NURSES’ MONITORING OF CENTRAL VENOUS AND PULMONARY ARTERY CATHETERS AFTER CORONARY ARTERY BYPASS GRAFT OPERATION

By

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Submitted in fulfilment of the requirements for the degree of

MASTER OF ARTS

in the

Department of Advanced Nursing Science

at the

UNIVERSITY OF SOUTH AFRICA

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FEBRUARY 2002
Student number: 792-033-4

DECLARATION

I declare that NURSES’ MONITORING OF CENTRAL VENOUS AND PULMONARY ARTERY CATHETERS AFTER CORONARY ARTERY BYPASS GRAFT OPERATION is my own work and that all the sources that I have used or quoted, have been indicated and acknowledged by means of complete references and that this work has not been submitted before for any other degree at any other institution.

..............................................
SIGNATURE
(MARGARET ELLIS)

..............................................
Date
ACKNOWLEDGEMENTS

I am grateful to God for giving me the opportunity to complete this study and give Him thanks and praise.

I would also like thank to the following persons for their invaluable support and unending encouragement:

• Dr Annali Botha, my supervisor at Unisa, for all your encouragement and sacrifices.

• The Unisa librarians, for assisting in finding available literature sources.

• My husband, Alexander, daughter, Nadia, parents and friends who had encouraged me and who had never given up supporting and believing in me.

• Mr. S. Millard who assisted in interpreting the statistics.

• Mrs. Hermien Liebenberg for editing and proof-reading the dissertation.

"And do not forget to do good and to share with others, for with such sacrifices God is pleased"

Hebrews 13:16
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ABSTRACT

A quantitative research design for a descriptive and contextual study to determine the critical care nurses knowledge and data preferences regarding the central venous and pulmonary artery catheters management and decision making after coronary artery bypass graft operations and the utilization period of the pulmonary artery catheter after coronary artery bypass graft operations. The data was collected through a questionnaire completed by critical care nurses and retrospective analysis of patient records through a structured checklist. Data analysis indicated the following: critical care nurses have a knowledge deficit in the management of the central venous and pulmonary artery catheters and felt more competent and confident in the central venous measurements. The utilization period of the pulmonary artery catheter was 48% compared to the 100% of the central venous catheter.

KEY CONCEPTS

Central venous, central venous catheter, pulmonary artery, pulmonary artery catheter, pulmonary artery wedge pressure and coronary artery bypass graft.
List of abbreviations

<table>
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<tr>
<td>CABG</td>
<td>Coronary artery bypass graft</td>
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<td>CVP</td>
<td>Central venous pressure</td>
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<tr>
<td>ECG</td>
<td>Electrocardiogram</td>
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<td>ICU</td>
<td>Intensive care unit</td>
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<td>LA</td>
<td>Left atrium</td>
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<tr>
<td>LV</td>
<td>Left ventricle</td>
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<tr>
<td>LVEDP</td>
<td>Left ventricular end-diastolic pressure</td>
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<tr>
<td>Me</td>
<td>Median</td>
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<tr>
<td>Mo</td>
<td>Mode</td>
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<tr>
<td>Mx</td>
<td>Mean</td>
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<tr>
<td>PA</td>
<td>Pulmonary artery</td>
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<tr>
<td>PAWP</td>
<td>Pulmonary artery wedge pressure</td>
</tr>
<tr>
<td>PEEP</td>
<td>Positive end-expiratory pressure</td>
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<tr>
<td>PTCA</td>
<td>Percutaneous transluminal coronary angioplasty</td>
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<tr>
<td>RA</td>
<td>Right atrium</td>
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<tr>
<td>RV</td>
<td>Right ventricle</td>
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<tr>
<td>RVEDP</td>
<td>Right ventricular end-diastolic pressure</td>
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<td>SA</td>
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CHAPTER 1

BACKGROUND INFORMATION

1.1 INTRODUCTION

For monitoring purposes, the pulmonary artery (PA) catheter and the central venous pressure (CVP) catheter are routinely introduced into patients undergoing coronary artery bypass graft (CABG) surgery. The data and measurements obtained from the PA and CVP catheters, improve the ability of critical care nurses to make haemodynamic assessments, diagnoses and clinical decisions.

Controversy surrounds the issue of indications for PA catheterisation. One reason for this controversy is the differences of opinion regarding the risks versus the benefits of introducing a PA catheter. The perception prevails that, in some countries at least, the PA catheter has been misused for pecuniary benefits. (Goldhill & Withington 1997: 275.)

Invasive haemodynamic monitoring is one of the major competencies required of the critical care nurse in the cardiothoracic intensive care unit (ICU). Knowledge of the theoretical base that underlies haemodynamic monitoring, assists the critical care nurse in developing decision-making skills. A critical care nurse should be able to interpret and analyse trends and to formulate a nursing plan appropriate for each CABG surgery patient. (Thelan, Urden, Lough & Stacy 1998: 442.)

The decision to monitor, like any other clinical decision, should be based on therapeutic objectives and careful weighing of the expected benefits against the costs and clinical risks. The fact that a monitor proved useful for the care of some patients, does not justify its routine use for all patients. Monitoring is physiologically, technologically and economically complex. In evaluating the potential use of a
monitor for a patient, technical capability, clinical usefulness and costs should be considered (Tobin 1998: 1474).

1.2 THE RESEARCH PROBLEM

Invasive haemodynamic monitoring is an essential part of diagnosis and management of the cardiothoracic surgical patient. The invasive catheter is inserted by the medical practitioner, usually the anaesthetist, and thereafter managed by the critical care nurse. Technology is only safe when it is managed skilfully and interpreted correctly. The critical care nurse should know how to manage and maintain the PA and CVP catheters in a safe and therapeutic manner.

Management of the critically ill cardiothoracic surgical patient is intensive, invasive and expensive. Invasive monitoring should be critically assessed and evaluated, comparing risks and benefits of standard PA catheterisation. By limiting invasive monitoring, possible patient complications can be prevented, the reliability and appropriateness of technology enhanced and expenses cut down. (Benner, Hooper-Kyriakidis & Stannard 1999: 339.)

These considerations lead to the following questions:

- Does the critical care nurse have adequate knowledge to manage PA and CVP catheters?
- Does the monitoring of PA pressures enhance the confidence of critical care nurses regarding decision-making and treatment choices after CABG operations?
- What is the utilisation period of the PA catheter after a CABG operation?

1.3 BACKGROUND TO THE PROBLEM

Many people - more than 800 000 annually worldwide - are undergoing CABG operations. A working knowledge of recent advances in the postoperative care of these patients is essential for all practising critical care nurses (Bernet 1997: 23). Monitoring haemodynamic parameters in the CABG surgery patient is important for sound clinical judgement by the critical care nurse. Invasive monitoring (such as PA
and CVP monitoring) may assist in clinical decision-making and nursing management of the cardiothoracic surgical patient.

The routine use of PA catheters is an example of technologies that were once considered standard treatment for critically ill patients but have recently come under formal scrutiny. Technology is never an end in itself, therefore its design and use must be subordinate to patients' needs and concerns, and interventions should be limited to those that are absolutely necessary (Benner et al. 1999: 341-344).

The routine use of PA catheters potentially can improve the precision of monitoring and fluid administration to all CABG patients, that is if the critical care nurse correctly manages the catheter. However, the cost and complexity of routine care will increase, as will the risk of complications for all these patients. Many CABG patients are elderly with multiple medical problems, and a greater demand for cost containment does exist (Bernat 1997: 23).

Ensuring a safe environment in the critical care setting, is no small achievement. In the stressful, high-stakes environment of cardiothoracic critical care, invasive catheters and sophisticated monitors are managed by critical care nurses. For safe management, these technologies require advanced clinical knowledge, skilled know-how and respect for the device and the hazards present (Benner et al. 1999: 356-359). PA pressure measurements are frequently misinterpreted and errors are common, even by professionals (Tobin 1998: 851).

Invasive monitoring is safe when it is managed skilfully and interpreted correctly by the critical care nurse caring for the critically ill patient. PA and CVP catheters are inserted by the anaesthetist intra-operative but are managed by critical care nurses postoperative. This is standard practice in the hospital where this research was done. The anaesthetists' postoperative responsibilities comprise the transportation of the CABG patient from theatre to intensive care, as well as the stabilisation and the handing-over of the patient to the critical care nurse in charge. The postoperative management, care and all decision-making regarding these patients, are the responsibilities of the critical care nurse.
1.4 SIGNIFICANCE OF THE STUDY

The significance of this research is that it could lead to the improvement of the quality of nursing care and a reduction in costs for the patient undergoing a CABG operation. Invasive monitoring has the potential to improve outcomes, but it also has the potential to cause harm, directly and indirectly.

While monitoring a critically ill patient, the critical care nurse repeatedly assesses illness severity and prognosis and continuously makes decisions in the patient's best interest. Decisions are made about further diagnostic procedures or changes in existing treatment of preventive, supportive and therapeutic care. Critical care nurses must decide on priorities in patient care. A decision should depend on diagnostic measurements, as well as on an analysis of the risk and potential benefit associated with each management option for the individual patient. The value of this study is its potential to promote nursing care and nursing standards.

No similar study previously done in South Africa (SA), could be found. In the current economic climate there is significant and growing pressure for cost containment. The promotion of nursing care and nursing standards could also lead to a reduction in costs for the medical aid insurance funds. The relationship between patient outcome and critical care monitoring is one of the relevant factors in this study.

1.5 AIMS AND OBJECTIVES

The aims of this research study are twofold: firstly, it aims to determine critical care nurses' knowledge about the management of PA and CVP catheters after CABG operations, and secondly it aims to define the utilisation period of the PA catheter after CABG operations.

The main research objectives are:

- To do a literature study about the management of PA and CVP catheters.
- To determine critical care nurses' knowledge regarding the management of PA and CVP catheters.
To determine the knowledge critical care nurses have regarding the interpretation of data obtained from PA and CVP catheters.

To determine critical care nurses' data preferences regarding CVP and pulmonary artery wedge pressure (PAWP) measurements in clinical decision-making after CABG operations.

To determine the utilisation period of the PA catheter after a CABG operation.

To make recommendations related to the use of PA and CVP catheters after CABG operations.

1.6 ASSUMPTIONS

Assumptions are beliefs that are held to be true without been proven (Nieswiadomy 1993:28). The art of nursing is the ability to see the person behind the disease or operation by focussing through the multitude of tubes, catheters, drains, bandages, monitors, ventilators and infusions on the frightened person. The comforting, caring presence, the touch and the listening ability, are nursing skills that enable the hospitalised patient and his or her family to tolerate the advanced and often painful technology. The critically ill usually have little or no time to prepare for their experiences upon hospitalisation (Searle 1986:65).

The critical care nurse must ensure that all critically ill patients receive optimal care. To accomplish this, critical care nurse must adhere to standards of nursing care for the critically ill and be committed to act in accordance with ethical principles. They are responsible and accountable. The critical care nurse is ever-present in the critical care environment and coordinates the care delivered by the multi-disciplinary team to restore stability, prevent complications and achieve and maintain optimal patient response (Holloway 1994:3). The critical care nurse should act in such a manner as to promote and safe-guard the well-being and interests of patients and clients, by maintaining and improving their professional knowledge and competence (Burnard & Chapman 1995:13-31).
1.7 DEScriptions of Concepts for THIS STUDY

1.7.1 CRITICAL CARE NURSE

An additional qualification is obtained by completing an advanced critical care nursing course. The duration of this course is at least one year and it could be an advanced diploma course or a Master of Arts (MA). On completion of the course, critical care nurses are regarded as highly specialised and skilled nurses who are able to apply and integrate their knowledge to improve or maintain the health of the critically ill. In SA the critical care nurse is a registered nurse who may or may not have additional critical care nursing qualifications.

1.7.2 CARDIOTHORACIC INTENSIVE CARE UNIT (ICU)

Cardiothoracic ICUs are highly sophisticated facilities in hospitals, dedicated to the care of the post-surgery cardiac and thoracic patient. Patients admitted to these units require specialised care by critical care nurses, surgeons, anaesthesiologists and other members of the multi-disciplinary team.

1.7.3 CENTRAL VENOUS PRESSURE

CVP is the blood pressure in the central venous system as the blood returns to the right side of the heart. When the tricuspid valve opens, CVP reflects filling pressures in the right atrium (RA). The volume of fluid that is available to return (in other words, the ability of the heart to deal with the fluid, that is to pump forward), mainly determines the pressure. CVP is often used as a guide to overall fluid balance. A normal CVP is 2-5 mmHg or 3-8 cm water (Thelan et al. 1998: 447; Woods, Sivarajon Froelicher & Underhill Motzer 2000:436).

1.7.4 PULMONARY ARTERY PRESSURES

PA pressures are measured by a flow-directed, balloon-tipped PA or Swan Ganz catheter, within the PA, obtaining pressure measurements of the left ventricular function in order to guide fluid administration. PA catheters are inserted when
specific haemodynamic and intracardiac data are required for diagnostic and treatment purposes. A significant advantage of the PA catheter is the simultaneous assessment of several haemodynamic parameters, including PA systolic and diastolic pressures, the PA mean pressure and the PAWP. This advantage also includes the capability of measuring cardiac output and the calculation of additional haemodynamic parameters (Thelan et al. 1998:459).

1.7.5 PULMONARY ARTERY WEDGE PRESSURE (PAWP)

Although the PAWP forms part of PA pressures, additional information about PAWP is necessary to fully understand the concept in this study. By inflating the syringe of the PA catheter, the balloon on the tip of the catheter records the static pressure of the pulmonary veins. PAWP is the pressure created by volume in the left side of the heart. When the mitral valve opens, the PAWP reflects filling pressures in the pulmonary vasculature. Pressures in the left side of the heart are transmitted back to the catheter and the catheter “wedges” into a small pulmonary arteriole. Normal PAWP measurement is 5-12 mmHg. (Beers & Berkow 1999: 1623; Thelan et al. 1998: 447.)

1.7.6 PRELOAD

Preload is the distending force stretching the muscle fibres of the left ventricle (LV) at the end of diastole and can be defined as the pressure exerted by a defined volume of blood in the ventricle. The CVP defines the right ventricular preload and the PAWP defines the left ventricular preload. (Soni, Welch, Colardyn & Billiet 2001:5; Thelan et al. 1998:349.)

1.7.7 AFTERLOAD

Afterload refers to the resistance to left ventricular ejection and reflects systemic resistance. The resistance that the ventricles have to overcome, is a combination of pressures in the pulmonary vasculature, aorta, systemic arteries and veins as well as peripheral vessels (Soni et al. 2001: 6).
1.8 RESEARCH DESIGN AND METHOD

1.8.1 THE DESIGN

Quantitative research will be done. The research design can be classified as descriptive and a survey will be performed. The research design also includes a retrospective study. The survey will describe critical care nurses' knowledge and data preferences regarding PA and CVP catheters, while the retrospective study will determine the utilisation period of the PA catheter after CABG operations in a cardiothoracic ICU in Gauteng.

1.8.2 DATA GATHERING

*Data gathering will be achieved as follows:*

- Implementation of a questionnaire to critical care nurses working in a cardiothoracic ICU.
- Retrospective analysis of patient records to determine the utilisation period of the PA catheter after CABG operations.

The research method will be discussed in detail in chapter 3.

1.8.3 SAMPLE AND POPULATION

To determine the knowledge and data preferences of critical care nurses regarding PA and CVP catheters, the target population will include all registered nurses working in the cardiothoracic ICU of a private hospital in Gauteng. The convenience sample will consist of volunteers - experienced or trained critical care nurses with diverse qualifications in intensive care nursing, regardless of staff appointment.

For the purpose of determining the utilisation period of the PA catheter after CABG operations, the convenience sample will consist of thirty CABG surgery patients' records from a cardiothoracic ICU in a private Gauteng hospital. Patient records will be drawn until the number of thirty has been reached.
1.8.4 VALIDITY AND RELIABILITY

Validity and reliability will be ensured by incorporating a literature review, professional experts' critiques as well as a pilot study. These concepts will be discussed in chapter 3.

1.8.5 DATA ANALYSIS

Data analysis will be done by means of descriptive research statistics, and will be further discussed in chapter 3.

1.8.6 ETHICAL CONSIDERATIONS

Throughout the study ethical considerations will be taken into account. Permission to conduct the study was sought and granted. (See Annexure I, p. 90.) Anonymity and confidentiality are guaranteed to all respondents who will complete the questionnaire. Information from patient records will also be used anonymously.

