic of non-integrated TDM to integrated TDM. Importantly, both primary nurses and assistant nurses present during patient crises were able to have either a stabilising or destabilising effect on the team. As integrated TDM had the potential to optimise patient outcomes and non-integrated TDM had the potential to compromise patient outcomes, all nurses during patient crises have important roles to play both in terms of their behaviours and actual patient management decisions.

6.7 Conclusions

In this chapter TDM has been presented as the primary decision making process arising from the social context that surrounds the reception and recovery of cardiac surgical patients by critical care nurses. Two forms of TDM were described: integrated and non-integrated. Each form of TDM influenced nurses and decision making practices. In the next chapter, primary nurses' perceptions of receiving and recovering cardiac surgical patients will be presented.
CHAPTER 7

NURSES' PERCEPTIONS OF RECEIVING AND RECOVERING POSTOPERATIVE CARDIAC PATIENTS

In this chapter, primary nurses' perceptions of assuming responsibility for the reception and initial recovery of postoperative cardiac patients are presented. As discussed in Chapter Two, cardiac surgical patients are distinguished by a high acuity, highly invasive haemodynamic monitoring technologies, and unique clinical presentations as a result of undergoing cardiopulmonary bypass. An exploration of primary nurses’ decision making experiences during the reception and recovery of patients offers an opportunity to describe effective processes, to identify ineffective system processes, and consider modifications to those processes in order to optimise nurses' decision practices.

Nurses' perceptions of receiving and recovering cardiac surgical patients have not been previously been investigated. However, there have been studies of critical care nurses' decision making that have reported nurses' reflections on their decision making practices. Findings in studies by Bucknall (1996) and Baumann and Bourbonnais (1982) suggested that knowledge of, and clinical experiences with, critical care processes, procedures, and equipment enhance nurses' decision making. What these studies do not tell us is how nurses feel about assuming responsibility for decision making while caring for critically ill patients, and what system processes nurses believe enhance or hamper their decision making during the initial recovery of cardiac surgical patients. The goal of this chapter is to describe nurses' perceptions of assuming responsibility for the reception and initial 2-hour recovery of postoperative cardiac patients.

Nurses described their perceptions of recovering patients in terms of the experience of making decisions for high acuity patients and in terms of system processes that surrounded and influenced their actual decision making. System processes refers to common processes and procedures that take place during the recovery of cardiac patients in clinical settings and, as such, are characteristics of the critical care environment.
The first theme identified was that nurses felt daunted when making decisions for cardiac surgical patients. Second, some nurses thought the decision making associated with recovering patients was challenging in an exciting sense. The third theme related to how nurses viewed the decision making associated with receiving and recovering patients as routine. This third theme was named the routine of wake, warm, and wean.

Nurses also identified three system processes that influenced their decision making while receiving and recovering cardiac patients. First, the handover from anaesthetists during nurses' reception of patients was crucial to nursing practice because it provided the initial framework for nurses' haemodynamic decision making. Second, nurses believed that there was a need for admission procedures to be carried out methodically when settling in patients to critical care. Finally, nurses provided their views about the collegial assistance provided by peers during the reception of patients.

The discussion of findings is divided into two major sections. The first section contains nurses' perceptions of their actual decision making experiences while receiving and recovering cardiac patients. In the second section, nurses' perceptions of system processes that they believed influenced their haemodynamic decision making are described.

7.1 Nurses' Experiences of Decision Making

The focus of this section is nurses' experiences of making decisions for postoperative cardiac patients in the initial 2-hour period. During the interview, nurses reflected on their decision making during the observation period. These reflections showed that nurses' level of experience influenced the ways in which they perceived their decision making experiences. Most inexperienced participants felt daunted when making decisions for patients whereas most experienced nurses felt challenged in an exciting sort of way. Some inexperienced nurses thought that the decision making associated with recovering patients was routine in terms of it being the same for each patient, whereas other experienced nurses used the term routine in terms of decision making being easy.
7.1.1 Daunted

Fifteen nurses (40%), 13 of whom were inexperienced, voiced feelings of anxiety, fear, or nervousness in relation to recovering postoperative patients. Nurses felt daunted because of their inexperience in cardiac surgical intensive care nursing, the complexity of patients' haemodynamic states, and a lack of confidence in their own decision making skills and abilities. In particular, nurses had little confidence in their abilities to appropriately prioritise haemodynamic assessments or respond rapidly and accurately to haemodynamic instability. Nurses were concerned that patient outcomes could be compromised by their self-reported lack of confidence and skills in haemodynamic decision making. During the recovery period, participant 14, who was inexperienced felt:

Frightened. I thought if anything major happens basically I’m accountable for all of this. I felt it was really difficult today…also I have a problem with prioritising, I sort of have to ask people what is most important.

Nurses realised that they were accountable for their decisions and said that accountability was a heavy burden to carry. Nurses' lack of confidence in their skills to proficiently troubleshoot haemodynamic instability was compounded when patients experienced episodes of profound deterioration that were unresponsive to their interventions. Such clinical experiences also perpetuated nurses' feelings of anxiety. As explained by participant 5:

The fact that I haven’t experienced a lot of cardiothoracics means that I walk into a situation less confident than I normally am. Then when something doesn’t go right it alters my confidence again. Then when that continues to go wrong I just I really feel…(unfinished sentence). But at the end of the day you are the person that is responsible for that patient…its difficult because you then have a high anxiety level when you’re looking after the patient and you take that with you when you leave. And the next patient that you take, you carry some of that anxiety again.

Inexperience in cardiac surgical nursing and the sheer amount of decision making required in the recovery period intensified nurses' fear and anxiety. Indeed, the
responsibility of making rapid and accurate decisions for high acuity patients with precarious and unpredictable haemodynamic states overwhelmed some nurses. Participant 18 simply said:

I think its (the 2-hour postoperative period) just a short period of time because so many things could go wrong. Like today the pacing problem, but he could have been bleeding at the same time. He could then have had no blood pressure and he could have had a really rotten chest…you’re a novice, that’s why I think its overwhelming…I feel like there’s a lot of decision making.

Reflecting on her experience over the previous 6 months, participant 18 recognised that her anxiety had been reduced by learning the principles of cardiopulmonary bypass and associated clinical sequelae during a postgraduate diploma in critical care nursing. In recalling her experiences of receiving patients only 6 months earlier participant 18 said:

At the start of the year I freaked out because there’s a lot to think about. Oh I nearly died. I just found it very scary…I didn’t really understand (cardiopulmonary) bypass properly and the actual potential for the patient.

The assistance provided by nursing colleagues during the reception phase was valuable in reducing nurses’ feelings of anxiety. For the assistance to be of benefit in reducing inexperienced nurses' anxiety and building their confidence, primary nurses said that their colleagues needed to be experienced.

The circumstances of receiving patients alone, receiving intermittent assistance, or receiving assistance in the form of non-integrated TDM increased nurses' anxiety levels and reinforced their low confidence. In response to being asked to compare how she felt when receiving the patient by herself with how she felt when three nursing colleagues came to assist her, participant 14 replied:

Not coping. Like I thought hell I don’t know what to do, I didn’t know who to ask or anything. I was kind of in a bit of a panic I think for a bit…I just know everyone kept coming back and saying, oh there’s no CRP (clinical resource person), there’s no CRP and I was thinking okay well I’ll have to sink or swim
here...there seemed to be only junior people around...(and then, having three
nurses to assist) maybe that I might be a bit incompetent.

Although inexperienced primary nurses had a preference for those colleagues
who helped them to be experienced so that they could gain access to haemodynamic
troubleshooting skills and knowledge, experienced colleagues were not always available.
During observation 18, the participant sought advice from the researcher regarding a
problem with the pacemaker because there were no experienced nurses available in the
unit. Participant 18 explained:

That was the issue to start with, there was no nurse senior more than
me...because it wasn’t pacing adequately, and I was concerned about his outputs,
I knew that he didn’t have a very good underlying rhythm, so I know there
wasn’t really anyone around who was more experienced than me with
pacing...So that was a little bit stressful...oh the other nurse said it will be okay
just to do that. It’s not really. Especially when I know that the other nurse said to
me that her (knowledge of) pacing is not really that great. It’s not really
reassuring that the assistant nurse feels pacing is an area that she's not really
confident in.

Thirteen of the fifteen primary nurses who felt daunted while recovering
postoperative patients were inexperienced nurses. The two experienced nurses who felt
daunted had not received a patient directly from theatre for several months and both
worked part-time in critical care. These findings suggest that the role of experience,
employment status, and frequency of exposure to immediate postoperative patients play
an important part in nurses' confidence and self-perceived abilities to recover cardiac
patients. The strategy used by most nurses to deal with feeling daunted was to seek
decision making support from experienced colleagues.

7.1.2 Challenging

For some nurses, decision making associated with recovering a cardiac surgical
patient was challenging in the sense of it being exciting and positive. The majority of
nurses who considered decision making associated with recovering patients challenging
were experienced nurses. Only one inexperienced nurse described recovering patients as
a challenge. Nurses described how they felt pleased and proud when they met challenges associated with detection, and responding to, episodes of haemodynamic instability and postoperative complications. In particular, nurses expressed satisfaction that their decision making had been instrumental in patients' recoveries. Nurse 11 said:

I felt they (last 2 hours) went very well considering he’d had a rocky postoperative period and he needed to go back onto (cardiopulmonary) bypass, and he was having some coagulopathic problems. I felt that (in) the last 2 hours he stabilised and now he’s improving.

Although nurses said that they welcomed the decision making challenges associated with recovering patients, some nurses were not as challenged as they wanted to be because the patients were considered stable. For instance, participant, 20, said of her time recovering the patient:

Fairly uneventful, she was reasonably stable, no real dramas. Reasonably uneventful.

However, patient 20 had bled intraoperatively, suffered hypotension (MAP of 62 mmHg) on arrival and during the recovery period, had a pacemaker that was incorrectly set up on admission, and was treated with inotrope, vasodilator, and sedation infusions. This scenario suggests some nurses may be inclined to down play the complexity of patients' haemodynamic status. As most nurses who felt challenged while recovering patients were experienced nurses, it is likely that those nurses were familiar with recovering complex patients and, therefore, considered patients with complicated postoperative courses commonplace.

