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Assessment of agreement between invasive and non-invasive blood pressure measurements in critically ill patients

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CHAPTER ONE

OVERVIEW OF THE STUDY

1.0 INTRODUCTION

1.1. Background to the Study.

Critical care nurses play a pivotal role in monitoring and ensuring that a critically ill patient's hemodynamic status is optimized by continuously monitoring the blood pressure with the intention of ensuring adequate cardiac output and tissue perfusion (Araghi, Bander, & Guzman, 2006; Currey, Botti & Browne, 2003:32; Dekyser, Frazier, Friedman, Liehr & Thomas, 2002; Dubin, Mignini & Piacentini, 2006; McGhee & Bridges, 2002; Pinsky & Payen, 2005; Vivien, Griffiths & Philpot, 2002). Critical care nurses aim to achieve this goal by continuous vigilance and thorough understanding of monitoring systems as best practice for ensuring high quality standards of care.

In the Republic of South Africa (RSA), the South African Nursing Council (SANC) Scope of Professional Practice of a registered nurse (SANC, R2598 of 1991) stipulates that the nurse is responsible for the supervision over and maintenance of a supply of oxygen, fluid, electrolytes and acid base balance on a patient under his or her care. Scribante, Muller and Lipman (1995) in their interpretation of the Scope of Practice of the critical care nurse stated that monitoring of vital signs of the critically ill patient, both invasively and non invasively, comprise an important part of a critical care nurses' direct patient care function. These authors also stated that a critical care nurse should know the benefits and limitations of the invasive and non invasive monitoring techniques used in critical care units.

Traditionally, invasive blood pressure (IBP) was generally considered the gold standard in the critical care setting because of its accuracy and reliability (Prys-Roberts, 1981), and accessibility to laboratory blood sampling. This technique is also not without complications, for example thrombosis at the site of catheterization (McEllistrem, Toole, Keane, 1990), risk of partial or complete radial artery occlusion (Slogoff, Keats, Arlund, 1983), local and systemic infection (McEllistrem, Toole, Keane, 1990), and hemorrhage from the connection sites as well as being expensive and labour intensive.

Currently within critical care settings, given more recent advancements in technology, non invasive blood pressure (NIBP) monitoring systems are increasingly more widely used (Geven, van Genderingen, Lafeber et al., 1996; Saul, Klaus, Aristidou et al., 1996). Non invasive blood pressure monitors are easy to handle, effective in detecting and suppressing artifact and they are highly recommended for use in critical care patients (Papadopoulos, Mieke, Kuhn et al. 1996) for their simplicity, affordability and they have less complications than invasive blood pressure monitoring.

Within the critical care setting, both invasive and non invasive blood pressure measurement techniques are used simultaneously. Critical care nurses are often requested to make frequent adjustments to patient care (treatments) based on blood pressure measurements, such nurses are also accountable for the decisions they make in patient care (SANC, R387 of 1985). The question then arises as to whether these two techniques based on very different principles, can be used interchangeably and what then are the limits of agreement between these two different blood pressure measurement techniques.

A number of studies have indicated that there is a discrepancy in measurements between non invasive blood pressure and invasive blood pressure measurement techniques, and that this discrepancy can range from an over read of 13% to 21% in systolic measurements and under read of 5% to 27% in the diastolic blood pressure (Chelma, Denis, Teboul & Richard, 2008; Jeff, Clark, Lieh-Lai, Sarnoik & Mattoo, 2002); Umana, Ahmed, Fraley, Matthew & Alpert, 2006). A study by Gibbs, Larach and Derr (1991) showed that clinical significance of these discrepancies of >20 mmHg are clinically unacceptable.

Current clinical practice indicates that critical care nurses are inconsistent in their responses, showing different preferences for the invasive blood pressure techniques, whereas others indicated that they use the two techniques interchangeably depending on the higher measurements, irrespective of the technique (Chelma, Denis, Teboul & Richard, 2008). In one study of Liehr, Dedo, Laborde, Torres and Meiniger (1995) assessed the limits of agreement between the IBP and NIBP measurements using advanced statistical testing. These authors concluded that the two methods of blood pressure measurement are neither related nor alike and as such cannot be used interchangeably. Therefore this study intends to provide some clarity on the misunderstanding of the discrepancy between IBP and NIBP in the critical care unit in order to improve critical nursing care and promote safe nursing practice.