1.9 CONCLUDING REMARKS

All patients undergoing CABG surgery in a private hospital in Gauteng, receive PA and CVP catheters as standard procedure. Invasive monitoring through PA and CVP catheterisation should only be done when catheters are managed skilfully, data are interpreted correctly or when it is essential for decision-making regarding the patient. Critical care nurses' knowledge about PA and CVP catheter management, as well as their data preferences in clinical decision-making, will be determined by the use of a questionnaire. The utilisation period of the PA catheter after CABG operations will be defined and recommendations be made about the use of invasive catheters. The questionnaire will be based on a literature study which is to follow in chapter 2.
CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The management of the critically ill post-surgical CABG patient requires a high level of both medical and nursing skills. Critical care nurses' knowledge and experience in close observation and early intervention are essential for positive patient outcome. Critical care nurses are responsible and accountable for providing quality nursing care.

Haemodynamic monitoring plays a central role in the monitoring of these critically ill patients. Monitoring of the circulation allows evaluation of the etiology, severity and course of circulatory instability and its response to treatment, supplementing clinical judgement. CVP provides an indication of the state of distension of the venous collecting system and the relative effectiveness of the pumping action of the heart in emptying the system. CVP monitoring has been established as an important index for diagnostic purposes, as well as for assessing the therapeutic effect of volume replacement in patients with critical circulatory problems (Cormock 1996: 38). The PA catheter allows a number of continuous and intermittent measurements. However, it is difficult to prove the relevancy of these variables to treatment and prognosis. The PA catheter may allow the evaluation of responses to therapy and the assessment of physiological and perhaps prognostically important factors for resuscitation, supplementing the clinical indicators of circulatory instability (Webb, Shapiro, Singer & Suter 1999:1090 -1095).

2.2 CONCEPTUAL FRAMEWORK

The critical care nurse, as independent practitioner, functions according to the Nursing Act, 1978 (Act No. 50 of 1978), within a legal framework, and is responsible and accountable for her or his actions or omissions.
The critical care nurse of the 21st century needs expert critical thinking skills, clinical skills and clinical leadership abilities (Hudak, Gallo & Morton 1998: 4-8). Critical care nursing will continue to change as it faces new demands. Higher patient acuity, rapid technological advances, older populations, legal and ethical dilemmas and cost containment pressures are but a few of the challenges confronting critical care nursing. The effective critical care nurse must be able to merge technology and patient care because patients and their families see nurses as the vital link between themselves and technology. The "high tech - high touch" metaphor never had greater meaning (Bucher & Melander 1999:14). A caring, focused, expert, intelligent, critical and research-based practice is needed to meet these challenges (Hudak et al. 1998:4).

2.2.1 THE NURSING PROCESS

The nursing process is a scientific approach to problem-solving. It implies a logical, systematic organisation of nursing intervention. The components of the nursing process manifest logically and sequentially in practice. The principles of the process are learned and practised on a continuous basis in the clinical situation. The six components of the process are assessment, nursing diagnosis, outcome identification, planning, implementation and evaluation, and the three characteristics of the process are purpose, organisation and creativity (Naudé, Meyer & Van Niekerk 2000: 25). For beginners or less experienced critical care nurses this process provides a sound method for developing thinking patterns. Expert nurses may use it when they are faced with a new, complex or puzzling situation (Benner et al. 1999: 92).

The nursing process has seven distinct features: It is in the legal scope of practice, based on knowledge, it is planned, patient-centred, goal-directed, it prioritises and it is dynamic (Timby 1996:17).

2.2.1.1 ASSESSMENT

Assessment comprises the systematic and orderly collection and analysis of data for the purpose of making the nursing diagnosis. Critical care nurses collect an enormous amount of data about a patient's bio-psycho-social health status. By virtue of an array of
techno-physiological monitoring devices, critical care nurses process additional data in
the form of measurements of physiological parameters. (Urden & Stacy 2000: 2). Data
gathering depends on the patient's condition, as well as the critical care nurse's
knowledge, past experiences and creativity (Naudé et al. 2000: 27). The relevant data
in this study are PA and CVP measurements, and they will be used as the basis for
decision-making by critical care nurses managing CABG patients.

2.2.1.2 NURSING DIAGNOSIS

A nursing diagnosis is a clinical judgement about the critically ill patient's response to
actual or potential problems or crises. A nursing diagnosis results in appropriate goal-
setting, prioritised nursing interventions and outcome criteria (Naudé et al. 2000:47). To
accurately diagnose a problem in its early stage is a life-saving skill. The main objective
of excellent patient care is to recognise a problem and to intervene before the crisis

2.2.1.3 PLANNING

Comprehensive planning of all care and services for the patient is done with the focus
on increasing quality of care and services, while containing or decreasing costs.
Planning is the determination of what could be done to assist the patient in resolving
actual and potential problems. Planning can be done in the form of outcome
statements. An outcome is a measurable change in a patient's condition in response to
health care (Naudé et al. 2000: 49). Outcome statements consist of specific indicators
which the critical care nurse could use as criteria in the evaluation phase that either (1)
the actual diagnosis has been resolved or reduced or (2) the risk diagnosis has not
realised (Thelan et al.1998:7).

2.2.1.4. IMPLEMENTATION

Implementation refers to nursing actions. It is "putting the plan into action", and is based
on nursing knowledge and expertise (Naudé et al. 2000: 58). Assessment and
evaluation occur continuously throughout this phase. This phase of the nursing process
depends entirely on the intellectual, interpersonal and technical skills of critical care nurses. A problem or crisis may exist momentarily or last for hours, depending on the cause, the interventions and the patient's response. All life-threatening situations require instantaneous interventions and skilful management (Thelan et al. 1998:9).

2.2.1.5 EVALUATION

Informal evaluation occurs continuously. Evaluation is the final phase but it does not end the process. Evaluation may lead to a reassessment of the expected patient outcomes. It is essential to document or record all the phases of the nursing process (Holloway 1994:13; Thelan et al. 1998: 10). (See Figure 2.1).

![Circular model of the nursing process](image)

*Figure 2.1: Circular model of the nursing process*

2.2.2 CRITICAL THINKING AND THE NURSING PROCESS

Critical thinking describes a process that is deliberate, analytical and logical. It relates to the scientific process, the nursing process, diagnostic reasoning and problem-solving (Hudak et al. 1998: 4). Critical care nurses are required to make endless and complex decisions regarding the care of patients, and their families, by using critical thinking skills. Critical thinking involves an attitude and an approach to ideas or decisions. The attitude relates to a degree of willingness to give fair and equal consideration to all possible ideas or decisions. The approach involves accepting an idea or decision only after carefully reflecting on it. Reflective analysis incorporated into this process, defines
the essence of critical thinking and is the key to improving patient outcomes (Bucher & Melander 1999: 14). Critical thinking is therefore also reflective - the critical care nurse uses past experiences to reflect on all available data before decision-making (Naudé et al. 2000: 27).

The nursing process provides a systematic framework for critical thinking. It is within this framework that critical care nurses could seek information and respond to patients and families' needs. Clinical decisions are made after consideration and analysis of all available data. They are important in formulating nursing diagnoses and statements about clinical problems or wellness and strengths. Planning involves defining and prioritising nursing interventions. The process is not completed until all problems are solved and evaluation, based on expected outcomes, is done (Hudak et al. 1998:4). To provide order and direction to nursing care, the nursing process is used as the "tool" and methodology in arriving at decisions, and in predicting and evaluating consequences for positive patient outcome.

2.2.3 REFLECTIVE ANALYSIS AND THE NURSING PROCESS

Reflection is a willing and conscious attentiveness to what is being done and why. When the critical care nurse consciously notes what is being done, the reasons for the action are more easily identified (Burnard & Chapman 1995:79). The development of critical thinking skills is a gradual process. When clinical experiences are accumulated and expert knowledge amassed, critical thinking skills will guide clinical decisions to quality patient care. The depth and breadth of expert knowledge are largely gained from opportunities to apply theory in practice, and these opportunities and knowledge gained, greatly enhance the development of critical thinking skills (Bucher & Melander 1999: 15).

Incorporating reflective analysis, further aids in the following:

- It transforms the nursing process into a dynamic process.
- Nursing diagnoses identify and predict actual and potential problems, as well as patient strengths and weaknesses.
- Through comprehensive planning multiple options are considered.
• Through implementation the readiness to act is assessed and modified.
• Evaluation not only concerns goal achievement, but assesses current health status, accuracy of diagnosis and appropriateness of goals.
• Finally, those factors that promoted or impeded goal achievement, are reflected upon. (Bucher & Melander 1999: 14; Naudé et al. 2000: 100.)

Throughout the nursing process experience leads to new knowledge, and the reflection upon that experience and new knowledge informs practice (Burnard & Chapman 1995: 43).

2.2.3 MULTI-LEVEL NURSING SKILLS

A high level of competency in critical care nursing requires both an expansive knowledge base and an extensive repertoire of clinical skills. Without timely and thorough updating, knowledge becomes incomplete and clinical skills outdated (Timby 1996: 12).

*Caring for the critically ill patient in a highly technical setting demands the application of multi-level nursing skills, such as:*

• Skill as a clinical practitioner, operating in a sophisticated technical environment.
• Skill as an independent diagnostician, using scientific information to identify and treat the patient's response to illness.
• Skill as an interdependent health care team member, practising within the context of team relationship.
• Skill as a problem-solver.

Critical care nurses use cognitive processes and critical care clinical skills in order to decide on and promote independent nursing intervention (Hudak et al. 1998: 5-8; Thelan et al. 1998:3).
2.3 MONITORING IN THE INTENSIVE CARE UNIT (ICU)

Intensive care patients' clinical conditions may change rapidly, and their situation is such that the risk of death or major morbidity exists. Furthermore, procedures and therapies that are being used in ICUs may cause some morbidity and rapid physiological changes in the patient (Hill & Summers 1994:1).

Patients may be admitted to an ICU for three reasons:

- Their conditions is such that they require assessment and monitoring that cannot be accomplished elsewhere.
- They require therapies or procedures that cannot optimally be carried out in another location.
- They require nursing care of an intensity that cannot conveniently be done in another part of the hospital (Tobin 1998: 33).

Most of the interventions have increased the invasiveness, complexity and cost of intensive care. Intervention has been accepted in view of its focus on saving lives and preventing morbidity. (Hill & Summers 1994:1.)

Hudson (1988) defines the term "monitoring" as follows: "Monitoring is making repeated or continuous observation or measurements of the patient, his or her physiological function, and the function of the life support equipment, for the purpose of guiding management decisions, including when to make therapeutic interventions, and assessment of those interventions" (Tobin 1998: 34). Monitoring must include a human component for assimilation of data and decision-making.

2.3.1 GOALS AND PURPOSE OF MONITORING

The word monitor is derived from the Latin "monere", which means "to warn". Alerting to a significant change in a patient's condition, is an important goal but the scope of monitoring is broader. The use of monitoring technology must never become an end in itself, but should prepare a more focused and reflective approach to patient management. (Tobin 1998:34.)
The general purposes of intensive care monitoring are:

- To assess the adequacy of vital organ function.
- To follow the course of acute illness.
- To detect complications, adverse events and track their severity.
- To determine the need for interventions.
- To determine the effects of therapeutic interventions.
- To assess the performance of support devices or equipment and their monitors.
- To detect readiness for and predict success in reduction and withdrawal of therapeutic interventions and support devices. (Hill & Summers 1994: 3; Tobin 1998: 35.)

Data gathered from monitoring, must be accurate, used in an appropriate manner and always be recorded. To optimise the impact of haemodynamic monitoring on patient outcomes, critical care nurses must be highly competent at measuring and interpreting waveforms and pressures. Proper levelling, zeroing and dynamic response assessment are the first crucial steps. These measurements must be integrated with other haemodynamic indexes for making treatment decisions and evaluating patients' responses to nursing care (Ahrens & Schallom 2001: 37).

2.3.2 ADVANTAGES OF MONITORING

Most of the time monitoring is done electronically, but often human assistance is required. Today monitoring automatically can perform repeated measurements. The data can be processed electronically, transferred to a computer for storage and reviewed at a later stage. Monitors can save lives and can directly change therapy. Monitors facilitate education in ways that would not have been possible without them (Tobin 1998:35).
2.3.3 NEGATIVE ASPECTS OF MONITORING

*Failures, inadequacies or complications of monitoring techniques and devices are relatively easy to document, for example:*

- Inaccuracy and/or imprecision of measurements of monitoring device.
- Inter-individual variations in reading, interpretation or documentation of data.
- The clinical complexities of monitoring.

Considering the risks versus the benefits, routine monitoring should not be part of hospital policy, especially if monitoring data are not utilised.

2.3.4 INVASIVE VERSUS NON-INVASIVE MONITORING

The trend is towards less invasive monitoring but there is a limit to the degree to which a critically ill, unstable patient can be monitored without invasive techniques. A decision for monitoring is indicated by the need to detect relevant abnormalities or changes in the patient's condition, and by the need for assistance or direction in patient management.

Non-invasive techniques will become the standard for many of the new diagnostic and monitoring devices. Benefits of non-invasive monitoring include greater patient and nurse safety, a reduction in costs and the fact that sterile application is not required (Bucher & Melander 1999: 12).

2.3.5 MONITORING VERSUS CARE

Intensive care involves the patient in totality and not only the monitors or measurements. Because of the complex nature of critical care illness, there may be a tendency to treat the patient as an abstraction. To avoid this, the critical care nurse should make a special effort to maintain personal contact with the patient and family (Berk & Sampliner
The essence of critical care nursing lies not only in special environments or equipment, but in the critical care nurse's decision-making process that is based on a sound understanding of physiological and psychological entities (Hill & Summers 1994: 1).

In the 21st century the greatest research challenge for the critical care nurse, is to determine whether the advantages of technology justify the cost, and whether patient care and patient outcomes are improved by technology. The challenge for critical care nursing remains clear - the delivery of high-quality, holistic care that responds to the needs of patients and their families (Bucher & Melander 1999: 12-14).

Despite the high technology setting in the ICU, the critical care nurse as a primary carer and as the patient's advocate, is fundamental in preserving and upholding the dignity and humanity of the patient in her or his care. The critical care nurse applies knowledge and experience to plan and initiate supportive, preventive and promotional care at appropriate times, and to respond to and anticipate changes in the patient's condition. The critical care nurse at the bedside is responsible for maintaining the safety of the patient in the highly technological setting (Goldhill & Withington 1997: 63). The sounds and activities of the unit bombard the patient 24 hours a day, and, in addition, the patient has to cope with fears concerning illness. Touch, caring and support to the patient and family serve as a holistic approach to nursing intervention (Burnard & Chapman 1995: 17).

2.3.6 COST VERSUS THE BENEFITS

Intensive care management is generally complex and involves a large commitment of resources in terms of staffing, equipment and support facilities. In all these aspects costs are involved. Decisions on the type, pattern and delivery of care must be justified in terms of expected outcome and incurred expenses. Calculation of costs does not mean that lower quality care should be accepted but rather act as a stimulus to provide more effective delivery of an expensive source (Goldhill & Withington 1997: 773).
2.3.7 KNOWLEDGE OF MONITORING

The critical care nurse manipulates the cardiovascular system of the critically ill patient with fluids and drugs. Haemodynamic measurements allow a precise diagnosis, determine appropriate therapy and reflect the responses to that therapy. While monitoring critically ill patients, critical care nurses repeatedly assess illness severity and prognosis and decide whether intervention is necessary. Possible interventions include further diagnostic procedures, as well as supportive and therapeutic care. A decision should depend on the diagnostic value of the particular observation under review, and on an analysis of the risk and potential benefit associated with each management option (Tobin 1998: 141).

Critical care nursing requires an ability to deal with crucial situations rapidly and with precision. Today, more than ever, critical care nurses must be life-long learners, and their knowledge and past experiences must assist them in analysing information from multiple perspectives (Hudak et al. 1998:4).

2.4 INVASIVE HAEMODYNAMIC MONITORING

The cardiac monitor gives a continuous picture of the heart's activity. The heart is part of a closed, pressurised circulatory system. Measuring the pressures in the heart chambers can help to answer questions, such as: Is the left ventricular muscle contracting adequately? Is the treatment received effective? What is the fluid status? (Soni et al. 2001: 13.)

2.4.1 PRESSURE MONITORING SYSTEM

Pressure monitoring is done by means of a fluid-filled manometer system. This system can be regarded as a closed chain system. The chain consists of a catheter, a disposable pressure set (that includes a transducer, pressure extension tubing and access devices), the interface cable and monitor (Soni et al. 2001:10).
A haemodynamic monitoring system has four components:

- The invasive catheter, with a high pressure tubing, connects the patient with the transducer.
- The transducer receives the physiological signal from the catheter and tubing and converts it into electrical energy.
- The flush system maintains catheter patency of the fluid-filled system.
- The bedside monitor with the amplifier or recorder, transfers the electrical signal and displays it on an oscilloscope and on a digital scale in millimetres of mercury (mmHg). (Deal 1996: 28.) (See Figure 2.2).