One inexperienced nurse who felt the decision making associated with recovering patients was challenging received decision support from experienced colleagues. It was this support that contributed to the primary nurses' confidence about having met the challenges associated with complex patient management decisions in the 2-hour period. Participant 6 remarked:
When the patient came out we had expected that he would have been a little more unstable than he ended up being, just due to the fact that he went back and had been reopened. But as it turns out he's routine. He was just a little bit oozy and a little bit bleeding, but no major problems so its been quite good.

Some nurses, however, described the challenge of trying to reestablish haemodynamic stability as onerous. Furthermore, when one patient did not respond to therapies as anticipated, the nurse felt annoyed. In expressing her annoyance, it seemed the nurse had failed to meet the challenges associated with recovering the patient that she had imposed on herself. Participant 27 explained how she felt about the 2 hours with her patient:

They were busy and the patient was unstable, that was annoying, but anyway, near the end, in the last half an hour, then I felt as if the problems that were occurring I was on top of, instead of just reacting to.

As participant 27 indicated, part of the decision making challenge was being able to anticipate patient problems and respond appropriately before patients showed overt signs of haemodynamic instability. The nurse felt satisfied that she had been able to reach that stage near the end of the recovery period. In the next section, discussion focuses on nurses who considered decision making associated with the reception and recovery of patients routine.

7.1.3 The Routine of Wake, Warm, and Wean

Some nurses considered the patient management decisions associated with the reception and recovery of patients as routine, and one nurse used the term wake, warm, and wean as a way of describing the decisions considered routine. That is, decisions were considered to be pretty much the same for patients regardless of their surgical procedure or their postoperative haemodynamic parameters. Participant 30 made no distinctions between patients who had undergone coronary artery bypass graft surgery or valve replacement surgery:

Well I suppose you can put CABGS and valves in the same bucket.
The perspective that all cardiac surgical patients and associated haemodynamic management decisions were routine was typified by participant 22. Participant 22 was inexperienced in cardiac surgical intensive care nursing and had less than 2 years general critical care experience. When comparing her experience of managing cardiac surgical patients to her experience of managing general critical care patients, participant 22 remarked:

You work with numbers a lot more (with) the cardiothoracic patients, instead of actually looking and saying what’s happening. There’s nothing really to look at, they’ve only got an incision in their chest. I find cardiothoracic patients, just a, b, c, d, e, f, g, there’s no real change with any of them. They’re all pretty much the same, wake, warm, and wean…they always come back in various states, borderline states. So I don’t know why that is, they always do. Probably the only thing I’ve noticed as I’ve just said, they come back and they’re often very borderline. Their basic state is always hypotensive, under-filled, cold, and in a mess.

Experienced and inexperienced nurses considered patient management decisions to be routine. In contrast with the previous example however, experienced nurses seemed to link their routine perspective of patient management to their years of experience. Many nurses made brief comments such as the following by participant 30:

I’ve had a lot of cardiac patients previously, so it’s always the same issues.

Similarly, participant 8 declared:

I mean your cardiothoracic patients are pretty much routine usually. You know that they’re generally going to dilate and you’re going to have to either fill them or start inotropes. So you can sort of predict maybe what you’ll have to do next…it is fairly predictable what happens with these patients usually in the routine.
Although the peripheral circulatory system can vasodilate from the clinical sequelae of cardiopulmonary bypass and rewarming measures implemented in the recovery period, peripheral vasodilation does not occur in all patients. As discussed in Chapter Four, 6 out of 38 patients in this study remained vasoconstricted (SVR greater than 1200 dynes·sec·cm⁻²) despite half (n = 3) of them receiving active rewarming measures. These data suggest that if nurses base decisions upon routine expectations, patients may receive inadequate or inappropriate therapies.

Indeed, there was a potential risk to patient outcomes from nurses' perception of patient management decisions being routine. For instance, one nurse administered colloid fluid boluses to a patient when the patient was not showing signs of hypovolaemia. The nurse explained to the researcher that she thought all cardiac surgical patients are hypovolaemic. Despite the patient showing a high PCWP of 21 mmHg (normal 10 to 15 mmHg in a cardiac patient), participant 22 had summarised the patient's state as:

Fairly standard, fairly standard, just the normal post op., no real complications so it was fairly straightforward...The patient is fine, the patient was okay, came back with a labile blood pressure as they fairly normally do. But started inotropes and things and (the patient) was all right...I was more concerned with the PCWP. Don’t ask me why. It was more his filling pressures...he had a fairly high PCWP, it was 21...so had to get that sorted out with some filling (fluid boluses) and inotropes.

When asked the appropriateness of her actions to seek an order from medical staff for fluid boluses and the subsequent administration of that fluid in light of a PCWP of 21 mmHg, participant 22 replied:

Um. No. I missed that one.

Other similar situations occurred in this observation. Previously the nurse had administered pump blood to the patient to fill the patient because:
He had the pump blood, there was a litre of pump blood to go through and his CVP was low and his blood his blood pressure was, systolic it was about 95, so I just pumped that in first anyway, to see what that did...The CVP was about 9 or 10 and the PCWP was quite high, but I just always pump it in...because often they come back so under-filled. That’s the only reason I did that.

Given that participant 22 acknowledged that the patient's PCWP was quite high, her decision to give pump blood was not individualised to the patient. On two occasions, the same nurse had administered fluids in a routine way and both of these decisions had the potential to induce pulmonary oedema. Reflecting upon the meaning of haemodynamic parameters prior to implementing therapies would assist nurses to meet goals of therapy and optimise patient outcomes.

7.2 Nurses' Experiences of System Processes

Nurses identified three system processes, that is, common processes and procedures that took place during the recovery of cardiac patients, as major influences on their decision making. Nurses talked about these issues during the interview when they were asked to reflect upon their decision making during the observation period. The handover from anaesthetists, settling in procedures, and collegial assistance were the three system processes referred to by nurses. These processes were not protocols in any of the settings; rather, they were unwritten processes and procedures associated with receiving and recovering patients. The main thrust of nurses' comments related to the instrumental nature of these processes for their decision making and the way that they thought these processes could take place in order to enhance their decision making.

7.2.1 Anaesthetists' Handover: Setting the Framework for Nurses' Decision Making

Nurses said that the handover from anaesthetists during the reception of patients set the framework for their haemodynamic decision making in the recovery period. Nurses said that the information gleaned from anaesthetists' handover guided their immediate patient management decisions and identified specific decision priorities. Although an operating room nurse telephoned critical care approximately 30 minutes
prior to the admission of patients to advise them of the impending admission, only brief details about the type of surgery performed, drug infusions, and presence of pacing wires were handed over at the time. As a result, both inexperienced and experienced nurses relied heavily upon patient information contained in handover because it was the first information they received about patients' preoperative and intraoperative haemodynamic status.

Handover could have different meanings for nurses depending on their perception of receiving and recovering patients. For nurses who considered recovering patients a challenge, handover was used to identify specific decision challenges. For nurses who were daunted at the prospect of receiving patients, handover removed some of the mystery associated with patients' haemodynamic status and provided an insight into patients' likely trajectories. The consistent finding between nurses was that handover identified particular patient problems that needed to be addressed and prioritised in the recovery period. Participant 13 explained:

With the handover from the anaesthetist, we were able to get a bit of an idea about what the potential problems might be for this patient, the problems they had in theatre. I also asked a few questions along the lines of looking at his filling pressures to look at what would make his heart best perform under the circumstances and what pressures they were getting and achieving in the cardiac output.

Anaesthetists always asked primary nurses if they were happy before they left the cubicle to return to theatre. The term happy could refer to many issues, but was interpreted by nurses to mean that they had a satisfactory level of understanding of the patient's haemodynamic status and were prepared to assume responsibility for decision making. At this stage, there was an opportunity for nurses to clarify aspects of patient care. Most nurses were observed to ask the anaesthetists questions during handover or when asked if they were happy.

Some nurses said that they preferred to be standing next to the patient so that they could see the patient while they listened to handover. This seemed to help nurses recall information and prompt questions. Additionally, primary nurses wanted all the assistant nurses to hear handover. If assistant nurses arrived after handover, primary
nurses were diverted from important patient management decisions to explain vital patient information to assistant nurses. Primary nurses also preferred the procedures associated with settling the patient to be postponed until handover was completed so that due attention could be paid to handover. Participant 5 summed up all these important considerations regarding handover:

> Get physically near them so you can actually have a good look, see what’s happened, see what they look like, and be able to hear the handover and everyone being in the room, so that the doctor, the nurse that are going to be looking after the patient actually are there listening…I actually prefer for all the change over of monitors and things to stop for just the first 5 minutes so that everybody hears what has happened, what sort of anaesthetic he’s had, whether he’s going to wake up quickly or not, has he had any problems bleeding all that sort of thing. So that you just get yourself set at the beginning and then you can move on…I think it is really important for that initial time and it makes your decision making after then much clearer and much easier to make because you’ve got information.

Information contained in anaesthetists' handover provided the initial framework for both inexperienced and experienced nurses' haemodynamic decision making and the decision priorities within that framework. In the next section, nurses describe the importance of settling in processes when they receive postoperative patients.

### 7.2.2 Settling In

Settling in referred to procedures carried out by nurses during the reception of patients such as establishing haemodynamic monitoring and connecting the chest drainage system to suction. The aforementioned actions were considered by participant 15 to be:

> Just the menial tasks, you know, putting the drains on suction and all that kind of stuff.

However, the procedures carried out during settling in required decision making skills and were critical to patient safety. During observation 1, the inexperienced assistant nurse connected the chest drainage system to suction but did not turn on the
suction. The experienced primary nurse double checked actions of the assistant nurse and corrected the problem. If it had not been corrected, an accumulation of blood or air in the patient's chest would have occurred. While receiving patient 9, an experienced assistant nurse noticed that a tap in the chest drainage system was turned incorrectly. The patient had been transported to critical care with the tap turned incorrectly and, as a result, the patient was suffering hypoxaemia (SpO₂ 90%). Participant 9 related the incident in the interview saying:

Someone who had transported him from theatre had turned the little tap the wrong way, so it was closed to the patient. It was actually then opened. It looked like he could have tamponaded or had a pneumothorax or something like that and possibly endangered the patient's recovery. It was okay because one of the nurses picked up on it and turned the tap the right way...his saturation was dropping down to about 90 at that time.