![Diagram of a pressure monitoring system]

**Figure 2.2: Pressure monitoring system**

A bag of normal saline 0.9% solution with heparin, ranging between 0.25 and 2 units per millilitres, with a pressure infusion cuff, a three-ways stopcock on the transducer, and an in-line flow device for both continuous fluid infusion and manual flush, are attached. The tubing connects the invasive catheter to the transducer and prevents damping of the waveform. (Urden & Stacy 2000:130.)
2.4.2 ACCURACY

The accuracy of haemodynamic pressure readings depends on several factors, such as levelling, zeroing, the fast flush square wave test and patient position:

- **Levelling** aligns the transducer with the tip of the catheter to eliminate the effect of hydrostatic pressure on the pressure monitoring system. By levelling the air-fluid interface of the pressure monitoring device, the stopcock should be opened to air while the system is zeroed in alignment with the phlebostatic axis of the patient. The phlebostatic axis is a physical reference point on the chest located at the fourth intercostal space, midpoint between the anterior and posterior chest, in the 30-degree lateral recumbent position.

- **Zeroing** is performed by opening the system to air, while closing it to the patient and flushing the system. These actions equilibrate the pressure monitoring device to atmospheric pressure. (Soni et al. 2001: 12.)

- **Fast flush square wave test** involves the use of the manual flush system on the transducer. There is a rapid increase in pressure, which is displayed on the monitor with one or two oscillations.

- **Patient position**: For reliable measurements, the patient's position must be at 0 to 60 degrees while lying on his or her back (Berk & Sampliner 1990:93; Woods et al. 2000: 429).

2.5 CORONARY ARTERY BYPASS GRAFT OPERATIONS

Coronary artery disease is one of the most common diseases affecting the adult population, and one of the leading causes of deaths in the world. The major cause of coronary artery disease is atherosclerosis, a pathological process that causes irregularity and thickening of artery walls. The incidence of coronary artery disease increases because of certain risk factors such as: ageing, male gender, hypertension,
diabetes, stress, smoking, hypercholesterolaemia, heredity, obesity and a sedentary lifestyle (Finkelmeier 1995: 1-6). Often a combination of medical and invasive therapies are needed for treatment. If medical therapy is no longer effective, invasive therapy will eventually become necessary to restore blood supply to the cardiac muscle that is jeopardised by acute or chronic destruction of one or more coronary arteries. Available invasive therapies include percutaneous transluminal coronary angioplasty (PTCA) or CABG. The choice between PTCA and CABG is based on the anatomical appearance, location, number and severity of coronary artery lesion (Hall, Schmidt & Wood 1999: 321).

CABG operations have been performed since the late 1960's. It is a procedure in which internal thoracic arteries or saphenous veins, or a combination of the two, are used as conduit material to bypass obstructed coronary arteries (Finkelmeier 1995:5-13). The radial artery is an alternative for arterial revascularisation, especially in a second CABG procedure (Reger & Vegas 1999:27).

**The objectives of CABG surgery are:**
- Control of ischaemic symptoms.
- Prevention of myocardial infarction.
- Prolongation of life.

Haemodynamic monitoring is an essential component of intensive care provided for postoperative or critically ill cardiac surgical patients. Invasive catheters and sophisticated equipment assist critical care nurses in obtaining data that could detect correctable abnormalities and guide therapeutic interventions (Oh 1997: 831).

After CABG surgery the patient is admitted to an ICU for close monitoring. Critical care nurses are responsible for achieving and maintaining haemodynamic stability, and for identifying actual and potential problems in order to ensure positive patient outcome.

Major concerns for novice critical care nurses are the acquisition of competency in clinical and technical skills and a reduction in the theory-practice gap. Without purposeful integration of this knowledge base into a nursing practice perspective, much
of its relevance for the daily provision of critical care nursing is lost. In order for critical care patients to receive safe and optimal care, critical care nurses who provide this care must be able to daily and periodically demonstrate that they can apply their knowledge and skills in an effective manner. (Bucher & Melander 1999: 15.)

2.6 CENTRAL VENOUS PRESSURE

CVP is the pressure in the central venous system as it returns to the right side of the heart or RA. It is also known as the right ventricular end-diastolic pressure (RVEDP). The volume of fluid that is available to return, the ability of the heart to deal with the fluid, that is to pump it forward, mainly determine the pressure. CVP measurement is expressed as a numerical value, either in millimetres of mercury (mmHg) or centimetres of water (cmH2O). The normal range is 3-8 cmH2O or 2-6 mmHg. Clinically, CVP is used as a guide to overall fluid status. (Woods et al. 2000: 436.)

2.6.1 INDICATIONS FOR CVP

*Indications for CVP can be divided into the following groups:*

- A requirement for venous access.
- A requirement for a central venous route for drug or fluid administration.
- A requirement for haemodynamic monitoring and diagnosis. (Soni et al. 2001:18.)

*The indications apply to the following patients:*

- Those who are hypovolaemic.
- Those with known or suspected compromised myocardial reserves and who are undergoing surgery associated with large fluid shifts.
- Those with low perfusion status, hypotension and oliguria, and who are unresponsive to initial fluid or diuretic therapy.
- Those with pericardial tamponade.
- Those requiring CVP measurements as a preliminary step in passing to a PA catheter (Levine & Fromm 1995: 144).
2.6.2 CATHETERS

Central venous catheters may have single, double, triple or four lumens. The advantage of multiple lumens is that more than one solution or drug can be administered without interference. The tip of the catheter is radio-opaque (Hall et al. 1999: 24).

2.6.3 INSERTION OF CVP CATHETER

A central vein, usually the subclavian or internal jugular, is most commonly used for the insertion of the radio-opaque catheter into the vena cava entering the RA. During insertion the patient is laid in the Trendelenburg position to ensure a positive venous pressure. After the CVP catheter placement, a chest X-ray is obtained to verify the position and the absence of haemothorax or pneumothorax (Basset & Makin 2000: 20).

2.6.4 CENTRAL VENOUS WAVEFORM INTERPRETATION

Normal CVP, displayed as a low amplitude waveform on the oscilloscope, has three positive deflections (called a, c, and v waves) to specific atrial events in the cardiac cycle. The a wave reflects atrial contraction and follows the p wave seen on the electrocardiogram (ECG). The downslope of the a wave is called the X descent and represents atrial relaxation. The c wave reflects the bulging of the closed tricuspid valve into the RA during ventricular contraction. The c wave is small and not always visible but corresponds to the QRS-T interval on the ECG. The v wave represents atrial filling and increased pressure against the closed tricuspid valve in early diastole. The downslope of the v wave is named the Y descent and represents the fall in pressure as the tricuspid valve opens and blood flows from the RA to the RV. (Thelan et al. 1998: 456.)
Figure 2.3: The ECG and normal CVP waveform

All intrathoracic pressures, including negative pressure spontaneous ventilation and positive pressure mechanical ventilation, have a direct effect on the intravascular pressure measurement. To eliminate the resultant, all intravascular pressures should be recorded at end-expiration. (Soni et al. 2001:19.)

Any abnormal ECG waveform is at risk for measurement error, when the digital measurement technique is used. In atrial fibrillation the a wave of the CVP waveform is lost. (Ahrens & Schallom 2001: 28.)

2.6.5 WATER VERSUS MERCURY CVP

Two methods can be used to take CVP measurements:

- The mercury system (mmHg), using a transducer and a haemodynamic monitor.
- The water manometer system (cmH2O), which consists of extended three-way taps. The extension with measurement markings stands upright; a second extension joins the central venous cannula, and a third connects to a solution (normal saline or dextrose water). (Woodrow 1992: 27.)
If a patient is changed from one system to the other, the measurements can be converted as follows:

- To convert water to mercury, the water value is divided by 1.36.
- To convert mercury to water, the mercury value is multiplied by 1.36. (Cornock 1996:38.)

2.6.6 COMPLICATIONS OF THE CVP CATHETER

Possible complications associated with the CVP catheter are listed below:

Complications associated with insertion:
- Pneumothorax or haemothorax.
- Arterial puncture.
- Air embolism.
- Dysrhythmia.
- Nerve injury.
- Mediastinal or pleural effusion.
- Chylothorax.
- Haemotoma.
- Catheter malpositioning or kinking.

Complications associated with use:
- Infection.
- Disconnection - leading to bleeding or air embolism.
- Pleural or pericardial effusion due to malpositioning of catheter (Oh 1997: 833).
- Thrombosis or pulmonary embolism (Soni et al. 2001:22).

2.6.7 NURSING MANAGEMENT

A properly placed catheter can be used to measure filling pressures within the right side of the heart. When the tricuspid valve opens and blood flows from the RA to the right ventricle (RV), it reflects the RVEDP. With this information the relationship between
intravascular volume and right ventricular function can be determined. However, CVP is not a reliable indicator of left ventricular dysfunction. CVP measures the RVEDP and remains normal, until the increase in volume in the left side of the heart is reflected back through the pulmonary vasculature to the RV.

To ensure correct data, CVP must be zeroed using the level of the RA as a reference point (the phlebostatic axis), and calibrated. CVP monitoring can be done intermittently or continuously (Cornock 1996: 38).

**CVP is lowered by:**

- Hypovolaemia - there is insufficient blood volume in the ventricle at end-diastole to produce an adequate stroke volume. Peripheral vasoconstriction helps to maintain the blood pressure. The heart rate increases to maintain normal cardiac function, tachycardia is observed in hypovolaemic status and the myocardial oxygen demand increases.
- Systemic vasodilatation e.g. in septic shock, vasodilator overdose or sympathetic dysfunction.
- Regional analgesia. (Soni et al. 2001:19.)

CVP is used in combination with other parameters to assess haemodynamic status. An isolated CVP reading is of limited value. Low CVP is an early indication or warning that a patient has potential problems, is bleeding, vasodilating, receiving diuretics, has sepsis or is rewarming after cardiac surgery (Thelan et al. 1998: 455).

The possible causes of an elevated CVP are mainly related to excess volume of fluid or an inability of the right side of the heart to pump the available fluid forward.

**Causes may include:**

- Hypervolaemia.
- Right and/ or left heart failure.
- Right heart valve disease.
- Cardiac tamponade.
• Pulmonary vascular hypertension or embolism.
• Increased intrathoracic pressure, e.g. positive pressure ventilation, haemothorax or pneumothorax and chronic obstruction airway disease.
• Abdominal splinting, e.g. pregnancy, ascites.
• Increased venous tone, e.g. under sympathetic nervous stimulation. (Soni et al. 2001:19.)

With an elevated CVP the heart increases its contractile force in order to move a larger volume of blood. This leads to an increase in cardiac workload and myocardial oxygen consumption. (Basset & Makin 2000: 22.)

2.6.8 SPECIAL CONSIDERATIONS

The following special nursing considerations are important regarding CVP catheterisation:

• Explain the procedure to the patient and reassure the patient during catheterisation.
• Do daily chest X-rays to check catheter placement.
• Take care of the insertion site according to the facility’s policy; change the dressing every 24 to 48 hours and use an aseptic technique.
• Secure the catheter to the skin with tape to prevent catheter movement.
• Instruct the patient not to handle the catheter or site dressing.
• Pay attention to any sign of infection such as redness, tenderness or an elevated white blood cell count.
• After the initial CVP reading, frequently reevaluate readings to establish a baseline for the patient. Obtain readings at 15, 30 and 60 minutes intervals to establish a baseline.
• Replace the CVP catheter after seven days, in accordance with hospital policy.
• Document all the data obtained, the dressings used, the changing of lines or catheter, as well as any complications and actions taken (Woodrow 1992:25-29).
2.7 THE PA CATHETER

The PA catheter was invented by two doctors, Swan and Ganz, in the 1970's and is for that reason also known as the Swan-Ganz catheter. Originally the PA catheter had two lumens but current versions have up to six lumens for more comprehensive information gathering (Tobin 1998: 849).

PA pressures are measured by a catheter placed in the PA. The PA catheter simultaneously assesses several haemodynamic parameters, including: right atrial pressure, PA systolic, PA diastolic, PA mean and the PAWP. It samples mixed venous blood for the measurement of arteriovenous oxygen differences and an estimated cardiac output (Oh 1997: 833).

The PA catheter provides important information and permits a continuous, indirect diagnostic measurement of the left ventricular function. The function and haemodynamics of the LV are determined by the PA catheter in order that early detection and treatment of cardiopulmonary changes can be facilitated. A reduction in cardiac function manifests in two haemodynamic parameters: a decreased cardiac output and an increased LVEDP. During ventricular diastole, when the mitral valve opens, the pressure in the LV is reflected in the left atrium (LA), which in turn is reflected in the pulmonary vein and against the tip of the PA catheter, with the balloon inflated. Thus PAWP correlates with PA diastolic pressure. (Woods et al. 2000: 438.)

2.7.1 INDICATIONS FOR PA CATHETERISATION

*Indications for the use of a PA catheter are as follows:*

**Surgical:**
- Preoperative cardiovascular assessment and peri-operative management of high-risk patients undergoing extensive surgical procedures.
- Postoperative cardiovascular complications.
- Multisystemic trauma.
• Assessment of the effect of intravascular volume on cardiac functions.
• Shock - unresponsive to perceived adequate fluid therapy.
• Delineation of cardiovascular system, contributing to multiple organ dysfunction syndrome.
• Septic shock.

**Pulmonary:**
• To differentiate between noncardiogenic ("ARDS") and cardiogenic pulmonary oedema.
• To assess the effects of high levels of ventilatory support on cardiovascular status.
• To obtain mixed venous saturation measurements.

**Cardiac:**
• Complicated myocardial infarction.
• Unstable angina, requiring intravenous nitroglycerin therapy.
• Congestive heart failure - unresponsive to conventional therapy, and to guide preload and afterload therapy.
• Pulmonary hypertension, for diagnosis and monitoring during acute drug therapy (Berk & Sampliner 1990: 105).
• Cardiac output.
• Diagnosis of ventricular septal defect (Hall et al. 1999: 426).

### 2.7.2 TYPES OF CATHETERS

The flow-directed catheter monitors PA pressures and PAWP, and can sample mixed venous blood. The PA catheter has a distal and proximal lumen, a thermistor and a balloon inflation gate valve. The distal lumen is in the PA and monitors PA pressures. The proximal lumen is in the RA or vena cava, monitors the right atrial pressure (CVP) and can be used as the injected solution lumen for infusing solutions and for cardiac output determination. The thermistor measures temperature and allows cardiac output measurement. Attached to the thermistor connector is a cardiac output connector cable which connects to a cardiac output monitor. The balloon inflation gate valve is used for
inflating the balloon with air in order to determine the PAWP. (Thelan et al. 1998:464.) (See Figure 2.4).

![Diagram of catheter components]

**Figure 2.4: Catheter components**

Additional lumens can be used for interventions or to obtain other data. For additional fluid administration, the proximal infusion port in the RA or vena cava is an option. The right ventricular lumen exiting in the RV allows the options of fluid administration, RV measurement or the use of temporary ventricular pacing. Some PA catheters provide for atrioventricular pacing through right atrial and right ventricular lumens.

The PA catheter used in this research, is a flow-directed balloon-tipped catheter with a proximal, a distal and a balloon inflation gate valve lumen (cardiac output was not determined). The PA catheter is 110 cm in length and made from polyvinyl chloride. Sizes 7.5 and 8.0 French are commonly used. A sterile plastic sleeve is placed over the exterior of the catheter to maintain sterility to the part that exits from the patient. The catheter can be repositioned if it migrates, or when it is not in the desired position. (Montgomery Dossey, Guzetta & Vanderstaay Kenner 1992: 240.)
2.7.3 INSERTION OF THE PA CATHETER

If the patient is awake, a brief explanation of the procedure ensures the cooperation of the patient. The initial insertion technique for the placement of the PA catheter is similar to CVP insertion - previously described. The PA catheter is flow-directed. It follows the venous blood flow from the RA to the PA, therefore a fluoroscope is not required. The RA, RV and PA produce characteristic waveforms and pressures that can be observed on the monitor during catheterisation. (Hall et al. 1999:429.)

The brachial, internal jugular, subclavian or femoral vein can be used for PA placement. The percutaneous venous cannulation is a simple, quick and less invasive procedure than a venous cutdown. Before inserting the PA catheter, the integrity of the balloon is ensured by submerging the catheter in sterile water, and inflating the balloon. All lumens are flushed to ensure patency. After insertion of the needle, a guide-wire is inserted to remove the needle. The introducer is passed over the guide-wire and the guide-wire is removed. The PA catheter is inserted through the sheath and advanced towards the heart. (Levine & Fromm 1995: 148.)

The tip of the catheter may irritate the RV wall and cause ventricular dysrhythmia. An anti-dysrhythmia agent can be dispensed, and the defibrillator and resuscitation equipment must be nearby. The PA catheter is sutured to the skin, and a chest X-ray is taken to verify the position of the catheter and to rule out a pneumothorax, haemorrhage or other complication.

2.7.4 PA WAVEFORM

PA waveform interpretation can be simplified by remembering that electrical activity, as indicated by ECG, precedes mechanical activity. (See Figure 2.5).
Figure 2.5: Pressure waveforms during PA catheter insertion

When the PA catheter is positioned in the RA, a right atrial waveform must be visible on the monitor. The normal range is 2 to 5 mmHg. The balloon is inflated before passing it through the tricuspid valve to assist the catheter to float with the flow of the blood, and if the tip of the catheter comes into contact with the RV wall, it will cause less irritation and consequently fewer ventricular dysrhythmias. The RV waveform is pulsative and distinct. Systolic pressures measure at 20 - 30 mmHg and diastolic at 0 - 5 mmHg (Headley, 1995).

When the PA catheter enters the PA, the waveform changes. The diastolic pressure raises to 10 mmHg, while the systolic pressure remains at 20 - 30 mmHg. The closure of the pulmonic valve is represented by a dicrotic notch, which is visible on the downslope of the waveform. The balloon remains inflated and the catheter advances to the wedge position. The waveform is decreased in size because the balloon is wedged into a small pulmonary vessel. When the balloon is deflated, the catheter will spontaneously flow backwards in the PA. (Montgomery Dossey et al. 1992: 241; Urden & Stacy 2000: 138.)
The PAWP is obtained by inflating the catheter balloon with 1 to 1.5 ml. of air. This allows the catheter tip to advance until it obstructs forward flow within a branch of the PA (Hall et al. 1999:437; Lynn-Mc Hale, 1997). It can be assumed that there is a static column of blood from the catheter tip forwards to the left side of the heart (Soni et al. 2001:27). (See Figure 2.6).

![PAWP waveform]

\[a \text{ wave} = \text{Left atrial contraction}\]
\[X \text{ descent} = \text{Left atrial diastole}\]
\[v \text{ wave} = \text{Passive left atrial filling}\]
\[Y \text{ descent} = \text{Left atrial emptying}\]

**Figure 2.6: The PAWP waveform**

The flow-directed balloon-tipped catheter allows of three types of primary data: central venous, pulmonary arterial and balloon-occluded (wedge) pressures or PAWP. These data can be used in their primary form or manipulated to provide useful indices of fluid volume status, right and left ventricular performance and loading conditions or tissue perfusion. (Marini & Wheeler 1997: 20.)

The normal PAWP reading from the mid-axillary line is 5-10 mmHg. This pressure, for a normal heart, represents the preload that is required for a normal cardiac output. Both volume depletion and vasodilatation create a low PAWP. Both result in a reduced volume of blood returning to the left side of the heart, indicating that more volume is required to allow the ventricle to fill adequately. Acute right ventricular failure is an
important cause of low PAWP. The RV cannot pump the blood through the PA to the left side of the heart, which results in a low cardiac output.

**Table 2.1: PAWP and mechanical activity**

<table>
<thead>
<tr>
<th>PAWP WAVEFORM</th>
<th>MECHANICAL ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>a wave</td>
<td>LA contraction</td>
</tr>
<tr>
<td>X descent</td>
<td>LA relaxation</td>
</tr>
<tr>
<td>c wave (usually not seen)</td>
<td>Mitral wave closure</td>
</tr>
<tr>
<td>v wave</td>
<td>Venous inflow into LA against closed mitral wave</td>
</tr>
<tr>
<td>Y descent</td>
<td>Passive LA filling</td>
</tr>
</tbody>
</table>

(Woods et al. 2000:438.)

A raise in the PAWP causes left ventricular failure - an inability of the left side of the heart to deal with the volume that is returning to the LV. Mitral stenosis and cardiac tamponade cause a raise in PAWP. (Basset & Makin 2000:23.)

**2.7.5 OBTAINING VALID MEASUREMENTS**

Pressures measurements should be obtained after proper calibration and zeroing. Technical errors are frequent (20 percent) and may not be detected. Reliable data, relevant to the heart and vasculature, are essential for diagnoses, treatment and for timing interventions. The interpretation of the complex relationship between vasculature pressures and flows is often complicated by spontaneous fluctuations in metabolism and by variation of the respiratory pressures (Marini & Wheeler 1997: 19).

System requirements for accurate pressure measurements are zeroing, calibration and the correct interpretation of waveforms. Haemodynamic pressure should be measured at end-expiration. Alveolar pressures should then be closest to atmospheric pressure (Soni et al. 2001:28). Common technical difficulties encountered in the generation of pressure waveforms of the PA catheter, include overdamping, catheter whip, overwedging and incomplete wedging (Hall et al. 1999: 433).
A number of technical and physiological factors encourage errors in data acquisition, as well as misinterpretation of recorded values.

- **Zoning:** The upright lung can be divided into three zones, viewing the pulmonary vascular network as a variable resistor vulnerable to external compressions by alveolar pressure. These zones theoretically extend vertically, because regional vascular pressures within the lung are affected by gravity. In lung zone 1, near the apex of the upright lung, alveolar pressure exceeds both PA and pulmonary venous pressures, flattens alveolar capillaries, and stops flow. In lung zone 2, alveolar pressure is intermediated between PA and pulmonary venous pressure. Flow in this region is determined by the arterial-alveolar pressure gradient. In lung zone 3, near the lung base, alveolar pressure is less than either vein or artery pressures, and does not influence flow. The catheter tip must communicate with the pulmonary veins via a channel in which vascular pressure exceeds alveolar pressure. Only in lung zone 3 could patent vascular channels remain open to connect the catheter lumen and the LA. Outside lung zone 3, alveolar pressure would exceed pulmonary venous pressure, collapsing the capillaries in those regions. A catheter wedge outside the lung zone 3 will show an unusually smooth waveform. As long as the catheter tip lies at or below the level of the LA, the measurements will result in a valid PAWP value. (Woods et al. 2000: 445.)

- **Ventricular compliance:** PAWP is a reflection of LA preload only when ventricular compliance is normal or constant. Several conditions can alter ventricular compliance, such as: ventricular hypertrophy, positive pressure ventilation, myocardial ischaemia and myocardial oedema, e.g. after CABG surgery. Therefore, PAWP may not be a reliable index of LV preload in a large number of patients in the ICU. (Marini & Wheeler 1997: 28.)

- **Positive End-Expiratory Pressure (PEEP):** The presence of PEEP can reduce the area of zone 3 in the lung. When PEEP is being applied, the PAWP should be measured while PEEP is temporarily discontinued, if possible without decreases in arterial oxygenation. (Woods et al. 2000: 447.)
• **Wedged Blood Gases:** Fifty percent of the measured PAWP values represent damped PA pressures. Aspiration of blood from the catheter tip during balloon inflation can be used to identify a true PAWP.

*Criteria for wedge pressure validation are as follows:*

- (Wedge PO2- Arterial PO2) ≥19 mmHg
- (Arterial PO2- Wedge PO2) ≥11 mmHg
- (Wedge pH - Arterial pH) ≥ 0.008 (Marini & Wheeler 1997: 29.)

• **Left Ventricular End-Diastolic Pressure (LVEDP):** Even when wedge pressure is an accurate reflection of left atrial pressure, there may be a discrepancy between PAWP (left atrial pressure) and LVEDP.

*This may occur because of conditions, such as:*

- **Aorta insufficiency:** LVEDP can be higher than PAWP because the mitral valve closes prematurely, while retrograde flow continues to fill the ventricle.
- **Noncompliant ventricle:** Atrial contraction against a stiff ventricle produces a rapid rise in end-diastolic pressure that closes the mitral valve prematurely. The result is a PAWP that is lower than LVEDP.
- **Respiratory failure:** PAWP can exceed LVEDP in patients with pulmonary disease. The presumed mechanism is due to constriction of small veins in lung regions that are hypoxic.

• **Hydrostatic pressure:** Wedge pressure is often assumed to be a measure of hydrostatic pressure in the pulmonary capillaries. The PAWP is measured in the absence of blood flow. When the balloon is deflated and blood flow resumes, the pressure in the pulmonary capillaries is equivalent to the left atrial (wedge) pressure only when hydraulic resistance in the pulmonary veins is negligible. In the normal lung, wedge pressure is equivalent to capillary hydrostatic pressure. In the presence of pulmonary venoconstriction (e.g., hypoxaemia and ARDS) and pulmonary hypertension (e.g., ARDS), there can be considerable differences between PAWP and capillary hydrostatic pressure. (Woods et al. 2000: 446.)
• **Auto-PEEP (Intrinsic PEEP):** When insufficient time is allowed between ventilatory cycles for the chest to deflate to its relaxed volume, airflow continues across critically narrowed airways throughout exhalation, driven by an alveolar pressure higher than airway opening pressure. Auto-PEEP occurs in patients with airflow obstruction, inverse ratio ventilation, high frequency ventilation, noncompliant lungs and stiff chest walls.

• **Active Exhalation:** Active exhalation and chaotic breathing present difficulty in the interpretation of the wedge pressure. (Woods et al. 2000: 447).

• **Tachycardia:** Tachycardia reduces diastolic time, therefore the LA contracts against a partially shut mitral valve (Soni et al. 2001:28).

2.7.6 **COMPLICATIONS OF THE PA CATHETER**

The PA catheter should never be inserted without a firm indication, and once inserted, the data must be interpreted skilfully. Misguided decisions resulting from the misinterpretation of data may be the most prevalent serious "complication" of the technique (Webb et al. 1999:1098).

⇒ **INSERTION-RELATED COMPLICATIONS**

• **Catheter-Related Arrhythmias**
Premature atrial and ventricular contractions occur commonly during insertion of the PA catheter. If the patient is hypoxaemic or has an electrolyte disturbance at the time of procedure, special caution must be taken. Arrhythmia can occur with PA catheter insertion or maintenance, atrial or ventricular tachycardia, right bundle branch block, complete heart block, ventricular premature beats and ventricular fibrillation. Ventricular arrhythmias and heart blocks may occur in 12 to 70 percent of patients during PA catheterisation (Webb et al. 2000: 1098).
• **Catheter Malpositioning**
Experience is the most important determinant of successful catheter placement.

• **Knotting and Fragmentation**
Catheter knotting can occur, especially when the catheter is extensively manipulated, or becomes entangled with other intra-cardiac structures, such as papillary muscle, valves or pacing wires. It could also occur when an excessive length is inserted, the heart is dilated, or the balloon is not fully inflated during passage. Knotting is most likely to be detected while attempting catheter withdrawal or obtaining chest X-rays. The same is true for catheter fragmentation. The avoidance of forceful insertions or removals will prevent this serious complication. (Soni et al. 2001: 26.)

• **Pulmonary Infarction**
Pulmonary infarction is distressingly common. Persistent wedging of the catheter tip or dislodgement of clot formed on the catheter is the most likely explanation. Even with the balloon deflated, distal migration of the tip to a smaller branch of the PA can result in a PA infarction. Infarction occurs rarely when the catheter is well positioned, and the balloon acquires its maximum volume - 1.0 to 1.5 ml for inflation to the wedge position.

• **PA Rupture**
PA rupture can cause fatal haemoptysis and is a life-threatening complication. Several factors predispose PA rupture: advanced age, heparinisation, poor catheterisation techniques, hypothermia, pulmonary hypertension and overinflation of the catheter balloon. The balloon should never be inflated abruptly and if any resistance is experienced, balloon inflation should be stopped immediately. Advancing the catheter tip without balloon inflation, should not be undertaken. (Marini & Wheeler 1997: 36; Woods et al. 2000: 449.)

• **Other complications**
Other possible complications are pneumothorax, bleeding at the insertion site, cardiac tamponade, ventricular perforation, overdamping of the waveform and arterial puncture (Webb et al. 1999: 1098).
COMPLICATIONS RELATED TO LONG-TERM CATHETERISATION

- **Thrombosis**
  Thrombosis at the insertion site or at points along the catheter occurs frequently without serious consequences. Thrombosis can result in subclavian vein thrombosis, superior vena caval syndrome or internal vena jugular occlusion.

- **Infection**
  Infection is a problem with any indwelling catheter. The PA catheter advances through the RA, makes intimate contact with the tricuspid and pulmonary valves and increases the risk of endocarditis, development of vegetations and septic embolism. Myocardial abscess has also been described after PA catheterisation. Prolonged catheterisation, more than 72 to 96 hours, can predispose a colonization or infection. (Levine & Fromm 1995:151; Marini & Wheeler 1997: 36.)

- **Cardiac and valve damage**
  The pulmonary valve and particularly the tricuspid valve are susceptible to damage by the placement or movement of a PA catheter. Chordae tendineae rupture can occur when the catheter is manoeuvred in the heart, with the balloon inflated (Soni et al. 2001: 27).

### 2.7.7 NURSING MANAGEMENT

The more knowledgeable the critical care nurse has become about the management of the PA catheter, the more accurate and effective clinical decision-making and nursing care will be regarding the patient with the catheter.

*The critical care nurse should:*
- Verify the position of the PA catheter with a chest X-ray.
- Explain the procedure to the patient, particularly during PA catheterisation.
• Let the patient lie in supine position with backrest to 60 degrees, or in lateral position at 30 or 90 degrees.
• After positioning allow 5 minutes for pressure stabilisation.
• Level and zero the pressure-transducer system before measurements.
• Inflate the balloon to a maximum of 1.5 ml, and for no more than 30 seconds.
• Determine pressures by using analogue (graphical) tracing and recording.
• Deflate the balloon once PAWP has been obtained, and note the return of the characteristic PA waveform (Thelan et al. 1998: 468).
• Secure catheter and note insertion distance.
• Continuously monitor PA tracing to ensure that the catheter does not migrate forward into a spontaneous wedge position.
• Observe cardiac complications such as ventricular dysrhythmias etc. and be alert to potential problems.

2.8 ETHICAL ASPECTS OF CRITICAL CARE MONITORING

Considerable advances in the management of patients in intensive care have been made possible through research.

Care of all patients is guided by the following principles of medical ethics:
• Beneficence: Acting for the patient's benefit.
• Non-maleficence: Not intentionally doing harm.
• Autonomy: Respect for a patient's right to self-determination; including the right to consent to any procedure, or otherwise.
• Justice. (Webb et al. 1999:1037.)

The critical care setting leans towards the beneficence model. Critical care nurses make decisions that are believed to be in the patient's best interest. The primary ethic of critical care is the preservation of life by competent and compassionate care. Solutions
are not easy, but they must arrive at accepted answers. Studies of intensive care monitoring provide information on risks, benefits and costs. (Tobin 1998:1425.)

Monitoring in the ICU may appear straightforward, but it can be as complicated ethically as it is technically. Only monitoring methods that are more beneficial than burdensome, that do not interfere with autonomy and the fair allocation of resources, and that are worthy of trust on the part of the patients, should be initiated or maintained. (Tobin 1998:1448.)

2.9 SUMMARY

Critical care nurses utilise the nursing process as the basis for critical thinking and decision-making with regard to the critically ill patient. Critical care nurses in the ICU must be responsible and accountable. Intensive care demands knowledgeable and skilfully trained practitioners who could deliver quality patient care.

Haemodynamic monitoring is an essential component of intensive care provided for the CABG patient. The advantages and disadvantages of PA and CVP catheters were discussed. In the critical care setting monitoring can be complicated because of technical problems and ethical issues. The critical care nurse has the responsibility to always act in the best interest of the patient.
CHAPTER 3

RESEARCH DESIGN AND RESEARCH METHODOLOGY

3.1 INTRODUCTION

The purpose of this research study is twofold: Firstly, it aims to determine and describe the knowledge and data preferences of critical care nurses regarding the management of CVP and PA catheters after CABG operations, and secondly, it aims to determine the utilisation period of the PA catheter after CABG operations. The physical context in which this research study was done, is the cardiothoracic ICU of a private hospital in Gauteng. Management and staff consented to partake in the research study.

3.2 RESEARCH DESIGN AND METHOD

The research is done according to a quantitative research design. A questionnaire and a checklist were used as research instruments. A questionnaire is a printed self-report form, designed to determine information that can be obtained through written responses of respondents. Questionnaires are self-administered - the respondents read the question on a form and give an answer in writing. The design of this research is descriptive. It includes a survey and a retrospective analysis. Surveys focus on obtaining information about the attitudes, activities, beliefs and preferences of people by questioning a sample of respondents (Polit & Hungler 1995: 200). Questionnaires are essential to, and directly associated, with survey research (Babbie & Mouton 1998:239).

A quantitative research design is adopted with the purpose to investigate the knowledge of critical care nurses regarding CVP and PA catheter management after CABG operations. The specific research instrument is a questionnaire. The twin purpose of the questionnaire is to determine critical care nurses' preferences regarding the use of CVP and PA catheters after CABG operations, as well as to
establish their opinions about CABG management with or without a PA catheter. The research design and method are summarised in table 3.1.