These incidents illustrate that decisions associated with settling in procedures required specific knowledge and skills. If corrective action by the experienced assistant nurse in observation 9 had not been taken, the patient may well have quickly progressed from a low SpO₂ to a cardiac tamponade and cardiac arrest caused by a tension pneumothorax. Not surprisingly, many nurses believed that procedures associated with settling in were important to patient safety. As participant 1 said:

I've worked in this area for a long time, I probably have a way, like a system of accepting a patient, making sure that they are safe.

Indeed, there were benefits for patients and nurses alike by nurses methodically carrying out settling in procedures. For instance, well organised admission procedures enabled prompt establishment of the patients' baseline haemodynamic status and gave nurses a sense of being prepared for potential episodes of haemodynamic instability. As participant 8 said:

It's nice to be organised so that you can cope with things easier later down the track.
When the procedures of settling in were disrupted, there were delays in obtaining baseline assessments of haemodynamic data and nurses took longer to consider and implement appropriate therapeutic modalities. In one instance, a patient was shifted from one cubicle to another cubicle only 33 minutes after being admitted because of faulty monitoring equipment that nurses had tried in vain to troubleshoot. Participant 5 believed that delays in performing settling in procedures as a result of the faulty equipment and cubicle transfer profoundly affected her ability to make patient management decisions:

The room change was probably one of the worst things that could happen for that patient. The equipment didn’t work so I couldn’t tell if he was cold, I couldn’t tell if he had a good output, I couldn’t tell if he was, what his PCWP was, what his filling pressures were. I had a blood pressure, I had a heart rate and I had a pulse. Because he was so cold it was hard to get a good trace (on the pulse oximeter for the oxygen saturation). So we did gases which established that his oxygenation was okay…but to…move him around to another room, was less than ideal at that point in time, when we needed to get numbers (haemodynamic parameters) straight off to get a guideline as to whether he was really dilated or whether he had a really low cardiac index, what his output was like.

A complete assessment of the patient's haemodynamic parameters was not completed until 58 minutes into the recovery period. Although the cubicle change was carried out efficiently, problems with faulty equipment before the move and the need to manipulate the PAC in order to measure the PCWP in the new cubicle contributed to delays in patient management. The patient was extremely unstable and, without being able to measure all haemodynamic parameters for the first hour, neither the cause of the problem nor specific therapeutic interventions could be carried out. The nurse firmly believed that the delays to, and disruption of, procedures associated with settling the patient compromised the patient's recovery during the 2-hour period. Certainly, this incident suggests that when procedures associated with settling in are disrupted, there is a potential for patient outcomes to be compromised.

When carried out as planned, the completion of settling in procedures provided nurses with the confidence that they were prepared for episodes of haemodynamic
instability. Settling in was observed to take between 15 and 30 minutes depending on the experience level of the nurses involved and the haemodynamic stability of the patients. The skills associated with receiving and settling in patients in a systematic way did not come easily or quickly to nurses. For one experienced nurse, skills associated with rapid settling in of patients were important for him to master. Indeed, his confidence received a boost when he was able to settle patients quickly. Participant 12 recounted:

You’re very proud and you want to be confident and you want to do things and you want to be in control, but it takes you, it took a good 3 or 4 months of consistently taking back CABGS patients, where you can actually go, you’ve got that mental check list where you go, bang listen to handover, somebody is doing the ventilator, somebody is taking the module out of the rack and putting it in, somebody is emptying the urine, somebody has marked the drains off on return to ward, checking Swan levels, floating Swans in if they need to be floated in, all that sort of bizzo.

Many primary nurses said that they preferred experienced nurses to assist them receive patients because they considered experienced nurses familiar with, and skilled in, settling in patients. Experienced nurses' familiarity with the procedures of settling in patients allowed such procedures to occur rapidly. Participant 24 recounted:

Oh they (experienced assistant nurses) know exactly. Well, this is routine you know. The patient comes back from theatre, we do an ECG, we do bloods we do x-ray, we roll the patient. There are certain things we do activated clotting time, check bleeding, empty the catheter, check the drains, listen to the chest. Everyone knows what needs to be done.

Established working relationships with colleagues also facilitated rapid settling in of patients. On recalling her experience of receiving the patient with experienced nurses, participant 8 said:

It was really good. I've worked with them for ages. We had our little routines down pat. So its nice working with a group of people that know what they’re doing just right off the top of their heads.
Nurses who had established relationships with certain colleagues over many years knew their colleagues' skills and abilities and trusted them to complete procedures in a skilled and timely manner. In the next section, nurses' perceptions of collegial assistance are presented.

7.2.3 Nurses' Perceptions of Collegial Assistance

In the settings of this study, there were no formal processes in place to provide primary nurses with help from nursing colleagues while receiving and recovering postoperative patients. Yet, in the majority of cases, one or more nurses freed themselves up from other duties in nearby cubicles to provide assistance to primary nurses. The participants in this study identified key issues regarding the provision and forms of collegial assistance that they believed would enhance nurses' decision making during the reception and recovery of postoperative patients. Those issues included the 

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of assistant nurses, the experience level of assistant nurses, and the duration of assistance. All nurses said that they wanted collegial assistance when they received and recovered patients because of high workload issues and their desire to promptly establish the haemodynamic status of patients. Although none of the participants expressed a desire to receive patients without assistance, participant 12 who was an experienced nurse had received patients without assistance in the past. Those experiences led him to believe that patients could be disadvantaged when nurses received patients without assistance because it took a long time to settle patients and assess their haemodynamic status. Participant 12 explained:

I’ve taken cardiac patients back by myself. You just plod away... Instead of taking you half an hour to settle the patient with two people, it might take you an hour with one person... You can’t in that initial post op period when they’re unstable and they’re waking up and they’re under volumned and dry, you really can’t walk off for a long extended period of time and go and grab things on numerous occasions. You can do it quite quickly maybe once or twice but you can’t be leaving all the time because basically you really need to sit there and keep a good eye on people in that initial period.
The nurse's comments suggest that current system processes regarding the preparations for receiving patients are inadequate. All nurses wanted only one or two other colleagues to act as assistant nurses. As explained by Participant 5:

You don’t want, its not the more the merrier. It’s often just two people who really know what they’re doing.

Some nurses wanted one or two colleagues to help them for the first 10 to 15 minutes after the patient arrived in the critical care unit, whereas other nurses believed that colleagues were required for the first 30 minutes. Participant 23 explained:

Oh I think…two if you’ve got two that are very highly skilled, beautiful, and you only need two probably for the first 10 to 15 minutes because you cannot physically connect someone to a ventilator and connect them to the monitor at the same time…anymore (assistant nurses) than that and it just gets too much.

Nurses believed continuity of patient care would be enhanced if nursing management allocated one or two nurses specifically to the assistant nurse role rather than having numerous different nurses sporadically providing assistance. Primary nurses also wanted their colleagues to provide continuous referral and to document their findings and interventions on the patient's chart. Participant 14 summed up many of these requirements by saying:

If there was just one person to assist throughout, well for the first half an hour until you sort of get settled, rather than four different people or whatever coming in and out. Because then you’re able to communicate with that person, if there’s only two people doing things. As opposed to four or whatever, things get missed because you’re not sure what’s been done, no communication at all.

Participant 18 also believed that having certain colleagues dedicated to receiving and recovering patients was important because the coming and going of numerous different nurses had the potential to disadvantage patients. She said:
I think it’s good to have one support person, then maybe, have a couple, have a person maybe documenting for you. But you need to have someone who’s there the whole time so they know what’s going on, otherwise you’re always reexplaining everything. You don’t want to put the patient, disadvantage them at all.

In addition to the number of colleagues, nurses specified the roles and responsibilities that they wanted their colleagues to adopt. Primary nurses wanted their colleague or colleagues to establish the patient's ventilation and chest drainage system and to complete documentation. Nurses also wanted to delegate decisions to their colleagues in order to remain in control of what decisions their colleagues performed. As participant 9 said:

I think it should be the nurse who is looking after the patient should direct people and guide that, rather than people tell you what they are doing.

One responsibility that primary nurses considered their own was that of physical assessment. Primary nurses repeated physical assessments of patients whenever assistant nurses performed them. Even the documentation of assistant nurses' assessment findings on patients' charts did not deter primary nurses from repeating patient assessments. As participant 12 remarked:

I think patient assessments really need to be done by the person looking after the patient.

Inexperienced nurses preferred their colleagues to be experienced in cardiac surgical intensive care nursing in order to learn the theoretical underpinnings of their decision making, gain practical skills related to haemodynamic monitoring, and feel confident that decision making advice was sound. Participant 6 gave her reasons for preferring experienced colleagues:
I’m not predominantly cardiac based, although I have a general critical care knowledge. There are some areas which, it’s just better if you’ve got someone who’s specialist, so you can just clarify or double check, and say look, okay, I was going to do this. Is this what you would do it? Is this normal? Should we double check this? Should we get a doctor? And they just confirmed my original thoughts and yeah, sort of reinforced things.

In the initial 2-hour recovery period after cardiac surgery, patients are characteristically haemodynamically unstable and that creates high decision making demands and competing decision priorities for nurses. To help reduce the decision making demands during that time, nurses indicated a desire for collegial assistance.

7.3 Discussion

The purpose of this chapter was to describe the experience of receiving and recovering cardiac surgical patients from the perspective of the primary nurse. The findings showed that nurses considered the decision making associated with receiving and recovering patients either a daunting, challenging, or routine experience. Nurses singled out the anaesthetist's handover as the most important factor for determining their initial decision priorities. Nurses described the importance of the procedures associated with settling in patients for patient safety. Nurses also identified the ways in which they wanted collegial assistance to be provided during the initial 2-hour recovery period in order to benefit their decision making and patients’ recoveries.

Nurses' perceptions of receiving patients have not previously been explored in critical care nursing research. The common thread in the findings presented in this chapter was that experience altered nurses' perceptions of recovering patients. However, experience did not alter nurses' views regarding the importance of the anaesthetist's handover for framing haemodynamic decision making. Nor did experience alter nurses' desire to have settling in procedures carried out in a timely manner and experienced, collaborative, and communicative collegial assistance for the first 15 to 30 minutes of the recovery period.

In this study, most of the nurses who felt daunted while recovering cardiac surgical patients were inexperienced nurses. Given that nurses had developed their own
strategy for dealing with their anxiety and fear of recovering patients, for example, silence and maintaining vigilance, it is quite possible that nurse managers and clinical nurse educators are unaware of nurses' feelings. A lack of formalised clinical support during the recovery of patients also supports the notion that nurse managers and clinical nurse educators may be unaware of the way that some nurses feel.

Most of the nurses who felt challenged in an exciting way while recovering patients were experienced nurses. Experienced nurses said they enjoyed the decision making associated with recovering complex patients because they were able to do it skilfully and with ease.

The study's finding that nurses perceived decision making associated with recovering patients as routine had the potential to impact negatively on patient outcomes. Most nurses who held this perception were inexperienced. Hence, routine decision making may arise from a lack of experience recovering patients and a lack of knowledge regarding cardiopulmonary bypass and its clinical sequelae.

Procedures associated with settling of patients facilitated expeditious assessments of the haemodynamic status of patients, which, in turn, enabled nurses to feel prepared to respond to possible episodes of haemodynamic instability. It is not surprising that nurses perceived the systematic procedures associated with settling patients to be important for patient safety. Critical care nurses are trained to be methodical decision makers so that they can manage complex patients and advanced haemodynamic technologies. An important aspect of that methodical decision making is to rapidly establish the haemodynamic status of patients on admission in order to detect, and respond to, subtle nuances in haemodynamic cues during the recovery period that may have significance for patient outcomes. Some nurses in this study considered settling in patients an important skill to learn and one nurse remarked that it was a matter of professional pride when that skill was mastered.

The study's findings that colleagues did not always remain to complete settling in procedures nor fully complete particular procedures raises questions about nurses' roles and responsibilities. Several instances occurred in this study whereby assistant nurses placed patients in potentially life-threatening situations because they did not complete certain procedures. Fortunately the problems were discovered by primary nurses, but the incidents strained relationships between the nurses involved and created a situation
where primary nurses constantly monitored and repeated actions of their colleagues. Greater effectiveness was demonstrated when nurses trusted their colleagues to complete interactions with patients and equipment so that patient safety was assured and decision making demands on primary nurses were reduced.

Nurses considered the anaesthetist's handover pivotal to their decision making during the recovery period because it was used to set the decision making framework and decision priorities. By basing decision priorities on information contained in handover, nurses' decision making was individualised to patients and had the potential to optimise patient outcomes. It is somewhat surprising, however, that nurses relied upon information in handover to form a framework for their decision making. The latter issue raises questions about why nurses do not have a preconceived framework for the haemodynamic decision making in the recovery period based upon the principles and clinical sequela of cardiopulmonary bypass. Is it perhaps that nurses are not conceptualising the recovery of patients after cardiac surgery according to goals of therapy and therefore tend to act responsively rather proactively?

In order to improve decision making processes during the first 15 to 30 minutes of the recovery period, nurses wanted to receive decision support from one or two experienced nursing colleagues. Importantly, nurses wanted assistant nurses and primary nurses to have distinct decision making roles and responsibilities in order to encourage accountability and avoid having to repeat decision tasks. Moreover, nurses wanted the assistants to provide continuous referral to the primary nurse. The form of collegial assistance described by nurses incorporated all of the characteristics of integrated TDM, but none of the characteristics of non-integrated TDM. In integrated TDM, primary nurses directed patient management decisions, there were only one or two assistant nurses, and there was continuous referral to primary nurses. The time frame of decision support suggested by nurses is considerably shorter than the mean time of 55 (SD = 31) minutes observed in this study. This finding suggests that primary nurses may lose track of time while receiving patients or underestimate the time that assistance is provided. It is also possible that assistant nurses are staying longer than required by the primary nurse and that those assistant nurses could be better placed elsewhere.

In the study by Chase (1995), two nurses were assigned to recover patients in ways that were similar to those described by the nurses in this study. It is not clear in the
model described by Chase whether assistant nurses were always experienced nurses. Both inexperienced and experienced nurses in this study wanted at least one colleague who provided help to be experienced in cardiac surgical nursing. One benefit of having only experienced nurses as assistant nurses would be that issues related to nurses' lack of confidence in, and anxiety about, their decision making skills could, in part, be addressed. Additionally, experienced nurses could role-model goal-orientated decision making, mentor inexperienced nurses, and help nurses to identify salient cues and set decision priorities, all of which, in turn, have the potential to impact positively on patient outcomes.

7.4 Conclusions

Nurses' perceptions of assuming responsibility for the reception and initial 2-hour recovery of postoperative cardiac patients have been discussed in this chapter. Experience played an important role in varying nurses' perception of decision making associated with recovering patients. Handover from the anaesthetist was identified by nurses as being crucial to their practice in the initial recovery period because it provided the framework and priorities for their haemodynamic decision making. Nurses also described their perceptions of collegial assistance during the reception and recovery of cardiac patients. In the next chapter, all the results of the research program are brought together and recommendations are made for nursing practice, nursing education, and future research.
CHAPTER 8

DISCUSSION AND CONCLUSIONS

The research was designed to explore the effects of interplay between decision complexity, nurses' experience, and environmental characteristics on nurses' decision making. Specifically, the purpose was to explore variability in nurses' haemodynamic decision making in relation to three postoperative goals of therapy. Despite many studies of decision making in haemodynamic decision making, no previous attempts have been made to explore the effects of multifactorial influences on decision making on the outcomes of nurses' haemodynamic decision making. The purpose of this chapter is to discuss the implications of the findings presented in this thesis for our understanding of critical care nurses' haemodynamic decision making in the initial 2-hour recovery period after cardiac surgery. The discussion begins with a brief review of the unique approach taken in this research and the outcomes of the research program. This is followed by the implications of the research findings for nursing practice and professional development. Finally, suggestions for future decision making research are discussed.

The aim of the research program was to test the proposition that interplay between the multifactorial influences on decision making would vary nurses' haemodynamic decision making in ways that may have implications for patient outcomes. This proposition was based on a review of the literature that suggested decision complexity, nurses' experience, and environmental characteristics could individually, and jointly, influence nurses' decision making.

In order to explore the proposition that interplay between decision complexity, nurses' experience, and environmental characteristics would lead to decision making variability, a naturalistic decision making design employing a combination of demographic survey, observation, interview, and patient chart review was used. The design used in this research program represented a unique approach to the study of decision making because it encompassed the multifactorial influences on decision making, allowed for the study of real-world decision making, and addressed limitations of previous decision research associated with ecological validity and external validity. A
key aspect of this study was the development of an organising framework based on three postoperative haemodynamic goals of therapy. The goals of therapy were useful for describing complex practice issues. The framework captured the inherent complexity of haemodynamic decisions and variability in nurses' assessment and interventional decision making that had the potential to influence patient outcomes. The goals of therapy also provided a useful framework for analyses of nurses' decision making and evaluation of decision making according to best practice guidelines. The findings of the research program have implications for nursing practice, education, and system processes regarding patient allocation and clinical supervision.

8.1 Outcomes of the Research Program

In order to describe the complexity of cardiac surgical patients and set the scene for nurses' decision making, the haemodynamic status of cardiac surgical patients on admission and throughout the subsequent 2-hour period in critical care was described. Few attempts have been made to describe the nature of cardiac surgical patients in the immediate postoperative period and the findings represent a new contribution to existing knowledge of critical care practice. Sixty percent of patients ($n = 23$) were haemodynamically unstable on admission and 95% of patients ($n = 36$) exhibited haemodynamic instability throughout the 2-hour period. Patients presented with, and displayed during the recovery period, diverse permutations and combinations of haemodynamic instability. Indeed, it was not possible to describe patients' haemodynamic instability in terms of categories because there would have been as many categories as there were patients.

The haemodynamic instability and postoperative complications exhibited by patients related to cardiovascular function, bleeding, and hypothermia. Major cardiovascular complications experienced by patients included hypotension (50%), low cardiac output syndrome, and low SVR syndrome. In this study, 16% of patients had low cardiac output syndrome, whereas Kumon et al. (1986) reported an incidence of 22.3% in their institution. Sixteen percent of patients had low SVR syndrome (16%) in this study, whereas Myles et al. (1997) reported an average of 5% to 8%. Twenty-one
percent of patients in this study had significant postoperative haemorrhages due to a coagulopathy (13%) or surgical techniques (8%) and these data represent a higher rate of bleeding than the average of 2% to 12% reported by Hall et al. (2001). Although 92% of patients were hypothermic on admission, significantly less patients shivered in this study (24%) compared to the rate of 50% reported by Spaniol et al. (1994).

As 95% of patients experienced haemodynamic instability and postoperative complications, attention is drawn to the sampling procedures. Patients were not randomly selected; patients were included in the study if their nurse was a participant. The tertiary referral settings of this study may explain, in part, why patients suffered high rates of certain haemodynamic complications. Tertiary referral hospitals have staff with expertise and material resources to support critically ill patients and therefore tend to accept patients for surgery who are considered high risk.

Nurses' haemodynamic decision making responses to these patients in terms of how cues were used and physiological needs were met were presented using the three goals of therapy. Nurses' decision making was described as preparations of the physical and mental workspace in anticipation of haemodynamic decision making, and as continuous appraisal and evaluation of, and responsiveness to, haemodynamic cues for each goal of therapy. Nurses' decision making has not been described in this way previously, however, decision making in terms of preparing the physical workspace and preparing the mental workspace has been described among anaesthetists (Xiao, 1994; Xiao, Milgram, & Doyle, 1997).