**Table 3.1: Research design and method**

<table>
<thead>
<tr>
<th>AIM</th>
<th>SAMPLING &amp; POPULATION</th>
<th>DATA GATHERING</th>
<th>VALIDITY &amp; RELIABILITY</th>
<th>DATA ANALYSIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>To determine and describe the knowledge and preferences of critical care nurses regarding CVP and PA catheter management after CABG operations.</td>
<td>A convenience sample of voluntary critical care nurses working in a private cardiothoracic intensive care unit in Gauteng - regardless of staff appointment or qualifications.</td>
<td>Implementation of a questionnaire under controlled conditions.</td>
<td>Literature review, professional critiques and a pilot study.</td>
<td>Descriptive statistics.</td>
</tr>
<tr>
<td>To determine the utilisation period of the PA catheter after CABG operations.</td>
<td>A convenience sample of records of patients who had received CABG surgery at the same hospital and cardiothoracic unit during a specified time.</td>
<td>A retrospective analysis, using a structured checklist, of the utilisation period of PA catheters.</td>
<td>Literature review, professional critique and a pilot study.</td>
<td>Descriptive statistics.</td>
</tr>
</tbody>
</table>

The purpose of a descriptive study is to observe, describe and document aspects of situations as they naturally occur. No manipulation of the variables is involved. (Burns & Grove 1997: 250.)

Components of a descriptive study design are used to determine the knowledge and preferences of critical care nurses regarding CVP and PA catheter management after CABG operations. The examining and description of the variables lead to an interpretation of the theoretical meaning of the findings, and provide knowledge about
the variables and the population that can be used for future research in this field (Burns & Grove 1997: 251).

The quantitative research design adopted for this study, includes a retrospective analysis of patient records. It is used to determine the utilisation period of the PA catheter after CABG operations. Retrospective analyses are investigations into existing phenomena that can be linked to other phenomena that have occurred in the past. The researcher is interested in the present outcomes and attempts to shed light on causal antecedent factors (Polit & Hungler 1995: 164). CVP and PAWP measurements from patient records are compared to determine the utilisation period after CABG operations of the CVP measurement and the PA catheter respectively. In this study it was done by comparing CVP and PAWP measurements, which were recorded at specific time intervals over a period of 36 hours.

The literature review defines and describes concepts that are crucial to the development of the research study. The research instruments for this study comprise a questionnaire and a checklist that enable the researcher to make structured observations in order to do a retrospective analysis.

3.2.1 POPULATION AND SAMPLING

The population is the entire aggregation of cases that meet a designed set of criteria (Babbie & Mouton 1998:100). Sampling involves selecting a group of people, events, behaviours or other elements in order to conduct a study. Sampling is the process of selecting a portion of an aggregate (people, groups or elements) to represent the entire population (Brink 1996:109; Burns & Grove 1997: 293). A sample consists of a subset of the units that compose the population. The sampling plan describes the strategies that will be used to obtain a sample for a study (Polit & Hungler 1995: 279).
• Population

The population for the completion of the questionnaire consists of all registered nurses working in the cardiothoracic ICU of a private hospital in Gauteng. Critical care nurses could participate in the study, regardless of staff appointment or qualifications.

The population for the retrospective analysis consists of patient records of all patients who had received CABG surgery in a private hospital in Gauteng.

Written permission to implement the questionnaire and use patient records for the retrospective analysis, was obtained from the management of the private hospital. (See Annexure I).

• Sampling

The questionnaire was implemented on a convenience sampling basis. A convenience sample is a non-probability sample that is inexpensive, accessible and less time-consuming than any other sampling approach (Burns & Grove 1997: 302). However, the convenience sampling approach limits the extent of generalisation.

Critical care nurses who were working during March 2001 in the surgical cardiothoracic ICU of a private hospital in Gauteng, were requested to participate in the survey, irrespective of their intensive care training or experience status. Full-time staff, part-time staff, agency staff and students busy with post-basic intensive care training, were included in the sample. The sample thus consists of all nursing personnel on duty at a given time in a specific ICU in Gauteng. They are registered, professional nurses who have volunteered to partake in the study and to fill in the questionnaire (n=40).

A convenience sampling approach was chosen for the retrospective analysis of patient records. Patient records (n=30) used in this study, were drawn from the same cardiothoracic ICU of a private sector hospital in Gauteng. Records of the first 30 patients who had received CABG operations during July and August 2001, were
used to obtain CVP and PAWP measurements, taken at ten different time intervals over a 36 hour period. The data obtained from the patient records were transferred to a structured checklist, reflecting the different time intervals.

3.3 DATA GATHERING

Data gathering is necessary to address research problems (Polit & Hungler 1995: 700). The structured data collection approach chosen for this study, entailed the implementation of a questionnaire and a checklist. The questionnaire (Annexure III) was used for the purpose of obtaining data about critical care nurses' knowledge and preferences regarding CVP and PA catheter management after CABG operations.

A structured checklist (Annexure IV) was designed for the purpose of obtaining data regarding the utilisation period of the PA catheter after CABG operations. Patient records were retrospectively analysed by using the structured checklist.

3.3.1 QUESTIONNAIRE

The questionnaire is a data collection method which entails completion of questions and answers in a paper-and-pencil format (Polit & Hungler 1995: 712). The advantages of using a questionnaire for survey research, are as follows: It is less expensive in terms of time and money; the respondents have a greater sense of anonymity; they are more likely to express controversial opinions; questions are presented in a standard format to each respondent; and a greater amount of data over a broad range of topics may be collected from a large population (Brink & Wood 1994:155; Burns & Grove 1997: 359).

The development of the questionnaire will be discussed under the following headings:

- Development phase.
- Types of questions.
- Compilation of questionnaire.
- Pilot test.
- Degree of difficulty of questions.
• Development phase

The literature study was used as a basis to identify the essential content that has to be covered by the questionnaire. The content covered by the questionnaire, had to correspond with the educational level of the potential respondents (Burns & Grove 1997: 358). For this the researcher had to greatly rely on text books (and not on research articles), as the knowledge base for this study is contained in text books.

The covering letter (Annexure II) that accompanied the questionnaire, explains the purpose of the study, and names the researcher as well as the institutions supporting the study. The letter ensured confidentiality to all respondents.

• Types of questions

All questions are factual, multiple-choice or dichotomous questions that ensure comparability of responses and facilitate analysis of data (Brink & Wood 1994:157).

• Compilation of questionnaire

The questionnaire consists of nine sections. The layout is described in table 3.2.

Table 3.2 Layout of questionnaire

<table>
<thead>
<tr>
<th>Section A</th>
<th>Number and description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Demographic data.</td>
<td>Two questions: No. 1 and 2.</td>
</tr>
<tr>
<td></td>
<td>The level of qualification, the experience and staff appointment of each participant were identified by these questions. The data were required in order to describe the population group.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Section B</th>
<th>Number and description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Normal values of CVP and PA measurements.</td>
<td>One question: No. 1.</td>
</tr>
<tr>
<td></td>
<td>Question 1 concerns the normal measurements of CVP, PAWP, as well as systolic and diastolic PA pressures.</td>
</tr>
</tbody>
</table>
| 2. Fundamental principles of pressure measurements. | Seven questions: No. 3, 4, 7, 9, 18, 23, and 32.  

**Question 3** concerns the PAWP which reflects the left atrial, and thus the left ventricular function.  
**Question 4** concerns CVP as the direct measurement of pressure in the RA.  
**Question 7** refers to the inflation time of the PA catheter for a PAWP.  
**Question 9** inquires about a spontaneous wedge pattern.  
**Question 18** refers to the PA catheter which may provide means for temporary cardiac pacing.  
**Question 23** concerns the position of the PA catheter.  
**Question 32** refers to the effect of positive expiratory airway pressure on PAWP. |
|---|---|
| 3. Interpretation of pressure recordings. | Nine questions: No. 2, 6, 8, 13, 24, 26, 27, 28 and 29.  

**Question 2** concerns decision-making about a reduced CVP, blood pressure and renal output.  
**Question 6** inquires about the implication of an increased PAWP.  
**Question 8** refers to the cases of elevated CVP.  
**Question 13** concerns the haemodynamic effects and nursing actions associated with hypovolaemia.  
**Question 24** deals with CVP interpretation in conjunction with other haemodynamic measurements.  
**Question 26** probes the haemodynamic effects of a low CVP.  
**Question 27** inquires about the effects of pulmonary oedema on pressure measurements.  
**Question 28** concerns the increase in CVP due to ventricular afterload.  
**Question 29** refers to the effects of right ventricular failure on CVP and PAWP. |
<p>| | | |</p>
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</table>
- **Question 5** tests knowledge about the zero reference point for transducers.  
- **Question 9** asks about nursing action in case of a spontaneous wedge pattern.  
- **Question 19** asks about the frequency of zeroing the pressure monitoring system.  
- **Question 25** refers to the correct position of the tip of the PA catheter.  
- **Question 31** concerns the PA catheter position in the lung. |
| 5. | **Complications associated with CVP and PA catheters.** | Four questions: No. 10, 22, 30 and 32.  
- **Question 10** inquires about possible complications of PA catheterisation.  
- **Question 22** refers to possible damage done by a PA catheter.  
- **Question 30** concerns the waveform of a PA catheter balloon.  
- **Question 33** refers to sepsis as a complication of indwelling catheters. |
| 6. | **Identification of PA waveforms.** | Two questions: No. 11 and 12.  
- **Question 11** refers to the description of PA waveforms.  
- **Question 12** concerns the PAWP waveform during spontaneous breathing or full ventilation. |
| 7. | **Clinical use of CVP and PA measurements.** | Six questions: No. 14, 15, 16, 17, 18, and 21.  
- **Question 14** probes the effect of measurements in decision-making regarding CABG patient.  
- **Question 15** refers to nurses' confidence in CVP and PAWP measurements.  
- **Question 16** deals with the degree of competency in CVP measurements.  
- **Question 17** concerns the degree of competency in PAWP measurements.  
- **Question 21** inquires about the possibility of managing the CABG patient without a PA catheter. |
8. Removal of PA catheter.

One question: No. 20

**Question 20** deals with nursing action when the PA catheter is about to be removed.

- **Pilot testing of questionnaire**

The purpose of a pilot test is to identify unforeseen problems, such as ambiguous question wording, respondents' misinterpretation of questions or the effect of question sequences. Potential problems can be detected beforehand, and information may be obtained that could assess the feasibility of the study or improve the research study in its entirety (Brink 1996: 60). Before the pilot test had been implemented, the questionnaire was reviewed by experts in the field of cardiology. Cardiothoracic intensive care nursing personnel and critical care educators consequently made changes to the questionnaire.

A pilot study on a small scale, using three respondents, was performed to determine clarity of questions, effectiveness of instructions, completeness of response sets, time required to complete the questionnaire and success of data collection techniques.

The questionnaire was revised and presented for approval to the Department of Advanced Nursing Sciences at the University of South Africa (UNISA).

- **The degree of difficulty of questions**

The degree of difficulty of an item is determined by the percentage of respondents that have correctly answered that particular item. The lower the value, the more difficult the item will be. The degree of difficulty should be judged within the context of the learning objective, but may also give an indication of problems experienced in respect of either the question or the teaching. Compared to the learning objectives in textbooks and the content of critical care courses, the questionnaire falls within the average limits.
For the purpose of this study the degree of difficulty could not be determined, because of the small sample size. However, it is recommended that it be done, for the reason of replication or repetition of the study.

### 3.3.2 Retrospective Analysis

Much of nursing practice is orientated towards physiological monitoring of health. All data obtained while managing the CABG patient, have to be documented on the patient's record in the ICU. Data were thus available on ICU patient records to determine the utilisation period of PA catheters after CABG operations. Data gathering was done by means of a structured checklist. CVP and PAWP measurements (measured at ten different time intervals over a period of 36 hours) were obtained from patient records and compared retrospectively.

From patient records it could be determined whether CVP and PA catheters had functioned effectively over the period of 36 hours. The number of defaults could be estimated. An example of the checklist used for the determination of the utilisation period of the CVP and PA catheters, is included as Annexure IV.

### 3.4 Validity and Reliability

The term validity refers to the extent to which an empirical study adequately measures, or reflects the real meaning of the concept under consideration (Babbie & Mouton 1998:122).

The fact that a data collecting instrument appears to measure what it is supposed to measure, establishes the validity of the instrument (Brink & Wood 1994:174).

- **Face validity**

An instrument has face validity, when it is measuring what it is supposed to measure. The questionnaire and the structured checklist appeared to be appropriate and adequate means of obtaining data needed for this study (Brink & Wood 1994:175). The literature review provided the content information for the questionnaire. The knowledge and preferences of critical care nurses regarding CVP and PA catheter
management after CABG operations, were determined by the implementation of a questionnaire. The utilisation period of the PA catheter after CABG operations was determined by retrospective analysis of the data on the checklist.

- **Content related validity**

Content validity is ensured by incorporating and using the literature review on this topic, by consulting experts in the field and through the development of knowledge tests. The questions of the questionnaire were constructed to cover the known content represented in the literature (Brink & Wood 1994:176). The evidence for the questionnaire and checklist was obtained from the literature, representatives of the relevant population and content experts (Burns & Grove 1997:331). The validity of the questionnaire and checklist was upheld after being reviewed. All the experts' interpretations concurred.

- **Predictive validity**

Predictive validity deals with outcomes. For instance, the researcher predicted that there will be a correlation between critical care nurses' knowledge of CVP and PA catheters and their preferences regarding CVP and PAWP measurements. This study will compare the knowledge level of critical care nurses and their preferences in practice. (Brink & Wood 1994:167.)

- **Reliability**

Reliability represents the consistency of measures obtained. The question is whether a particular technique that is applied repeatedly to the same object, will yield the same result each time (Babbie & Mouton 1998:119). Reliability is a basic characteristic of an instrument when the instrument provides accurate, stable and usable research data (Mateo & Kirchhoff 1999:263).

Reliability can be measured by the test-retest method. A researcher administers the same test on two occasions to a sample of individuals, and then compares the results obtained. Reliability can also be tested by the split-half method where items composing a test, are split into two groups and scored independently. However,
these methods could not be used for the purposes of this study due to the limited number of respondents and the limitations of the study (Polit & Hungler 1995: 412).

**Reliability was, however, ensured as follows:**

- The questionnaires were not handled, or in possession of persons other than the researcher, except when participants completed the questionnaires.
- Internal consistency refers to all the measurements techniques that are measuring the same concept. The questionnaire tested critical care nurses' knowledge regarding CVP and PA catheters after a CABG operation, as well as their preferences regarding CVP and PA measurements.
- Before implementing the questionnaire, nursing personnel did not receive structured information from nursing experts in the hospital (Brink & Wood 1994: 101).
- Clinical facilitators at the hospital were not directly involved with the study and no information regarding the study was given to critical care nurses prior to completion of the questionnaire.
- When implementing the questionnaire, the researcher ensured that no group discussion or sharing of knowledge or consultation of textbooks took place.
- The researcher double-checked the measurements of CVP and PAWP obtained from patient records and transferred onto checklists. Completion of the checklists took place in a quiet room.
- The results were processed with the assistance of a consultant statistician. The involvement of an external source in the study strengthened the validity and reliability of the study.

Reliability is further ensured by the advantages of a controlled environment. The participants of the study were at work, and time was limited. Therefore, no opportunity existed for participants to find literature and read up about the subject. The researcher ensured that each participant, completing the questionnaire, was given a small private space, and thus prevented persons from sharing knowledge.
3.5 OPERATIONALISATION OF DATA COLLECTION

3.5.1 DATA COLLECTION

- The questionnaire

After written permission was obtained from the hospital management, the personnel working in the surgical cardiothoracic unit, were approached by the researcher. The researcher explained the purpose of the research and presented the questionnaire. The personnel who had participated, were assured anonymity and confidentiality. The researcher selected an opportune day and time to implement the questionnaire. The survey did not disrupt activities at the ICU.

Forty registered nurses, working in the surgical cardiothoracic unit, were approached to participate in the study. Day and night personnel participated. Thirty-two volunteered to complete the questionnaire. Eight persons declined to participate.

The tearoom of the surgical cardiothoracic unit was used by participants for completion of the questionnaire. The researcher handed the questionnaire to participants only when the research study was being conducted (not beforehand) and collected the questionnaire as soon as they were completed, ensuring equal opportunity and circumstances.

- The checklist

Permission to use patient records was obtained from hospital management. Anonymity and confidentiality were assured to hospital management, as information collected from patient records would not refer to any individual CABG surgery patient.

Patient records of patients who had received CABG operations from July to August 2001, were requested from hospital administration. An opportune date and time, convenient to hospital administration, was arranged. The structured observation checklists were completed in the hospital boardroom. After receiving patient records, the information obtained from ICU flow charts was transferred to the designed checklists.
The researcher processed the required information (CVP and PAWP measurements obtained at ten different time intervals over a 36 hour period) in a specific format. Data of thirty patient records were included for a retrospective analysis.