Nurses did not fully prepare the physical workspace to meet the goals of optimising cardiovascular performance and reestablishing normothermia prior to the admission of patients. Common practices and an apparent lack of anticipation regarding the haemodynamic decision making practices common to immediate postoperative patients accounted for some nurses' lack of preparations. As these preparations can, in part, illustrate nurses' clinical foresight, these findings make an important and original contribution to our understanding of decision making in the clinical setting. The information that nurses had available immediately prior to patient arrival limited preparations for the mental workspace. Nurses did not receive information about patients' preoperative or intraoperative haemodynamic status until they received a verbal handover from the anaesthetists during patient admissions. These findings illustrate the
influence of system processes on nurses' decision making concerning the anticipation of haemodynamic decision making. Furthermore, the findings highlight the importance of nurses being familiar with decision making common to immediate postoperative patients, and methodically preparing for such decision making in order to facilitate optimal patient recoveries.

During the 2-hour recovery period, nurses' decision making varied in terms of continuous appraisal and evaluation of cues, and responses to cues. Nurses varied in setting alarm limits on the MAP and heart rate and rhythm; recording a 12-lead ECG; assessing the pacemaker for correct settings and function; setting the temperature of the forced-air rewarming device used to rewarm patients; their responsiveness to shivering; and the frequency with which PCWP, cardiac index, SVR, physical assessments, body shell temperature, and chest drainage were assessed. Nurses also varied from best practice guidelines concerning the three goals of therapy. Nurses commonly assessed oxygen saturation and serum electrolytes, ensured that a postoperative chest x-ray was taken, assessed haematological status, responded to hypertension, monitored core temperature, and rewarmed patients.

Experience was found to be the dominant influence on nurses' continuous appraisal and evaluation of cues, and nurses' responses to cues in relation to the optimisation of cardiovascular performance, the promotion of haemostasis, and the reestablishment of normothermia. Experienced primary nurses, one inexperienced nurse, and inexperienced primary nurses who received decision support from experienced colleagues demonstrated optimal decision making. That is, through continuous appraisal and evaluation of patient data, and rapid responsiveness to those data, nurses aimed to prevent or alleviate haemodynamic instability and potential complications in relation to the three goals of therapy. Experienced nurses assessed most haemodynamic data more frequently and integrated data from numerous sources to determine the significance of those data. Experienced nurses initiated pre-emptive interventions in anticipation of potential complications and responded rapidly to haemodynamic critical incidents. This high level of responsiveness potentially limited the extent and duration of haemodynamic instability. The findings of this study support those of previous studies regarding the important role of experience in nurses' clinical decision making (Baumann & Bourbonnais, 1982, 1983; Benner, Hooper-Kyriakidis, & Stannard, 1999; Benner et
al., 1992; Benner et al., 1996; Ellis, 1997; Thompson & Sutton, 1985). Responses and explanations by nurses in the interviews also indicated that they considered the significance of patient data and were mindful of the effects of their interventions for the patients' overall haemodynamic status. These data support Benner and colleagues' (1984; 1992; 1996) assertions that experienced nurses view patients as a complex whole and perceive situations comprehensively.

As noted, inexperienced nurses who received decision support from experienced colleagues, either at the request of the primary nurse or at the initiation of an experienced colleague, detected and managed complex forms of haemodynamic instability and postoperative complications in the same way as experienced primary nurses. This finding confirms findings of Benner and colleagues (1984; 1992) that inexperienced nurses often call for decision making assistance during complex decision making or in situations when patients' conditions are evolving such as postoperative periods. The finding that the outcomes of inexperienced nurses' decision making was on a par with experienced nurses highlights the importance of decision support for inexperienced nurses in terms of its provision and the experience of the nurse providing the decision support.

By contrast, the quality of inexperienced nurses' haemodynamic decision making varied when inexperienced nurses' access to experienced decision support was limited due to geographical isolation or the staffing mix. Inexperienced nurses' decision making regarding hypertension, cardiac tamponade, hypoxaemia, and hypothermia could be considered optimal in that nurses assessed data frequently, integrated complex sets of cues, and responded rapidly. However, decision making regarding hypotension, low SVR, bleeding, and shivering was less than optimal. Decision making for these haemodynamic states was less than optimal because inexperienced nurses assessed patient data less frequently, responded to cues without attending to the underlying cause, and had difficulty in recognising and responding to key patient data that indicated haemodynamic instability or potential complications. These findings support those of Bucknall (1996) who found inexperienced nurses made autonomous decisions when they had reduced access to roving senior colleagues because of geographical isolation. Furthermore, these findings suggest that inexperienced nurses can have difficulty in discriminating between relevant and irrelevant cues, understanding complex sets of cues,
and responding to cues in a timely manner without decision support. The decision strategies of inexperienced nurses in this study confirm the decision strategies used by inexperienced nurses described previously by Benner and colleagues (1984; 1999; 1992).

The variability in the quality of inexperienced nurses' decision making suggests some forms of haemodynamic instability may be more difficult than others to understand and manage. For instance, decisions surrounding assessments of heart rate and rhythm via complete pacemaker assessments appeared to be particularly complex for inexperienced nurses because none of the inexperienced nurses chose to carry out the task autonomously or with similarly inexperienced nurses. However, safe and optimal functioning of pacemakers is determined through assessments (Hickey & Baas, 1991; Mansfield, 2000) and therefore such assessments are important to patient recoveries. The observed variability in decision making quality suggests decision support for inexperienced nurses during the initial patient recovery period and specific education programs may be required to facilitate optimal patient recoveries in relation to the three goals of therapy.

The findings suggest that inexperienced nurses were slow to detect, and respond to, episodes of shivering. It is important that the onset of shivering in the immediate postoperative period is promptly detected and treated with appropriate therapies because shivering can cause profound haemodynamic instability and cardiovascular collapse (Guffin et al., 1987; Holtzclaw, 1986; Mort et al., 1996; Spaniol et al., 1994). Indeed, all patients who shivered in this study also had other forms of haemodynamic instability such as hypotension or oxygen desaturation where the SpO₂ was between 90% and 95%. Experienced nurses detected shivering in their own patients and assisted inexperienced primary nurses to detect and respond to shivering in their patients. Overall, however, most nurses' responsiveness to shivering in terms of the time taken for detection, administration of therapeutic interventions, and evaluation of the effectiveness of those interventions was poor. These data suggest nurses' knowledge of shivering may be incomplete or that current guidelines for assessing and treating shivering in the postoperative context are inadequate.

Some nurses varied from best practice guidelines because they did not implement a number of relevant evidence-based techniques to ensure that accurate pressure-based
parameters (MAP, PCWP, and CVP) and cardiac outputs were measured. Similarly, many nurses did not adhere to guidelines for rewarming hypothermic patients. Although unit-based protocols in relation to rewarming and requests by surgeons to position patients accounted for some decisions in relation to measuring parameters and cardiac outputs, poor knowledge of current research and a gap between research and practice appeared to account for most nurses' decision making. These findings support those of Grap et al. (1997) who found critical care nurses do not consistently or completely implement evidence-based practices surrounding the measurement of haemodynamic parameters in the clinical setting.

Practices based on clinical experience were observed that have not previously been described in the literature. The majority of nurses assessed CVP on a dynamic waveform rather than using a stop-cursor method because the monitors did not provide for a stop-cursor method of assessing CVP in the same way as they did for PCWP. During periods of profound hypotension, patients' heads of bed were positioned below 0° flat. However, the accuracy of pressure based parameters when the head of bed is below 0° has not been established. Similarly, 21% of nurses across all settings in the study rolled patients onto their sides to assess for a collection of blood in the chest. Although one patient's bleeding was discovered when he was rolled to each side, and the practice of rolling patients to assess for bleeding is carried out in settings beyond this research (Mennen & Garner, 2003), further validation of the practice is required. In relation to rewarming patients, 2 experienced nurses lowered the temperature setting of forced-air warming blankets from high to medium because they believed that too rapid rewarming could potentiate rapid peripheral vasodilation, low SVR, and hypotension. An observation in this research was that patients who had a lower than normal SVR had a more rapid rise in core temperature over the recovery period than patients with an SVR within normal limits. However, there are missing data regarding the temperature settings of forced-air warming blankets in all patients, and this study was not designed to explore a relationship between the temperature settings of forced-air rewarming devices and the SVR value. Hence, no claims are being made about a cause and effect relationship between rewarming on a high temperature setting and low SVR syndrome; but, rather, that the possible association has not previously been investigated.
Haemodynamic decision making by nurses occurred in the context of a social environment. The social context of clinical nursing was seen as a major factor in the ways that nurses interacted when managing complex patients. Findings revealed that primary nurses' decision making was strongly influenced by nursing colleagues who formed a team of nurses during the reception and recovery of patients. Team decision making was found to take either an integrated or non-integrated form.

The findings of TDM support Chase's (1995) finding that colleagues assist primary nurses to receive cardiac surgical patients and Jenks' (1993) finding that colleagues contribute to patient management decisions. However, the findings of this study have revealed for the first time the far-reaching influences of collegial assistance on nurses and their decision making practices. The two forms of TDM were distinguished by the nurses who directed and made most haemodynamic patient management decisions, communication processes between team members, and the number of assistant nurses. Both forms of TDM impacted upon nurses' emotions, actions, decision making practices, and had the potential to influence patient outcomes. Integrated TDM had the potential to optimise patient outcomes through coordinated clinical practice, nurses' feeling in control of patient management, and nurses being aware of patients' haemodynamic status. Non-integrated TDM had the potential to impact adversely on nurses' own feelings, nurses' feelings about colleagues, their awareness of patients' haemodynamic status, and their coordination of patient management. Importantly, primary nurses' level of experience appeared to influence the form of TDM that took place. Integrated TDM took place more often when primary nurses were experienced and non-integrated TDM took place when inexperienced nurses received patients.

Team decision making was also observed during patient crises. Group or team decision making has not been previously described during patient crises. During patient recoveries, the dynamic of TDM could shift from non integrated TDM to integrated TDM as a result of the crisis itself or the actions of individual nurses. These findings indicate that nurses can have some level of control over whether integrated TDM or non-integrated TDM takes place during patient crises.

Although the majority of nurses received patients with collegial assistance, some nurses, all of whom were inexperienced, initially received patients by themselves. These
nurses did not wish to receive patients alone and each nurse tried to access colleagues for support. In response to receiving patients alone, nurses felt unsupported by their colleagues and believed that delays in patient management occurred. This finding represents a new contribution to existing knowledge about critical care practice and the impact of such on nurses. Nurses believed that they received patients alone because of inadequate staffing levels and being placed in geographically isolated cubicles which limited easy visual and verbal access to neighbouring or roving colleagues.

The fourth aim of the research program was to explore nurses' perceptions of recovering patients in order to identify issues of concern and positive experiences that could be used to improve nurses' decision making. To achieve this aim, nurses were asked to reflect upon their experience of recovering patients during the observation period. The investigation and analysis of nurses' perceptions of receiving and recovering postoperative cardiac patients make a significant contribution to knowledge about nurses' decision making and critical care clinical practice generally. Nurses' level of experience appeared to influence whether nurses felt daunted or challenged by the decision making experiences encountered while recovering patients. Some nurses considered such decision making routine, that is, decision making was the same for every cardiac surgical patient.

Nurses' perceptions of receiving patients extended to factors that they considered impacted upon their decision making. Three factors were identified. First, it was important that procedures associated with settling in patients on admission were carried out in a systematic way in order to feel prepared for responding to patient instability later. Second, the handover from anaesthetists was identified as the most important factor in setting the framework for their decision making in the initial postoperative period. Nurses particularly used information in handover to frame decision priorities. These findings are similar to those of Chase (1995) who found that nursing reports or handovers were relied upon by incoming nurses to gain a sense of trajectory for the patient and to inform immediate decision making. In the context of receiving cardiac surgical patients, anaesthetists provided handover, so nurses in this study consulted anaesthetists for information about patients' physiological parameters and responses to interventions during surgery to inform their immediate decision making. Third, nurses were in agreement in wanting one or two experienced colleagues to provide continual
assistance for approximately 30 minutes from the time of admission and for there to be clear roles and responsibilities for each nurse in attendance. However, this study found that assistance was provided by at least one nurse for a mean time of 55 (SD = 31) minutes. Nurses' perceptions about optimal collegial assistance included some of the characteristics of integrated TDM, but none of the characteristics associated with non-integrated TDM. Importantly, both inexperienced and experienced nurses were united in their views about the forms of assistance required while receiving patients.

8.2 Implications of the Research for Nursing Practice and Professional Development

The results of the research program indicated variability in nurses' decision making related to decision complexity, nurses' experience, and environmental characteristics. Experienced nurses in particular were able to detect rapidly and respond rapidly to periods of haemodynamic instability in order to optimise patient outcomes concerning the three goals of therapy. The role of experience in haemodynamic decision making has important implications for the recovery of cardiac surgical patients, however, findings also indicate that factors associated with the actual decisions and the environment in which those decisions are made impact on nurses' decision making. Hence, findings of this study have several implications for nursing practice and professional development. These implications relate to practice guidelines for haemodynamic decision making and managing cardiac patient recoveries in the 2-hour postoperative period. To facilitate optimal patient recoveries, it is important that the quality of nurses' decision making is enhanced and that guidelines for managing patient recoveries are implemented.

The quality of nurses' decision making may be improved by implementing strategies to increase nurses' knowledge of evidence-based practices throughout their clinical careers and to enhance the outcomes of nurses' decision making. Nurses' knowledge of current literature regarding technical aspects of haemodynamic monitoring was incomplete which had implications for the accuracy of haemodynamic parameters measured. Additionally, some nurses believed they were implementing evidence-based practices to ensure accurate measurement of haemodynamic parameters, but the
practices had been revised and nurses were unaware of those changes. Since
haemodynamic data inform interventional decisions, inaccurate recordings of
haemodynamic parameters have the potential to impact adversely on patient outcomes.
To ensure nurses' decision making is based on current evidence-based knowledge,
strategies are required to enhance the knowledge of all nurses on an ongoing basis.

Strategies that may be useful in enhancing nurses' knowledge of current research
and reducing the research-practice gap include ongoing education and various
frameworks for promoting and facilitating the use of evidence-based practice in nursing
(Harvey et al., 2002; Loveland-Cherry, 2002; Taylor-Piliae, 1998; Thomson, Angus, &
Scott, 2000). During nurses' critical care education programs, it is important that the
information provided is research-based and current, and that nurses are encouraged to
think critically about their practice (Thomson et al., 2000). Inexperienced nurses who are
not undertaking formal critical care education programs need to be supported in the
clinical domain through informal education sessions, self-directed learning packages,
skills-based competency programs, and preceptorship programs.

Various frameworks have been advanced for promoting and facilitating the use
of evidence-based practice in nursing in order to keep nurses' knowledge current
(Harvey et al., 2002; Loveland-Cherry, 2002; Taylor-Piliae, 1998; Thomson et al.,
2000). The successful implementation of research findings in practice is likely to be
enhanced if clinical nurses have some ownership of, and involvement in, developing the
evidence for practice (Kitson, 2001). To promote and facilitate the use of evidence-
based practice in critical care nursing, a framework that involves nurses writing and
using clinical guidelines, protocols, integrated care pathways, and algorithms has been
suggested (Thomson et al., 2000). The use of informal education sessions centred around
one topic each month (Reu & Maple, 2003), journal clubs, and nursing rounds may also
provide means of promoting the use of research in clinical practice and enhancing
nurses' clinical knowledge development. Experienced nurses could lead special interest
groups that review and disseminate latest research findings related to cardiac patient
recoveries and haemodynamic monitoring. Additionally, opportunities should be
provided for nurses to develop skills to critically evaluate clinical research. Structures
and processes that support changes in practice also need to be in place. Partnerships
between nursing faculties in the university sector and critical care units in hospitals
provide scope and opportunities for building relationships between staff that can assist in implementing many of these strategies.

The introduction of a practice development nurse in critical care was evaluated and shown to be successful in assisting nurses to improve practice through the use of research findings (Manley, 1997). Furthermore, the practice development nurse assisted nurses to develop evidence-based practice protocols, supervised nurses in guided structured reflection, explored practice issues, and created a culture where nurses continually challenged their own practice through reflection (Manley, 1997). Practice development has been defined by McCormack, Manley, Kitson, Titchen, and Harvey (1999) as

> a continuous process of improvement towards increased effectiveness in person-centred care, through enabling of nurses and health care teams to transform the culture and context of care. It is enabled and supported by facilitators committed to a systematic, rigorous, and continuous process of emancipatory change (p. 256).

The notion of practice development and the strategy of appointing nurses to practice development roles has shown improvements in nurses' use of evidence-based practices and nurses' decision making (Manley, 1997, 2000a, 2000b; McCormack et al., 1999). McCormack and colleagues (1999) argue however, that a systematic approach to practice development must be taken and that practice development nurses require specialised skills to ensure desired outcomes are achieved.

In addition to encouraging the use of evidence-based practice, the quality of nurses' decision making may be improved by enhancing the outcomes of nurses' decision making. Clinical nurses use knowledge derived from clinical practice to guide their decision making as well as knowledge derived from research (Higgs, Burn, & Jones, 2001). Indeed, although external evidence can inform decision making, it can not replace individual clinical skills and past clinical experiences (Sackett, Straus, Richardson, Rosenberg, & Haynes, 1997). Since the quality of nurses' decision making in this study was enhanced by knowledge gained through experiential learning, that is, experienced nurses were more consistent than inexperienced nurses in making high quality decisions,
it may be useful to encourage experienced nurses to continue to build their clinical knowledge. To improve the outcomes of nurses' decision making, strategies such as small group interviews whereby critical incidents or exemplars are recounted and discussed, peer reviews of colleagues' clinical practice through participant observation, and nursing rounds could be conducted (Benner & Wrubel, 1982). Over 20 years ago, Benner and Wrubel (1982) argued that staff development of experienced nurses in the form of clinical knowledge development received little attention. As a consequence of experienced clinical nurses receiving very little time or support for systematically reviewing their practice, experienced nurses may not gain job enrichment, retention issues arise, and patients and less experienced nurses lose access to a wealth of knowledge (Benner & Wrubel, 1982). Although Benner and Wrubel suggested the aforementioned strategies in the context of providing a means for continuous improvement of experienced nurses' decision making, it may be useful to include inexperienced nurses in such forums. Sharing experienced nurses' knowledge with inexperienced nurses may improve the decision making skills of inexperienced nurses because quality of decision making can be increased by improving a decision maker's ability to assess situations (Klein, 1997b). In a study by Crandall and Getchell-Reiter (1993), interviews with experienced nurses revealed assessment cues indicative of early sepsis in neonates that either had not been reported previously in the literature or conflicted with cues that had been reported. Significantly, the elicited cues were used to form a guide for inexperienced nurses to assess sepsis in neonates. The sharing of information between nurses of varying experience levels enabled less experienced staff to improve their decision making skills regarding the detection of sepsis in clinical practice.

In addition to improving the quality of nurses' decision making to facilitate optimal patient recoveries, the findings of this research program have implications for the development of guidelines for managing cardiac patient recoveries in the 2-hour postoperative period. Specifically, there are implications for the provision of decision support, team decision making practices, and preparations for receiving patients.