A standardised checklist was used for documenting the data, obtained from the patient records. The researcher double-checked the transferred observations from patient records in a quiet room. The researcher returned the patient records, as soon as the required data were obtained.

### 3.5.2 Indicator of Adequate Competency

The scope of practice (SANC Regulation 2598, 1984) describes and explains to critical care nurses their professional-ethical responsibilities. To assist in the critical care patient’s recuperation, critical care nurses engage in the nursing process - a methodology through which critical nursing care is provided. The researcher expected of critical care nurses a normal standard of specialist knowledge, in order to provide safe and competent nursing care to the CABG surgery patient. The literature review confirms that the critical care nurse should have the ability (knowledge, skills, values) to manage CVP and PA catheters, to make a correct nursing diagnosis and to act accordingly. In the management of critically ill patients it is vital to make crucial decisions before a situation becomes critical (Scribante, Muller & Lipman 1995: 437-441).

Critical care nurses base their decisions regarding the management of CABG patients on the measurements of CVP and PA pressures. The researcher assumes a figure of 70% to be an indicator of adequate competency, and this percentage was confirmed by three critical care educators. A knowledge deficit can be a potential threat for the successful management of CABG surgery patients in the cardiothoracic ICU.

### 3.6 Data Analysis

Data analysis was done by means of descriptive statistics. The statistics were facilitated by an expert consultant statistician. The descriptive statistics describe,
organise and summarise the data of the research study, and include frequencies, percentages and descriptions of central tendency (Bailey 1991: 119).

3.7 SUMMARY

A questionnaire was used as an instrument to determine and describe critical care nurses' knowledge and preferences regarding the management of CVP and PA catheters after CABG operations in a private hospital in Gauteng. A convenience sample of critical care nurses working in a cardiothoracic ICU was chosen and quantitative research was done. A literature review established a conceptual framework and identified critical aspects which were integrated into the questionnaire. The validity and reliability of the survey were tested through the literature review, professional experts' critiques and a pilot study.

A retrospective analysis of patient records was done to determine the utilisation period of the PA catheter after a CABG operation. A checklist was used for data gathering from patient records. A convenience sample of thirty CABG patient records from a private cardiothoracic unit was used to compare the effectiveness of PA and CVP catheters after CABG operations.
CHAPTER 4

PRESENTATION AND DISCUSSION OF DATA

4.1 INTRODUCTION

The results of the study are presented and discussed in this chapter. Where possible, graphs and tables are used to illustrate and facilitate the significance of the results. The purpose of the questionnaire was to determine and describe critical care nurses' knowledge and preferences regarding PA and CVP catheter management after CABG operations. By analysing patient records retrospectively, the researcher aimed to determine the utilisation period of the PA catheter after CABG operations. This chapter is organised in the following manner:

- **Analysis and interpretation of questionnaire by:**
  - Identifying the sample, and demographic data of the respondents.
  - Discussing respondents' competency levels with regard to essential knowledge and individual performance.
  - Assessing the overall knowledge level of respondents.

- **Analysis of patient records by:**
  - Comparing obtained data.

In analysing the results of this study, the mean score (Mx) intends to describe the average score. The mean is the sum of the scores, divided by the number of scores being summed (Burns & Grove 1997:431). The median (Me) is that point on a numeric scale that falls above and below 50% of the cases. The median is an index of average position in a distribution of numbers (Polit & Hungler 1995: 449). The mode (Mo) is the numeric value that most frequently appears in a distribution of numbers (Polit & Hungler 1995: 448).
4.2 BIOGRAPHICAL DATA

4.2.1 QUALIFICATIONS OF RESPONDENTS

Critical care nurses who either have intensive care training, or intensive care experience, took part in the study. The level of qualifications varied. Some have obtained a degree or an advanced diploma in intensive care, while others have experience in intensive care nursing but no formal training. The qualification levels of the respondents are as follows:

- Degree in intensive care nursing = 1
- Diploma in intensive care nursing = 20
- Intensive care nursing experience = 11

For the purpose of this study the respondents were divided into two groups. Trained intensive care staff, that is critical care nurses with degrees or diplomas in intensive care, comprise the first group. The second group has intensive care nursing experience but no formal intensive care training. This division allows the researcher to compare the intensive care trained group to the group that has no formal training. A total of 32 (n=32) critical care nurses volunteered to participate in the study. (See Figure 4.1).

![Pie diagram illustrating respondents' qualifications](image)

**Figure 4.1** Pie diagram illustrating respondents' qualifications
4.2.2 STAFF APPOINTMENT

Critical care nurses on duty at the chosen cardiothoracic ICU, were approached by the researcher and considered eligible for the study. The participants were selected on a convenience sampling basis. The respondents include permanent staff, part-time staff and agency or session workers. The data are summarised in figure 4.2.

![Staff Appointment Diagram](image)

**Figure 4.2: Pie diagram illustrating staff appointment of respondents**

Full-time permanent staff compose the largest group of 24 (75%) respondents. These critical care nurses work on a full-time basis at the cardiothoracic ICU. The two other groups of participants are permanent part-time staff (9%) and agency or session staff (16%) - 3 and 5 respondents respectively.

Part-time staff work infrequently, but are connected with the same unit, nursing speciality and private hospital. It is, however, unlikely that agency staff will be committed to the same ICU, hospital or nursing speciality on a long-term basis. Students receiving post-basic ICU training, did not participate in the research study. Part-time and agency staff are assumed not to be a true reflection of reality, and are therefore grouped together.
4.3 COMPETENCY INDICATOR

Critical care nurses at the cardiothoracic ICU should have a standard level of skill, ability and knowledge to be competent and safe practitioners. These critical care nurses daily use PA and CVP catheters when caring for CABG patients. The researcher assumes a figure of 70% to be an indicator of adequate competency. This percentage was discussed and verified with three critical care nursing educators who supported the study. A knowledge deficit of more than 30% may increase the risk of complications for the critically ill patient in the cardiothoracic ICU.

Figure 4.3: Column graph reflecting average percentages attained for each question
Figure 4.3 shows the average percentage attained by respondents for each question in the questionnaire - with the exception of questions 14 to 17, and 21. These questions deal with critical care nurses' preferences in decision-making and reflect the respondents' opinions regarding their competency level in managing CVP and PA catheters after CABG operations, and are therefore not included in Figure 4.3.

Figure 4.3 thus illustrates the respondents' achievements regarding each question in the questionnaire, as measured in relation to the competency indicator. Respondents met the competency level of 70% to only 10 questions on the questionnaire. The aspects respondents were judged competent in, are covered by questions 2, 3, 4, 7, 11, 22, 24, 26, 30 and 33. Questions 2, 3, 4 and 7 concerned the principles of CVP and PA catheter measurements; questions 22, 30 and 33 referred to the complications of CVP and PA catheters and questions 11, 24 and 26 tested knowledge levels regarding waveforms and pressure measurements. The averages scored for these questions, are above the competency level.

4.3.1 KNOWLEDGE RELATED TO STAFF APPOINTMENT

Full-time permanent staff represent 75% of the respondents. Part-time and agency staff are grouped together and comprise 25% of respondents. Table 4.1 reflects the knowledge level of each group:

<table>
<thead>
<tr>
<th>STAFF APPOINTMENT</th>
<th>KNOWLEDGE LEVEL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mx</td>
</tr>
<tr>
<td>Permanent staff (24)</td>
<td>56%</td>
</tr>
<tr>
<td>Part-time and agency staff (8)</td>
<td>54%</td>
</tr>
</tbody>
</table>

The table shows that the 24 permanent staff participants (75%) form the highest scoring group. However, the permanent staff's average score of 56% does not represent an adequate knowledge level for critical care nurses who are daily working in cardiothoracic ICUs. The competency level should be at least 70%.
The second group, consisting of 3 part-time and 5 agency staff members (25%), has an average score of 54%. The knowledge level of this group is inadequate compared to the required competency level.

The low mean score attained by both groups, is a clear indication of inadequate knowledge and that further training or refreshment of relevant data, is needed.

### 4.3.2 QUALIFICATIONS AND KNOWLEDGE LEVEL

Table 4.2 shows the average percentages of the mean, median and mode scores of respondents when they are divided into two groups, according to qualifications obtained.

**Table 4.2 Knowledge related to qualifications**

<table>
<thead>
<tr>
<th>QUALIFICATIONS</th>
<th>KNOWLEDGE LEVEL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mx</td>
</tr>
<tr>
<td>Degree or diploma in intensive care nursing (21)</td>
<td>58%</td>
</tr>
<tr>
<td>Experience in intensive care nursing (11)</td>
<td>50%</td>
</tr>
</tbody>
</table>

The respondents who have a degree or diploma in intensive care nursing, achieved an average score of 58% in comparison with experienced critical care nurses (with no formal qualifications), who have scored an average of 50%. The difference of 8% between the two groups could indicate that qualified respondents are more competent. The difference in the median score between the two groups (10%) strengthens this indication.

### 4.3.3 CRITICAL CARE NURSES' PREFERENCES

The results of questions 14 to 17, and 21, give an indication of critical care nurses' preferences regarding CVP and PAWP measurements in decision-making and management of the CABG patient.
• Measurements' influences

According to the results of question 14, fifty percent (16) of critical care nurses are much influenced by CVP measurements when they have to make decisions about the management of a CABG patient. Fifty percent of respondents (16) indicated that they prefer PAWP measurements as the basis for decision-making regarding the CABG patient.

![Measurement Influences](image)

*Figure 4.4: Pie diagram illustrating influences of CVP and PAWP measurements in decision-making*

• Confidence in measurements

The results of question 15 give an indication of the confidence critical care nurses have about using CVP and PAWP measurements in clinical decision-making. The results are illustrated in figure 4.5. They indicate that 81% of critical care nurses (26) are confident about using both CVP and PAWP measurements in clinical decision-making. Nineteen percent of respondents (6) are confident about CVP measurements only, and prefer to base their decision-making not on a combination of CVP and PAWP measurements. None of the 32 participants selected PAWP measurements as the only data to base their decisions on.
• Critical care nurses' competency level regarding CVP measurements

The results of question 16, (figure 4.6), show that critical care nurses have different opinions about their abilities to obtain and interpret CVP measurements.

Figure 4.5: Pie diagram illustrating nurses' confidence in measurements

Figure 4.6 Pie diagram representing respondents' self-assessed competency levels regarding CVP data
All respondents (n=32) completed the question. The results show that only 12 respondents (38%) believe that they are very competent in obtaining and interpreting CVP measurements. Nineteen participants (59%) feel competent, 1 participant (3%) slightly competent while none has expressed no competence at all.

- Critical care nurses' opinions regarding PAWP measurements

The results of question 17, as illustrated in figure 4.7, reflect critical care nurses' opinions regarding their competency levels in obtaining and interpreting PAWP measurements.

![Pie diagram illustrating respondents' opinions about their competency levels with PAWP measurements](image)

*Figure 4.7: Pie diagram illustrating respondents' opinions about their competency levels with PAWP measurements*

Seven respondents (22%) said that they feel very competent in obtaining and interpreting PAWP measurements; 17 respondents (53%) feel competent, 4 participants (12%) slightly competent and 4 participants (12%) not competent at all. The inference is that critical care nurses have more confidence in, and feel more competent about CVP than PAWP measurements.
Table 4.3 compares the results of questions 16 and 17 which indicate that critical care nurses feel more confident and competent about CVP measurements.

**Table 4.3: Competency comparison of CVP and PAWP measurements**

<table>
<thead>
<tr>
<th>CRITICAL CARE NURSES</th>
<th>MEASUREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMPETENCY LEVEL</td>
<td>CVP</td>
</tr>
<tr>
<td>Very competent</td>
<td>38%</td>
</tr>
<tr>
<td>Competent</td>
<td>59%</td>
</tr>
<tr>
<td>Slightly competent</td>
<td>3%</td>
</tr>
<tr>
<td>Not competent at all</td>
<td>0%</td>
</tr>
</tbody>
</table>

The table shows that 97% of the respondents feel either competent, or very competent in obtaining and interpreting CVP measurements. By comparison, 75% of the respondents feel either competent or very competent about PAWP measurements. Twenty four percent of all respondents feel insecure when they have to obtain and interpret PAWP measurements. By contrast, only one respondent (3%) feels less competent about CVP measurements.

- **CABG patient management with or without a PA catheter**

The results of question 21, as illustrated in figure 4.8, indicate critical care nurses' opinions regarding CABG patient management and clinical decision-making with or without the introduction of a PA catheter.

All respondents (32) completed the question. Twenty seven (84%) of the respondents feel that it is possible to make clinical decisions and manage the CABG patient without the introduction of a PA catheter. By contrast, only 5 respondents (16%) are of the opinion that it is not possible to manage a CABG patient and make clinical decisions without a PA catheter.
Figure 4.8: *Pie diagram illustrating nurses' opinions about CABG patient management without a PA catheter*

4.4 KNOWLEDGE BASE

The majority of questions tested respondents' knowledge about the fundamental principles of pressure measurements, the obtainment and interpretation of measurements, the identification of pressure waveforms and complications associated with CVP and PA catheterisation. The results tabled below, only reflect the number of questions correctly answered and the corresponding percentages.

4.4.1 NORMAL VALUES OF MEASUREMENTS

The first question (question 1 in section B) was a matching type multiple-choice question and the column that needed to be matched, was numbered 1 to 4. The question tested respondents' knowledge about the normal values of pressure measurements. The results are summarised in table 4.4.
Table 4.4 Normal values of measurements

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>QUESTION ANSWERED CORRECTLY</th>
<th>% ANSWERED CORRECTLY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 1 dealt with the normal values of the following measurements:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• CVP</td>
<td>5</td>
<td>16%</td>
</tr>
<tr>
<td>• PAWP</td>
<td>7</td>
<td>22%</td>
</tr>
<tr>
<td>• Systolic PA pressure</td>
<td>25</td>
<td>78%</td>
</tr>
<tr>
<td>• Diastolic PA pressure</td>
<td>14</td>
<td>44%</td>
</tr>
</tbody>
</table>

The average percentage attained for this question, is 40%. When considered in the context of the competency indicator of 70%, 40% is far below the competency level. Critical care nurses working in cardiothoracic ICUs, should know the normal values of pressure measurements. The researcher assumes confusing literature to be one of the reasons for the low competency level in this section. Literature on CVP and PA pressures display different values for each measurement, and different normal values, for mmHg as well as cmH2O.

4.4.2 FUNDAMENTAL PRINCIPLES OF PRESSURE MEASUREMENTS

There are 7 questions in this section: 3, 4, 7, 9, 18, 23 and 32. The questions tested respondents' knowledge about the relationships between measurements and function, the phlebostatic axis, wedging time of the PA catheter, spontaneous wedging, and the PA catheter as a means of temporary cardiac pacing.

Question 4, relating to CVP measurements of the RA, attained the highest score of 93%. Questions on the principles of PA catheter measurements delivered an average score of 54%, and implicate the inadequate knowledge level of critical care nurses regarding PA catheter management. The average score is below the competency indicator of 70%. The following results are obtained and summarised in table 4.5.
Table 4.5  **Fundamental principles of pressure measurements**

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>QUESTIONS CORRECTLY ANSWERED</th>
<th>% ANSWERED CORRECTLY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 3 concerned PAWP, reflecting left ventricular function.</td>
<td>28</td>
<td>87%</td>
</tr>
<tr>
<td>Question 4 referred to CVP as direct measurement of the RA.</td>
<td>30</td>
<td>93%</td>
</tr>
<tr>
<td>Question 7 inquired about the inflation time of the PA balloon.</td>
<td>27</td>
<td>84%</td>
</tr>
<tr>
<td>Question 9 concerned the actions of critical care nurses during spontaneous wedging of the PA catheter.</td>
<td>16</td>
<td>51%</td>
</tr>
<tr>
<td>Question 18 referred to the PA catheter as a means of temporary cardiac pacing.</td>
<td>11</td>
<td>34%</td>
</tr>
<tr>
<td>Question 23 concerned the position of the PA catheter.</td>
<td>10</td>
<td>31%</td>
</tr>
<tr>
<td>Question 32 referred to the effect of PEEP on PAWP.</td>
<td>12</td>
<td>37%</td>
</tr>
</tbody>
</table>

### 4.4.3 INTERPRETATION OF PRESSURE RECORDINGS

The following nine questions dealt with the interpretation of pressure measurements, namely: 2, 6, 8, 13, 24, 26, 27, 28 and 29.

The total average score of 60% is below the competency level, indicated at 70%. The average score for questions 6, 8, 13, 27, 28 and 29 is 54%. These questions dealt with the interpretation and effects of an increased PAWP and/or CVP. The interpretation of these measurements seemed to pose a problem for participants. Questions 2 and 24, regarding CVP and other haemodynamic measurements, attained an average score of 90%, exceeding the competency indicator by 20%. It can be deduced that critical care nurses are more confident about CVP measurements. The results are summarised and presented in table 4.6.
<table>
<thead>
<tr>
<th>QUESTION</th>
<th>QUESTION ANSWERED CORRECTLY</th>
<th>% ANSWERED CORRECTLY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 2 concerned decision-making about a reduced CVP, blood pressure and renal output.</td>
<td>26</td>
<td>81%</td>
</tr>
<tr>
<td>Question 6 dealt with the implications of an increased PAWP.</td>
<td>16</td>
<td>50%</td>
</tr>
<tr>
<td>Question 8 referred to the interpretation of an elevated CVP.</td>
<td>20</td>
<td>62%</td>
</tr>
<tr>
<td>Question 13 dealt with the haemodynamics and nursing actions associated with hypovolaemia.</td>
<td>20</td>
<td>62%</td>
</tr>
<tr>
<td>Question 24 referred to the interpretation of CVP in conjunction with other haemodynamic measurements</td>
<td>32</td>
<td>100%</td>
</tr>
<tr>
<td>Question 26 dealt with the interpretation of a low CVP measurement.</td>
<td>29</td>
<td>90%</td>
</tr>
<tr>
<td>Question 27 referred to pulmonary oedema and pressure measurements.</td>
<td>20</td>
<td>62%</td>
</tr>
<tr>
<td>Question 28 concerned the increase in CVP on ventricular afterload.</td>
<td>17</td>
<td>53%</td>
</tr>
<tr>
<td>Question 29 referred to the effect of right ventricular failure on CVP and PAWP.</td>
<td>12</td>
<td>37%</td>
</tr>
</tbody>
</table>

4.4.4 OBTAINING ACCURATE MEASUREMENTS

Four questions were asked about the procedures to obtain accurate measurements, namely: 5, 19, 25 and 31. The results are summarised in table 4.7.
Table 4.7: Accurate measurements

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>QUESTIONS ANSWERED CORRECTLY</th>
<th>% ANSWERED CORRECTLY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 5 referred to the zero reference point for transducers.</td>
<td>21</td>
<td>65%</td>
</tr>
<tr>
<td>Question 19 dealt with zeroing of the pressure monitoring system.</td>
<td>21</td>
<td>65%</td>
</tr>
<tr>
<td>Question 25 referred to the correct position of the tip of the PA catheter.</td>
<td>11</td>
<td>34%</td>
</tr>
<tr>
<td>Question 31 concerned the position of the PA catheter in the lung.</td>
<td>18</td>
<td>56%</td>
</tr>
</tbody>
</table>

The average score for this section is below the 70% competency level. Respondents attained an average score of 65% for questions 5 and 19 regarding the transducer and pressure monitoring system. Questions 25 and 31 were poorly answered. Their average score of 45% is another indication that critical care nurses do not have adequate knowledge about the management of PA catheters.

4.4.5 COMPLICATIONS ASSOCIATED WITH CVP AND PA CATHETERS

Four questions dealt with this subject: 10, 22, 30 and 33. The results show a competency level above 70%. Only question 10, referring to complications of PA catheterisation, attained an average score of 65%; 5% below the competency indicator. It can be deduced that critical care nurses are aware of the complications associated with invasive catheters.

The results are summarised and presented in table 4.8.
Table 4.8: Complications of CVP and PA catheters

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>QUESTIONS ANSWERED CORRECTLY</th>
<th>% ANSWERED CORRECTLY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 10 referred to the identification of complications of PA catheterisation.</td>
<td>21</td>
<td>65%</td>
</tr>
<tr>
<td>Question 22 concerned the possible complications of a PA rupture.</td>
<td>27</td>
<td>84%</td>
</tr>
<tr>
<td>Question 30 inquired about the absence of a waveform as result of a ruptured PA catheter balloon.</td>
<td>23</td>
<td>74%</td>
</tr>
<tr>
<td>Question 33 dealt with sepsis as a complication of invasive catheters.</td>
<td>29</td>
<td>91%</td>
</tr>
</tbody>
</table>

4.4.6 IDENTIFICATION OF PRESSURE WAVEFORMS

Two questions were asked about the identification of pressure waveforms: 11 and 12. The results are presented in tables 4.9 and 4.10.

Table 4.9: Identification of PA waveforms during catheterisation

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>QUESTIONS ANSWERED CORRECTLY</th>
<th>% ANSWERED CORRECTLY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 11 concerned the identification of different waveforms during PA catheterisation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• PAWP</td>
<td>24</td>
<td>75%</td>
</tr>
<tr>
<td>• RA</td>
<td>25</td>
<td>78%</td>
</tr>
<tr>
<td>• PA</td>
<td>21</td>
<td>66%</td>
</tr>
<tr>
<td>• RV</td>
<td>25</td>
<td>78%</td>
</tr>
</tbody>
</table>
The average score of question 11 is 74%, indicating an adequate knowledge level concerning the identification of PA waveforms during catheterisation.

Table 4.10: PAWP waveform during ventilation

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>QUESTIONS ANSWERED CORRECTLY</th>
<th>% ANSWERED CORRECTLY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 12 concerned the description of the PAWP waveform during:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Spontaneous breathing.</td>
<td>18</td>
<td>56%</td>
</tr>
<tr>
<td>• Full ventilation.</td>
<td>18</td>
<td>56%</td>
</tr>
</tbody>
</table>

The average score for question 12 is 56%. The question referred to the interpretation of the PAWP waveform during spontaneous breathing and full ventilation. The low average score is an indication that critical care nurses do not have adequate knowledge to interpret the waveform and to make accurate measurements in clinical practice.

4.4.7 REMOVAL OF THE PA CATHETER

One question was asked: question 20. The results are summerised in table 4.11.

Table 4.11: Removal of PA catheter

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>QUESTIONS CORRECTLY ANSWERED</th>
<th>% ANSWERED CORRECTLY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 20 inquired about nursing actions when the PA catheter is removed.</td>
<td>20</td>
<td>62%</td>
</tr>
</tbody>
</table>

Once again the average score (62%) is below the competency indicator of 70%. It can be deduced that critical care nurses do not take proper action when the PA catheter is removed. As a result, complications may occur.
### 4.4.8 COMPARISON OF CVP AND PAWP QUESTION RESULTS

A comparison of CVP and PAWP question results gives an indication of critical care nurses' knowledge and competency levels regarding the management of CVP and PA catheters.

**Table 4.12: Comparison of CVP and PA question results**

<table>
<thead>
<tr>
<th></th>
<th>CVP</th>
<th></th>
<th>PA</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>QUESTION THEME</strong></td>
<td><strong>% ANSWERED</strong></td>
<td><strong>QUESTION THEME</strong></td>
<td><strong>% ANSWERED</strong></td>
<td><strong>CORRECTLY</strong></td>
</tr>
<tr>
<td>Normal values</td>
<td>16%</td>
<td>Normal values</td>
<td>48%</td>
<td></td>
</tr>
<tr>
<td>Decision-making</td>
<td>81%</td>
<td>PAWP reflecting</td>
<td>87%</td>
<td></td>
</tr>
<tr>
<td>with a reduced CVP</td>
<td></td>
<td>left ventricular</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>function</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CVP is a measurement</td>
<td>93%</td>
<td>Interpretation of an</td>
<td>50%</td>
<td></td>
</tr>
<tr>
<td>of RA</td>
<td></td>
<td>elevated PAWP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interpretation of an</td>
<td>62%</td>
<td>Inflation time of the</td>
<td>84%</td>
<td></td>
</tr>
<tr>
<td>elevated CVP</td>
<td></td>
<td>PA balloon</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CVP and other</td>
<td>100%</td>
<td>Action required</td>
<td>51%</td>
<td></td>
</tr>
<tr>
<td>measurements</td>
<td></td>
<td>during spontaneous</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>wedging</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interpretation of a</td>
<td>90%</td>
<td>Complications of</td>
<td>74%</td>
<td></td>
</tr>
<tr>
<td>low CVP</td>
<td></td>
<td>PA catheters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effect on afterload</td>
<td>53%</td>
<td>Identification of PA</td>
<td>69%</td>
<td></td>
</tr>
<tr>
<td>and increased CVP</td>
<td></td>
<td>and PAWP waveforms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identification of a</td>
<td>78%</td>
<td>Cardiac pacing</td>
<td>34%</td>
<td></td>
</tr>
<tr>
<td>CVP waveform</td>
<td></td>
<td>through PA catheter</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Removal of the PA</td>
<td>62%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>catheter</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Correct position of</td>
<td>40%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>the PA catheter</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>The effect of PEEP</td>
<td>37%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>on PAWP</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>AVERAGE RESULT OF CVP</strong></td>
<td><strong>72%</strong></td>
<td><strong>AVERAGE RESULT OF PA</strong></td>
<td><strong>58%</strong></td>
<td></td>
</tr>
<tr>
<td><strong>QUESTIONS</strong></td>
<td></td>
<td><strong>QUESTIONS</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Respondents' average score for questions about CVP catheter management is 72%. This is above the competency level of 70%. Their knowledge regarding PA catheter
management resulted in an average score of 58%. It indicates a knowledge deficit, as 58% is below the competency level. Critical care nurses have more knowledge about CVP measurements and CVP catheter management than PA catheter management and PAWP measurements. Critical care nurses prefer CVP measurements to PA catheter measurements and are more confident about CVP measurements than PA measurements. The general opinion is that they can manage a CABG patient without a PA catheter.

4.5 PATIENT RECORDS

The records of 30 patients who had received CABG operations, were obtained for retrospective analysis. A structured checklist was used to compare CVP and PAWP measurements, as documented on patient records, in order to determine the utilisation period of CVP and PA catheters after CABG operations. CVP and PAWP measurements, recorded at ten different time intervals over a period of 36 hours, were transferred to the checklist and analysed. The comparative results are as follows:

- The CVP catheter was used for 30 patients over a period of 36 hours. Regarding each patient ten different measurements were taken at corresponding intervals (details in chapter 3), which resulted in 300 measurements. The average duration of usage of the CVP catheter was 36 hours. No problems were recorded.

- The PA catheter was used simultaneously with the CVP catheter to measure the PAWP. The average duration of usage of the PA catheter for PAWP measurements was 17.4 hours. Reasons for the limited period of usage are absence of wedge patterns or waveforms and the removal of the PA catheter on doctors' instructions.

- The ratio of default of the PA catheter was 26.6%, with an average of two defaults per CABG patient record.

On a percentage basis, the CVP catheters were effective for a 100% of their utilisation period, while the PA catheters were effective for only 48% of the intended period of usage.
4.6 SUMMARY AND CONCLUSION

With respect to the questionnaire, only one participant (3%) exceeded the competency level of 70%. Permanent staff who comprised 75% of respondents, had a mean score of 56%; well below the competency level of 70%. Both the ICU trained and the ICU experienced group showed inadequate knowledge. The respondents' knowledge levels regarding CVP catheter management, the identification of PAWP waveforms during catheterisation and complications associated with PA and CVP catheters, were generally acceptable. However, the following knowledge-based sections indicated a knowledge deficit:

- Normal values of measurements.
- Fundamental principles of pressure measurements.
- Interpretation of pressure recordings.
- Obtainment of accurate measurements.
- Identification of pressure waveforms.
- Removal of the PA catheter.

The results about critical care nurses' preferences regarding the use of PA and CVP catheters indicate that they are less competent and confident about PAWP measurements than CVP measurements. Critical care nurses generally believe it is possible to manage a CABG patient without a PA catheter. The comparison of CVP and PA question results indicates that critical care nurses have adequate knowledge regarding CVP catheter management but inadequate knowledge about PA catheters and PAWP measurements. The average score for questions about CVP catheter management was 72%, compared to an average score of 58% for questions about PA catheter management. The retrospective analysis of patient records indicated that CVP catheter measurements were a 100% effective, as opposed to the 48% of PAWP measurements. The average utilisation period of the PA catheter after CABG operations was 17.4 hours. With respect to CVP measurements, no problems were documented.
CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter includes an overview of the research study with emphasis on reporting the results, drawing conclusions, discussing the limitations and making recommendations for further study.

The objectives of this research study are as follows:

- Determining critical care nurses' knowledge regarding the management of CVP and PA catheters.
- Describing the knowledge of critical care nurses regarding the interpretation of measurements and data obtained from CVP and PA catheters.
- Determining critical care nurses' data preferences regarding CVP and PAWP measurements in clinical decision-making after CABG operations.
- Determining the utilisation period of the PA catheter after CABG operations.
- Making recommendations about the use of PA and CVP catheters after CABG operations.

5.2 CONCLUSIONS

5.2.1 CRITICAL CARE NURSES' KNOWLEDGE BASE

The following conclusions are drawn from data obtained about critical care nurses' management and interpretation of PA and CVP catheters:

- Full-time permanent staff represent the majority of participants in the cardiothoracic unit, while part-time and agency staff represent minority groups.
• Permanent staff members attained a higher average score than part-time and agency staff. However, none of the groups reached the competency level of 70%.

• Most of the participants (66%) were ICU trained, and obtained a higher average score of 58%, in comparison with the ICU experienced personnel (34%) who obtained an average score of 50%. The difference in average of 8% between the two groups indicates that the qualified staff are more competent and safe practitioners.

• One participant who obtained a score of 74%, was found to be highly competent and knowledgeable. The participant is ICU trained.

• The knowledge level of critical care nurses regarding normal values of measurements, fundamental principles, interpretation of pressure recordings, obtainment of accurate measurements, the identification of pressure waveforms and the removal of the PA catheter, was below the competency level.

• The respondents’ knowledge level regarding complications associated with PA and CVP catheters, was above the competency level.

• A comparison between CVP and PA question results, indicated that critical care nurses have a greater understanding of CVP measurements than PA catheter measurements.

Conclusions drawn from this research study are of great concern to the researcher. Only one participant exceeded the required competency level of 70%. ICU trained critical care nurses attained an average score of 58%. These critical care nurses daily manage CABG surgery patients, and it seems as if critical care nurses are inadequately trained to interpret information from the PA catheter. PAWP measurements in the ICU are proved to be 15% inaccurate (Tobin 1998: 849). There are amongst interpreters considerable differences of opinion about the same wedge pressure waveform and its interpretation, even when the measurements are accurate (Marini & Wheeler 1997: 23).
5.2.2 THE PREFERENCES OF CRITICAL CARE NURSES

The following conclusions are drawn from the survey of respondents' preferences regarding the use of PA and CVP catheters after CABG operations:

- Fifty percent of the participants felt that CVP measurements had the greatest influence on their decision-making, while 50% of the participants were influenced by PAWP measurements in their decision-making and management of CABG patients.

- A large percentage of critical care nurses (81%) showed confidence in both CVP and PAWP measurements as a basis for clinical decision-making. Only 19% based their decisions on CVP measurements only, while none preferred PAWP measurements as the only data for decision-making.

- The respondents' competency levels in obtaining and interpreting CVP measurements, were as follows: 38% was highly competent, 59% competent, 3% slightly competent, and none was not competent at all.

- The respondents' competency in obtaining and interpreting PAWP measurements showed that 22% was very competent, 53% competent, 12% slightly competent and 12% not competent at all.

- The majority of the respondents (84%) felt that it is possible to make clinical decisions and manage CABG patients without a PA catheter.

The above-mentioned results indicate that critical care nurses do not feel safe and competent using the PA catheter, and that they prefer to base their decisions on CVP catheter measurements. According to respondents, it is possible to manage the CABG patient without a PA catheter. Several studies have reported that PA catheters affect therapy in only 50% of patients. PA catheters can aid in the management of critically ill patients when combined with other objective and clinical data (Beers & Berkow 1999: 1623).

The cardiovascular system of the critically ill patient can only be manipulated by fluids and drugs if the performance of the system is adequately monitored. Haemodynamic
measurements, such as CVP and PAWP, are important in order to establish a nursing diagnosis, to make decisions about appropriate actions or a nursing plan, and to monitor the response to that therapy (Oh 1997: 831). Critical care nursing requires an ability to deal with crucial situations immediately and with precision (Hudak et al. 1998: 3).

5.2.3 PA CATHETERS’ UTILISATION PERIOD

*CVP and PAWP measurements from patient records were compared through a retrospective analysis, and the conclusions are as follows:*

- According to 30 CABG patient records, CVP measurements (taken at ten different time intervals), were 100% effective during the utilisation period of 36 hours.
- By contrast, PAWP measurements were effective in only 48% of cases, as was estimated by an analysis of the same patient records and a corresponding trial period. The results were due to absence of waveforms, the inability to obtain measurements or the removal of the PA catheter, on doctors' instructions.
- The PA catheter's ratio of default was 26.6%, with an average of two defaults per patient record.