An important strategy for facilitating optimal patient recoveries is to ensure that primary nurses, especially inexperienced nurses, are provided with decision support by an experienced nurse during the immediate 2-hour recovery period. In this study, nurses
either received patients alone, received patients with one or two colleagues, or received patients with three or more colleagues. This variability in decision support had the potential to impact on the quality of nurses' decision making, nurses' feelings, and patient outcomes. These findings suggest the way in which primary and assistant nurses are allocated to postoperative patients requires review. A formalised means of providing decision support to primary nurses through the allocation of two nurses to receive patients is required to facilitate optimal patient recoveries. Findings indicate that it is preferable that one of the two nurses is experienced and that it is better if the primary nurse is experienced. Additionally, nurses in this study were in agreement in wanting experienced nurses to provide decision support. In situations where primary nurses are experienced, it is suggested that decision support is provided for the first 30 minutes. However, in recognising that it is important that inexperienced nurses learn how to receive patients in the primary nurse role, it is suggested that inexperienced nurses are allocated to patients who do not have preoperative risk factors known to increase operative mortality and complicated postoperative courses (Higgins et al., 1996), and that they are assisted by an experienced nurse for the first 60 minutes of the recovery period. The time periods for decision support differ between experienced and inexperienced primary nurses because inexperienced participants said that they required assistance for the first 30 minutes whereas experienced nurses indicated approximately 15 minutes of decision support was required. However, in light of this study's finding that all primary nurses received assistance for a mean time of 55 (SD = 31) minutes, and in the event that an experienced nurse is not available to provide decision support, 60 minutes of decision support for inexperienced nurses appears warranted. The 60 minute period of decision support for inexperienced nurses also takes into consideration comments by inexperienced nurses regarding their need for decision support in terms of priority setting, time management, and theoretical explanations about patient data and pharmaceutical therapies.

To facilitate optimal patient recoveries, findings suggest that it is preferable that inexperienced nurses are not allocated to highly complex patients, such as those with a valve replacement. Likewise, it is preferable that inexperienced nurses are not allocated to patients with preoperative factors known to increase operative mortality and complicated postoperative courses (Higgins et al., 1996). To assist in allocating nurses
with different levels of experience to prospective patients, it is suggested that Associate Charge Nurses establish the past history of patients prior to the admission of patients. Nurses may consult staff on preoperative wards or use the telephone call from theatre staff 30 minutes prior to admission to gain information about the haemodynamic status of patients. This way, in the possible event that two staff are not available to receive a patient, the likelihood of an inexperienced nurse receiving a highly complex patient alone should be minimised. Knowing information about patients’ haemodynamic status prior to patient admissions may also assist primary nurses to prepare the mental workspace. The suggestions advanced regarding patient allocation recognise and support the 'gold standard' in critical care nursing of a ratio of one nurse to one patient (Pilcher et al., 2001) and, further, assert that the experience of the nurse may be as important to patient outcomes as the ratio itself.

The findings of this study showed that when nurses assisted primary nurses during the 2-hour recovery period, TDM took place. Therefore, it is important that the implications of findings in relation to the social context of decision making are addressed in guidelines for managing patient recoveries. These implications relate to the ways in which decision support and collegial assistance is provided in terms of the roles and responsibilities of primary nurses and assistant nurses, and communication patterns between nurses.

The findings of this study have shown that integrated TDM is the best form of practice to optimise patient outcomes. It is, therefore, important that decision support is provided in the form of integrated TDM. In doing so, experienced nurses can foster TDM in the critical care unit and create a culture where integrated TDM is the norm. To provide assistance in the form of integrated TDM, it is suggested that the primary and assistant nurses discuss the roles and responsibilities that they will adopt during the next 30 or 60 minutes and commit to open, free flowing communication about all aspects of patient management. By doing so, characteristic behaviours associated with non-integrated TDM such as assistant nurses directing patient management and a lack of communication between nurses in relation to patient management decisions may be minimised. In turn, feelings of anger by primary nurses and delayed or uncoordinated decision making practices that were observed in this study during periods of non-integrated TDM may also be minimised.
The reception of patients by two nurses who have clear roles and responsibilities may also help nurses to build trusting and productive working relationships with each other. According to Orasanu and Salas (1993), members of a team must have an established working relationship for TDM to be effective. Yet, in critical care nursing, multiple teams exist, with members altering frequently according to rosters. One might ask, ‘How can a team work together in an integrated manner when the team members rotate’? Or, ‘How can nurses be prepared for TDM in a way that ensures the behaviours characteristic of non-integrated TDM do not occur’? In terms of nursing management, there is a need to consider what structures can be put in place to facilitate behaviours of integrated TDM and to prevent non-integrated TDM behaviours. Such structures may involve the promotion of self-reflection activities (Burton, 2000; Schon, 1995), roster systems for the reception of postoperative patients on each shift, unit policies that delineate roles and responsibilities of nurses when receiving cardiac surgical patients, and communication workshops. An atmosphere where open, free-flowing communication is fostered is important in order for all staff to meet the challenge of making complex decisions for critically ill patients. Good communication between nursing staff and medical staff can lead to a lower than expected mortality rate in critically ill patients (Knaus, Draper, Wagner, & Zimmerman, 1986) and it is likely that good communication between nursing staff can also lead to improved patient outcomes.

Improvements in TDM practices are required during patient crises as well as during the reception and recovery of patients. Nurses’ reflections on their own behaviours and the forms of assistance that they provide during patient crises should be encouraged. Findings suggest that the content of educational preparation for nursing actions during patient crises may need to extend beyond the most appropriate assessments and interventions for optimising patient outcomes to include issues surrounding communication between nurses, nurses’ roles and responsibilities, and how to coordinate a team of nurses.

The findings also indicated the value of experienced nurses adopting the role of mentoring and educating inexperienced nurses while providing decision support. The provision of theoretical rationales, decision advice, and clinical supervision by experienced nurses to inexperienced nurses helped inexperienced nurses to link theory to practice and facilitated consistent, quality decision making. The findings of this research
indicate a need for a systematic process for mentoring inexperienced nurses to acquire the knowledge and skills associated with receiving and recovering cardiac patients. Mentoring inexperienced critical care nurses helps nurses to develop skills necessary in clinical practice (Ellis, 1993). Moreover, mentoring can help to instil a sense of self-worth in nurses, promote professional satisfaction, and maintain a high quality of patient care (Caine, 1990). In light of the detrimental effects to the morale and self-confidence of inexperienced nurses who felt daunted when recovering patients, decision support for, and clinical supervision of, inexperienced nurses by an experienced colleague may play an important role in staff development and retention.

Constant appraisal of system factors that facilitate optimal patient recovery are also recommended. Findings regarding incomplete preparation of equipment for recovering patients and comments by some nurses raise some important questions about the organisation of critical care equipment. Cardiac surgical patients are received frequently. Yet, nurses in this study showed a surprising lack of consistent, planned preparation of equipment required for haemodynamic decision making in the recovery period. Improved preparation will require establishing answers to questions such as: What equipment do nurses need to access? How often do nurses have to leave the cubicle while recovering patients? For how long is the nurse absent? While these questions may take some time to answer, it is suggested that standards, which do not have to be evidence-based (Thomson et al., 2000), concerning preparations for receiving and recovering patients are implemented. Standards describe appropriate procedures or processes that must be adhered to, and the use of standards is a way of demonstrating that nurses have thought proactively about the nursing care they provide (Thomson et al., 2000). Findings of this study indicate that a standard concerning preparations for the recovery of patients needs to include a list of equipment required to be placed in the cubicle and preparatory checks of equipment, including alarm settings on monitors. Additionally, the standard should direct nurses to place a trolley with equipment that may be required during the recovery of patients, such as spare pulse oximetry and monitoring cables, near the cubicle to reduce nurses' absences from the patient.

In sum, the findings of this study have implications for the quality of nurses' decision making and guidelines for managing patient recoveries in the 2-hour recovery period in order to facilitate optimal patient recoveries.
8.3 Strengths and Limitations of the Research

The major strength of this research program was the naturalistic decision making approach. The approach differed from many previous studies of decision making and was critically important because it provided for an understanding of complex decision making in complex environments. In particular, the approach enabled an exploration of the important interplay between the multifactorial influences on nurses' decision making. This approach addressed limitations of previous research associated with external validity and ecological validity.

A second strength of the study was the development of the goals of therapy to describe postoperative haemodynamic management decisions made by critical care nurses. Together, the goals of therapy and the naturalistic decision making approach enabled a comprehensive and systematic study of extraordinarily complex decision making and interactions in a clinical environment. Few studies have attempted to explore nurses' decision making in such an all encompassing way.

A third strength of the study was that it investigated nurses' perceptions of their decision making experience. These insights were important to understand and clarify observations of interpersonal interactions during the reception and recovery periods.

The major issues to consider in evaluating the limitations of the findings of the research relate to the sampling procedures and use of observation and interview. The use of purposive sampling and the number of participants limited the generalisability of the findings. The use of both observation and interview provided large volumes of data, and the sample needed to include experienced and inexperienced nurses. To balance the need for an in-depth analysis of data and greater reliability of data through verification of emergent categories in a reasonable number of observations and interviews, sample size was kept below 50 participants (Cohen et al., 2000; Sandelowski, 1995). The sampling methods were considered appropriate to provide an in-depth understanding of nurses' decision making in the clinical setting.

As patients were included in the study if their nurse was a participant, there was a potential for systematic bias in patient sampling if experienced nurses were allocated to higher acuity patients. However, this was minimised by ad hoc methods of patient allocation used by Associate Charge Nurses.
The use of observation as method, although considered a strength of the study, has potential methodological limitations such as the Hawthorne effect (Polit & Hungler, 1995). It was recognised that the presence of the researcher can affect participants’ behaviour and measures were taken to minimise participants’ awareness of the researchers' presence. These measures included adopting the complete observer role, sitting or standing outside the perimeter of patients' cubicles, avoiding eye contact with participants, using discreet recording devices to record observed actions, and speaking quietly to lessen the chance of participants hearing the researcher speaking.

Selective observation bias was identified during analysis of Phase One data. This bias had the potential to limit the findings of the study if certain decision making by nurses was neglected such as poor quality decision making. The detection of bias confirmed that the decision to conduct the study in two phases was appropriate. In Phase Two, changes were made to the structure of observation in order to provide for more comprehensive and systematic data collection (Polgar & Thomas, 2000; Robson, 1993). Two observers may be a consideration to capture complex observation data in situations where there are many concurrent activities. In doing so, observation reliability could be further enhanced.

The reliability of using retrospective interviews has been raised as an issue in previous discussions. Participants' recall of events can be subject to memory lapses, participants can reconstruct a biased version of events according to what they think they did, or they can create a version of events that they think the interviewer wants to hear (Carroll & Johnson, 1990; Clarke, 1999). Audio taping the interview with participants immediately after the 2-hour observation may have reduced the interview bias to some degree. Although recognising these limitations, the use of interview complemented the observation and the use of two methods to collect data increased research rigour (Patton, 1990).

8.4 Implications for Future Research

Findings of this study point to the need for research related to evidence for practice and team decision making practices. In terms of evidence for practice, research
is required to validate or refute current practices of experienced nurses as well as to ascertain evidence for haemodynamic monitoring practices. Research into these patient management issues may help inform nurses' decision making and benefit patient outcomes.

Findings from this study suggest issues surrounding the antecedents and management of shivering in the postoperative period are not fully understood. Two experienced participants also believed that rapid rewarming of patients may be associated with low SVR syndrome which, in turn, has been associated with complicated and prolonged patient recoveries in critical care (Myles et al., 1997). Potential relationships between rewarming practices and low SVR syndrome have not been explored. Likewise, the practice of rolling patients to assess for a collection of blood in the chest was carried out by 21% of nurses, however, the effectiveness of rolling patients to their sides to detect bleeding has not been explored in previous studies.

The literature review and nurses' use of technology during haemodynamic decision making suggest that some practices are poorly understood. In this study, 95% of nurses measured CVP at end expiration on a dynamic waveform, however, there is no research to indicate the accuracy of this method. Additionally, during periods of profound patient deterioration, some patients' heads of bed were placed below 0° flat, but no study could be located to indicate the accuracy of levelling transducers to the phlebostatic axis when patients' heads were below 0°. Since interventional decisions are based on blood pressure and preload values measured while patients are positioned in this way, research is required to inform practice.

The decision making practices of nurses in situations where colleagues form a team of nurses around the primary nurse are needed. In particular, there is a need to look more closely at how TDM can be enhanced in order to improve the effectiveness and efficiency of nurses working with each other and patient outcomes. This study explored decision making in the context of receiving and recovering cardiac surgical patients, but teams of nurses work together in many areas of clinical nursing to receive patients. The issue of many nurses responding to patient crises and the effects of such on patient outcomes are particularly important to understand. During TDM in crises in this study, breakdowns in integration occurred when many nurses assisted the primary nurse. As
patients experience haemodynamic crises in many clinical areas of nursing, it would be important for such studies to be conducted across clinical settings.

Substantial research is required in relation to exploring relationships between nurses' decision making and patient outcomes during the initial recovery period. The findings of this study have shown that the quality of nurses' decision making can vary as a function of experience, however, the impact on patient outcomes in ways that can be measured requires investigation. It would also be important to explore differences in assessment techniques of, and therapeutic responses to, certain haemodynamic parameters such as cardiac index in order to provide insights into relationships between nurses' decision making and patient outcomes. In this study nurses could feel disempowered, angry, and out of control during non-integrated TDM. Following the introduction of a formalised means of decision support and guidelines for management of patient recoveries, it would be important to explore nurses' experiences of recovering patients and nurses' decision making outcomes. A study exploring the effect of different forms of TDM on nursing retention and recruitment both before and after the implementation of guidelines for managing patient recoveries is also recommended.

8.5 Conclusion

The purpose of the research reported in this thesis was to explore the notion that interplay between haemodynamic decision task complexity, nurses' cardiac surgical intensive care experience, and environmental characteristics would influence nurses' haemodynamic decision making. The findings suggest that the quality of nurses' decision making was influenced by nurses' level of experience and decision support in terms of whether or not it was provided, the experience of the nurse providing decision support, and the ways in which it was provided. Haemodynamic decision making varied from best practice guidelines, between nurses as a function of experience, and within nurses as a function of decision complexity and social interactions with colleagues. Nurses varied in their experiences of recovering patients, preparations for receiving patients, frequency of appraising and evaluating haemodynamic cues, and responsiveness to haemodynamic cues for each goal of therapy. Team decision making
was the primary decision making process arising from social context that surrounds the reception and recovery of patients. Two forms of TDM were described and each form of TDM influenced nurses' emotional and action-based responses and nurses' practice. The observed variability in haemodynamic decision making has implications for patient outcomes and recommendations were made pertaining to nursing practice, nurses' professional development, and system processes regarding patient allocation and clinical supervision. Future research directions focused on exploring specific haemodynamic decision making aspects of practice encountered while receiving and recovering patients, communication patterns between nurses during collegial interactions, and relationships between nurses' decision making and patient outcomes are recommended.
REFERENCES


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APPENDIX A

Flyer to Recruit Participants
Are you interested in participating in nursing research in your unit?

Critical care nurses make numerous, complex clinical decisions in dynamic and busy environments. Nurses have to consider multiple information, yet make rapid decisions, sometimes with many distractions in the background.

Sound familiar?

I have some research questions about nurses' decision making and I need your help in answering them.

If you would like information regarding the study, please contact Judy Currey by paging 9387 1000.
APPENDIX B

Demographic Survey
Demographic Data Survey

These questions relate to your personal and professional characteristics. Please tick your response in the appropriate box.

1. Are you

   female  
   male

2. What is your age?
   24 years or less than 24 years  1
   25-34 years  2
   35-44 years  3
   45-54 years  4
   55-65 years  5

3. How many years have you been qualified as a Registered Nurse?
   !! year (s)

4. What general nursing qualification do you have?
   Hospital certificate  1
   Diploma in nursing  2
   Degree in nursing  3
   Other

5. Have you completed a hospital or university accredited critical care course? If no, continue with question 8.
   yes  
   no

6. How long has it been since you completed the hospital or university accredited course?
   !! month(s) {If less than 1 year}
   !! year (s)
7. What critical care qualification do you hold? (Tick more than one box if appropriate)

Intensive care certificate 1
Coronary care certificate 2
Critical care certificate 3
Cardiothoracic certificate 4
Postgraduate diploma (Critical Care) 5
Postgraduate Degree (Critical Care) 6

Other (please specify)

8. How many years experience do you have in critical care nursing? {Include time before, during and after critical care course, if relevant}

!! month(s) {If less than 1 year}
!! year(s)

9. In which critical care area do you currently work?

General Intensive Care 1
Trauma Intensive Care 2
Cardiothoracic Intensive Care 3
Combined Unit - please specify

10. Are you

Permanently employed in this unit, full time 1
Permanently employed in this unit, part time 2
Nurse Bank 3
Agency staff 4
Other, please specify


11. How long have you worked in this unit?
   !! month(s) {If less than 1 year}
   !! year(s)

12. How many days a week do you work?
   ! day(s) a week

13. What position do you hold in this unit?
   Registered Nurse    1 !
   Associate Charge Nurse  2 !
   Clinical Nurse Specialist  3 !
   Clinical Educator    4 !
   Nurse Manager       5 !
   Team Leader         6 !
   Other, please specify

14. For how many years have you nursed immediate post-surgical cardiac surgical patients?
   !! month(s) {If less than 1 year}
   !! year(s)

15. How often do you care for immediate post operative cardiac surgical patients?
   Less than once per year    1 !
   Less than once per month   2 !
   Less than once per week    3 !
   One to two times per week  4 !
   Three or more times per week  5 !

Thankyou for completing this survey.
APPENDIX C

Observation Checklist
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APPENDIX D

Plain Language Statement
February 18, 2000

PLAIN LANGUAGE STATEMENT

Dear colleague,

INTRODUCTION

This is a research project in which we invite your participation. It is being conducted by Judy Currey, PhD student, School of Nursing, Deakin University as part of her PhD studies and Associate Professor Mari Botti, School of Nursing, Deakin University (student supervisor).

In the course of caring for patients immediately following surgery, nurses make many decisions. The purpose of this research is to explore the sorts of decisions made for patients after surgery. A better understanding of these decisions may ultimately lead to better outcomes for patients.

THE STUDY

If you agree to participate in this study, you will be observed by the researcher as you care for a post-operative patient in the first two hours of recovery. The researcher will be positioned in the patient's bed area and will be speaking quietly into a tape recorder as she observes your care delivery. Following this two-hour period, you will be interviewed briefly to clarify aspects of your care. This interview will also be audiotaped and it is anticipated that this interview will last less than 10 minutes. Questions may relate to why you made a particular decision or why you chose to start a certain drug.

POSSIBLE RISKS / BENEFITS TO YOU

There is no perceived risk to you or the patient in your care. Data collection can be ceased by you at any stage if you think you or others are at risk. It may be stopped to perform certain procedures or to provide patient privacy. There is no direct benefit to you however, your contribution could be very important. The findings of this research may help develop educational tools for new staff. The decision processes described in the study will help nurses to understand and validate the nature of their work and describe their role.

CONFIDENTIALITY

Please be assured that in all circumstances, your privacy and confidentiality will be maintained. All records will be securely stored for a minimum of 7 years following publication of the study and then destroyed in accordance with Deakin University guidelines. You will be allocated a coded number, so your name will not be recorded on file. Records from the study may only be inspected by authorised persons during this period. Total results may be published in a professional nursing journal. At no stage will the hospitals or the participants be identified in such a publication. You may request a report of the findings from the investigators following completion of the study.

PARTICIPATION IN THE STUDY

Your participation in this study and consent to have the interview audiotaped is entirely voluntary. You may also withdraw from the study at any time without penalty. Any data related to you will be withdrawn from the study and destroyed.

You may contact Judy Currey 9276 3012, or Associate Professor Mari Botti (my supervisor), School of Nursing, Deakin University telephone 9244 6123 or 9276 3012 for further information regarding any aspect of this study. If you have any complaints or queries that have not been answered or require information or independent advice, you may contact Ms Rowan Frew, Administrative officer of The Alfred Hospital's Ethics Committee, telephone 9276 3848 or the Secretary, Ethics Committee, Research Services, Deakin University, 221 Burwood Highway, BURWOOD VIC 3125. Tel (03) 9251 7123 (International +61 3 9251 7123).
APPENDIX E

Publications Arising from the Thesis