CVP catheters, as diagnostic and decision-making instruments, are more reliable and effective than PA catheters. When technical problems are experienced, such as damped tracings, poor dynamic response, and overinflation or incomplete wedging of the balloon, the prevalence of measurement errors can be as high as 33% (Tobin 1998: 849). Even with great care, these technical problems cannot be eliminated completely.

Interpretations of the complex relationships among vascular pressures and flows are often complicated by fluctuations in metabolism and respiratory pressures (Marini & Wheeler 1997: 19). Even when data and measurements are reliable, they may be interpreted differently by doctors and nurses (Ahrens & Shalom 2001: 26).
5.3 LIMITATIONS OF THE STUDY

The more important limitations of this study are as follows:

- A convenience sampling method was used; therefore results cannot be generalised.
- In some cases participants did not complete or answer all questions of the questionnaire.
- The study was done at the surgical cardiothoracic ICU of a private hospital in Gauteng. It is therefore contextual, and generalisations are bound.

5.4 RECOMMENDATIONS

Although the research cannot be generalised, recommendations are made that are specifically applicable to the nursing practice. Recommendations and suggestions for future studies are included.

5.4.1 NURSING PRACTICE

The following recommendations are made for the nursing practice:

- The implementation of a training programme for trained and experienced critical care nurses working in cardiothoracic ICUs, to ensure accurate measurements of PA and CVP catheters, as well as accurate recording and the correct interpretation of measurements.
- Ongoing in-service training for critical care nurses, to ensure a thorough knowledge of vascular anatomy, equipment and technical aspects of the procedures, as well as potential complications associated with PA and CVP catheter management.
- Regular workshops to improve the skills of critical care nurses and physicians, managing PA and CVP catheters.
The availability of training manuals and guidelines from training programmes, for all critical care nurses working in cardiothoracic ICUs. Critical care nurses must be enabled to consult these guidelines whenever necessary.

After completion of training programmes, re-evaluate critical care nurses and physicians' knowledge levels and practical skills regarding PA and CVP catheterisation and measurements. This will ensure improvement of knowledge and skills.

The implementation of a quality assurance plan by the unit manager and preceptors of the cardiothoracic unit to assure correct procedures, materials and measurement techniques and to obtain valid data and measurements.

5.4.2 NURSING RESEARCH

The following recommendations are made regarding nursing research:

- This study can be used as a pilot study for research on a larger scale.
- A comparative research study can be done regarding the management of PA and CVP catheters after CABG operations at the same unit, before and after implementation of a training programme, to determine whether the knowledge level of critical care nurses has improved.
- Further research could be done to:
  - Determine the relationship between CVP and PAWP, as an estimate of a CABG patient's fluid status.
  - Determine the reasons and factors contributing to the risk of default regarding PAWP measurements.
  - Investigate whether the PA catheter causes or decreases patient mortality and morbidity.
  - To investigate less invasive monitoring techniques that could supplant invasive haemodynamic monitoring.
  - Provide information on the risks, benefits and costs of intensive care monitoring.
  - Determine the financial implications of CVP and PA catheterisation.
According to sources in the private sector, the financial difference between a CVP (R800) and a PA catheter (R1268) is approximately R450. These amounts do not include the anaesthetist's fee. Considerable savings could be made for the patient and medical aid insurance funds, if the PA catheter is not used.

5.4.3 GENERAL

The following general recommendations are made:

- Reserve the use of the PA catheter for the very ill. There must be no doubt about the indications for PA catheterisation.
- The professional-ethical responsibilities of critical care nurses worldwide, are to seek maximal care at the lowest possible expense for patients.

Although invasive haemodynamic monitoring is very useful for the management of the CABG patient, it should not be performed simply because it is possible. A decision about invasive monitoring, like any other clinical decision, should be based on therapeutic objectives and careful weighing of the expected benefits against the costs and clinical risks. A monitor is useful for the management of some patients, but that does not justify its routine use for all patients.

5.5 SUMMARY

This research was done to determine critical care nurses' knowledge and preferences regarding invasive monitoring (PA and CVP catheters) after CABG operations, and to determine the utilisation period of the PA catheter after a CABG operation. Recommendations were formulated with regard to invasive monitoring.

A questionnaire was used to determine critical care nurses' knowledge and preferences regarding the management of PA and CVP catheters. One participant exceeded the competency level of 70%, while the average score for ICU trained critical care nurses
was 58%. The majority of critical care nurses - permanent and agency staff - showed insufficient knowledge. When managing a critically ill patient, it is sometimes vital to make crucial decisions before a crisis completely unfolds. Therefore critical care nurse should be able to base their clinical decisions on knowledge and skills (Thelan et al. 1988: 12).

A retrospective analysis of patient records determined the utilisation period of the PA catheter after CABG operations. The results showed that CVP measurements were 100% effective. PAWP measurements were only 48% effective due to absence of waveforms, wedge patterns or removal of the PA catheter.

The purpose of an ICU is to concentrate and focus resources, both material and human, on the assessment and management of critically ill patients. Invasive haemodynamic monitoring is indicated when it could facilitate the identification of an abnormality or assist in directing the management of the patient. Two patients receiving the same operation may not necessarily need the same monitoring (Tobin 1998: 33).

The nursing process offers an organised, systematic and problem-solving method to the critical care nurse, and incorporates a feedback loop that maintains quality control of its decision-making outputs (Thelan et al. 1998: 4). The quality of nursing care is dependent on the competence, knowledge and skills of critical care nurses. Critical care nurses have the responsibility and duty to remain professionally competent and knowledgeable (Hudak et al. 1998: 7). The critical care nurse also has the responsibility to act as the patient’s advocate. If a monitoring device does not contribute to better patient care and outcomes, it is the critical care nurse’s duty to act on behalf of the patient and point to the fact (Bucher & Melander 1999: 3).
BIBLIOGRAPHY


SANC see South African Nursing Council


ANNEXURE I

LETTER GRANTING PERMISSION TO CONDUCT RESEARCH

Mrs M. Ellis

RE: RESEARCH AT A PRIVATE HOSPITAL IN THE CARDIOTHORACIC INTENSIVE CARE UNIT.

1. You are hereby given permission to do your research at the hospital.
2. You may, however, not conduct your research in working hours.
3. The hospital may not be mentioned in the literature or publication.

The best of luck with your research and studies. If you need more information or assistance, please feel free to contact me.

Yours faithfully,

[Signature]

R. VAN WYK
CHIEF NURSING SERVICE MANAGER
ANNEXURE II

COVERING LETTER EXPLAINING PURPOSE OF RESEARCH

M. ELLIS
PO. BOX 5644
PRETORIA
0001

March 2, 2001

Dear Respondent,

RESEARCH: THE KNOWLEDGE OF THE CRITICAL CARE NURSE REGARDING CENTRAL VENOUS AND PULMONARY ARTERY CATHETER

I am in the process of completing the MA (CUR) degree at Unisa.

It would be appreciated if you would complete the attached questionnaire. All information will be kept strictly confidential. Permission for undertaking the research has been granted.

Thank you for your participation. The purpose of this research is to ensure and improve the quality and cost-effectiveness of nursing care.

MARGARET ELLIS
ANNEXURE III

CENTRAL VENOUS PRESSURE AND PULMONARY ARTERY PRESSURE QUESTIONNAIRE

Section A - Biographical Data

Read each item below and circle the letter of the correct response(s). More than one response may be correct.

<table>
<thead>
<tr>
<th></th>
<th>Your level of qualification or experience in intensive care nursing is:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>• Degree in intensive care nursing; A</td>
</tr>
<tr>
<td></td>
<td>• diploma in intensive care nursing; B</td>
</tr>
<tr>
<td></td>
<td>• intensive care nursing experience. C</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>As a staff member you are:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>• A permanent staff member; A</td>
</tr>
<tr>
<td></td>
<td>• a part-time staff member; B</td>
</tr>
<tr>
<td></td>
<td>• an agency (or session) worker; C</td>
</tr>
<tr>
<td></td>
<td>• full-time intensive care student. D</td>
</tr>
</tbody>
</table>
Section B - Knowledge Base

Multiple-choice questions: Select the appropriate answer or answers.

For each term in column A, select the correct normal value from column B.

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Central Venous Pressure (CVP)</td>
<td>A 06-15 mmHg</td>
</tr>
<tr>
<td>2</td>
<td>Pulmonary Artery Wedge Pressure (PAWP)</td>
<td>B 01-07 mmHg</td>
</tr>
<tr>
<td>3</td>
<td>Systolic pulmonary artery (PA) pressure</td>
<td>C 08-12 mmHg</td>
</tr>
<tr>
<td>4</td>
<td>Diastolic PA pressure</td>
<td>D 15-30 mmHg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>E 02-12 mmHg</td>
</tr>
</tbody>
</table>

1. 2. 3. 4.

Please select the most appropriate answer; more than one answer may be correct.

2. If the patient's CVP is < 10mmHg, blood pressure 90/70 mmHg and urine output < 30 ml/h, will you:
   - Start inotrope (Adrenaline); A
   - give fluids (bolus); B
   - give Lasix. C

3. The PAWP reflects:
   - Right ventricular function; A
   - left ventricular function. B
4  CVP is a direct measurement of the...
   • left atrium pressure;  A
   • right atrium pressure.  B

5  The phlebostatic axis is the standard zero reference point for the transducer. The phlebostatic axis is at...
   • 2nd intercostal space and mid-axillary line;  A
   • 4th intercostal space and anterior axillary line.  B

6  If the PAWP is > 20 mmHg, it can result in:
   • Pulmonary embolism;  A
   • pulmonary oedema;  B
   • cardiac tamponade;  C
   • cardiomyopathy.  D

7  The PA catheter should be wedged for less than...
   • 50 seconds;  A
   • 30 seconds;  B
   • 10 seconds.  C

8  An elevated CVP can be interpreted as...
   • congestive heart failure;  A
   • cardiac tamponade;  B
   • right atrial enlargement;  C
   • hypervolaemia.  D
9 When the PA catheter wedges spontaneously, make certain:

- that the balloon is fully deflated; A
- to pull back the catheter; B
- to flush the catheter. C

(18-19)

10 Complications of PA catheterisation include:

- Pleural effusion; A
- pulmonary infarction; B
- arrhythmias; C
- emboli; D
- endocarditis; E
- ventricular rupture. F

(20-22)

11 Place the letter from the waveform diagram below next to its correct description below the diagram:

[Diagram of PA waveforms]

- PAWP;
- RA;
- PA;
- RV.

(23-26)
Place the letters from the description on the correct places on the diagram.

PAWP waveform

- Measures the wedge pressure of a patient on full ventilation;  
  A
- measures the wedge pressure of a patient on spontaneous breathing.  
  B

(27-28) Mrs B had a CABG operation. She is admitted to the ICU. She weighs 100 kg and is still intubated.

### Vital data

<table>
<thead>
<tr>
<th>With admission:</th>
<th>After 2 hours:</th>
</tr>
</thead>
<tbody>
<tr>
<td>BP 110/60 mmHg</td>
<td>BP 90/50 mmHg</td>
</tr>
<tr>
<td>HR 98 pm</td>
<td>HR 120 pm</td>
</tr>
<tr>
<td>CVP 8mmHg</td>
<td>CVP 6mmHg</td>
</tr>
<tr>
<td>PAWP 10mmHg</td>
<td>PAWP Over wedged</td>
</tr>
<tr>
<td>PEEP 10 cmH₂O</td>
<td>PEEP 10 cmH₂O</td>
</tr>
</tbody>
</table>

13.1 With reference to the information above, which of the following conditions can be the cause of change in the vital data?

- Hypervolaemia;  
  A
- hypovolaemia;  
  B
- cardiogenic shock.  
  C
### 13.2 Which of the following nursing actions will you apply:

<table>
<thead>
<tr>
<th>Action</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start inotrope without administration of fluids (bolus);</td>
<td>A</td>
</tr>
<tr>
<td>only administration of fluids (bolus);</td>
<td>B</td>
</tr>
<tr>
<td>inotrope with fluids (bolus);</td>
<td>C</td>
</tr>
<tr>
<td>no action will be taken because wedge is not available;</td>
<td>D</td>
</tr>
<tr>
<td>observe only.</td>
<td>E</td>
</tr>
</tbody>
</table>

(29-30)

### 14 Which measurement has the greatest influence in your clinical decision-making in management of CABG patients?

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>CVP;</td>
<td>A</td>
</tr>
<tr>
<td>PAWP.</td>
<td>B</td>
</tr>
</tbody>
</table>

(31)

### 15 In my clinical decision-making I make my decisions as follows:

<table>
<thead>
<tr>
<th>Decision</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am confident about the CVP measurements and will base my decision-making only on the CVP data.</td>
<td>A</td>
</tr>
<tr>
<td>I am more confident if I base my decision-making on a combination of the CVP and PAWP measurements.</td>
<td>B</td>
</tr>
<tr>
<td>I am more confident about the PAWP measurements and will base my decision-making only on the PAWP data.</td>
<td>C</td>
</tr>
</tbody>
</table>

(32)

### 16 How competent are you, according to your own opinion, in the obtaining and interpretation of a CVP measurement?

<table>
<thead>
<tr>
<th>Competence</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very competent</td>
<td>A</td>
</tr>
<tr>
<td>Competent</td>
<td>B</td>
</tr>
<tr>
<td>Slightly competent</td>
<td>C</td>
</tr>
<tr>
<td>Not competent at all</td>
<td>D</td>
</tr>
</tbody>
</table>

(33)
### Question 17
How competent are you, according to your own opinion, in the obtaining and interpretation of a PAWP measurement?

- Very competent: A
- Competent: B
- Slightly competent: C
- Not competent at all: D

### True or False Questions:

#### Question 18
PA catheters may provide means for temporary cardiac pacing.

- true;  
- false.

#### Question 19
Zeroing of the pressure monitoring system is performed two to three times daily.

- true;  
- false.

#### Question 20
Before removing a PA catheter, balloon inflation must be confirmed.

- true;  
- false.

#### Question 21
CABG patient's management and clinical decisions are possible without PA catheter.

- true;  
- false.
<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>PA rupture, the most serious complication of catheterisation, is typically manifest by a sudden brisk of haemoptysis.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>true;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>false.</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Inflation of the balloon at the tip of the PA catheter obstructs blood flow and creates a static column of blood between the catheter tip and right atrium.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>true;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>false.</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>A sudden elevation in CVP reading must be interpreted in conjunction with other haemodynamic measurements.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>true;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>false.</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>The tip of the PA catheter should be positioned below the level of the left atrium to ensure an accurate PAWP.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>true;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>false.</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>A low CVP is not acceptable even when the renal output is &gt; 1ml/kg/h.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>true;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>false.</td>
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<td></td>
<td></td>
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<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Pulmonary oedema causes an increase in PAWP, and a decrease in CVP.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• true;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• false.</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>As CVP increases, cardiac output increases due to the increase in ventricular afterload.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• true;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• false.</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>Right ventricular failure causes an increase in CVP and PAWP.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• true;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• false.</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>Balloon rupture may be detected by an inability to obtain a PAWP waveform.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• true;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• false.</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>The tip of the PA catheter should be positioned in WEST zone 3 of the lung.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• true;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• false.</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>When PEEP is applied, the wedge pressure increases by 50%.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• true;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• false.</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>Sepsis is a complication of PA, as well as central venous catheterisation.</td>
<td></td>
</tr>
<tr>
<td>----</td>
<td>------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>•</td>
<td>true;</td>
<td></td>
</tr>
<tr>
<td>•</td>
<td>false.</td>
<td></td>
</tr>
</tbody>
</table>

THANK YOU FOR YOUR PARTICIPATION
ANNEXURE IV

LAYOUT OF THE STRUCTURED CHECKLIST

Data from ICU patient records were transferred to the checklist for retrospective analysis. This is an example of the checklist used for the documentation of five patient records.

<table>
<thead>
<tr>
<th>Pt no.</th>
<th>Time intervals: Hours</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>CVP (mmHg)</td>
</tr>
<tr>
<td></td>
<td>PAWP (mmHg)</td>
</tr>
<tr>
<td>2</td>
<td>CVP (mmHg)</td>
</tr>
<tr>
<td></td>
<td>PAWP (mmHg)</td>
</tr>
<tr>
<td>3</td>
<td>CVP (mmHg)</td>
</tr>
<tr>
<td></td>
<td>PAWP (mmHg)</td>
</tr>
<tr>
<td>4</td>
<td>CVP (mmHg)</td>
</tr>
<tr>
<td></td>
<td>PAWP (mmHg)</td>
</tr>
<tr>
<td>5</td>
<td>CVP (mmHg)</td>
</tr>
<tr>
<td></td>
<td>PAWP (mmHg)</td>
</tr>
</tbody>
</table>