1.2 PROBLEM STATEMENT

Studies clearly indicate that there is a discrepancy in the blood pressure readings obtained from invasive and non invasive blood pressure techniques in critically ill patients (Bur, Hirschl, Herkener, Oschartz, Koffler, Woisetschlager, Laggner, 2000). The non invasive blood pressure technique tends to over read systolic blood pressure by 13% - 21% and under read diastolic blood pressure by 5 % - 27% in comparison to invasive blood pressure measurements (Runcie, Reeve, Reidy, Dougall, 1990; Stolt, Sjonell, Astrom & Hamson, 1993), whereas a discrepancy of > 20 mmHg between the two techniques are considered clinically unacceptable (Gibbs et al, 1991). However current clinical studies reveal that both IBP and NIBP techniques are used simultaneously in the critical care setting and often interchangeably for patients requiring haemodynamic monitoring (Araghi, et al, 2006; Denis, Chelma, et al, 2008; Mcghee & Bridges, 2002). The accurate measurement of blood pressure is particularly important for critically ill patients whose haemodynamic stability may be challenged during recovery from critical illness, like surgery or as a result of infection or sepsis.

Furthermore in a study by Liehr, et al (1995), the limits of agreement between IBP and NIBP measurements is that the methods are not related and not alike and as such cannot be used interchangeably. A literature survey shows that no studies to date have yet been conducted in South Africa to identify the limits of agreement between IBP and NIBP measurement techniques in critical care setting. For the critical care nurse in clinical practice, there are no guidelines or protocols on which blood pressure measurement technique is the preferred technique to guide their decision making such as in the titration

of inotropes. Often the discrepancy between the two BP measurements is ignored and the highest BP measurement obtained irrespective of the technique is used.

With accurate knowledge of the limits of agreement of BP readings obtained in critically ill patients using both IBP and NIBP measurement techniques, the confusion for the critical care nurses will be clarified to possibly influence the patient's outcome. In order to do this, the following research questions were formulated:

- Is there an agreement in terms of the information obtained between invasive blood pressure and non invasive blood pressure readings?
- What the difference is in terms of accuracy and sensitivity?
- What are the factors that affect accuracy of both techniques in the critical care unit?
- What are the reasons given for choice of invasive blood pressure or non invasive blood pressure techniques in monitoring blood pressures on a patient who is in the critical care unit?

1.3 PURPOSE OF THE STUDY

The purpose of this study was to describe and compare the two blood pressure measuring techniques, namely invasive and non invasive in order to assess the limits of agreement between the two readings obtained on patients in adult critical care units in a tertiary health care institution, to determine the difference in terms of accuracy and sensitivity, to describe the factors that affect the accuracy of both techniques in the critical care unit and to describe the reasons given by practitioners for the choice of blood pressure monitoring techniques in the critical care units.

1.4 RESEARCH OBJECTIVES

To meet the purpose of the study, the objectives of the study were:

- To establish whether there is a difference in terms of accuracy and sensitivity in the assessment of blood pressure using two different techniques of blood pressure monitoring.
- To determine what the difference is in terms of accuracy and sensitivity
- To describe the factors that affect accuracy of both techniques in the critical care unit
- To elicit the reasons given by clinical practitioners for choice of blood pressure monitoring technique in the critical care unit

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1.5 SIGNIFICANCE OF THE STUDY

Concerns are raised from a nursing perspective as to why the two techniques, invasive blood pressure and non invasive blood pressure measurements in the critical care units are used to measure the same clinical parameter (blood pressure). Pearson (1993) argues that although medical technology has saved many lives and improved the quality of lives even more; however the author also contends that it has also created new challenges and crisis for the nurses. Incorrect decision making may result in the inappropriate administration of fluids or inotropic support due to unreliable data and may lead to irreversible patient complication such as pulmonary edema, cardiac failure or loss of life. Accurate knowledge of the limits of agreement of blood pressure measurements is vital for critical care nurses accountability to ensure correct decisions are made in patient care.

1.6 RESEARCHER'S ASSUMPTIONS

Assumptions are statements that are taken for granted or are considered true even though they have not been empirically or scientifically tested (Silva, 1981). The study was based on the following assumptions.

1.6.1 Meta-theoretical Assumptions

Meta theoretical assumptions are non testable beliefs that are accepted to be true by the researcher .These Meta theoretical assumptions are related to four main constructs of nursing, namely person, environment, nursing and health. (Pitacco, Silvestro & Drigo, 2001:27).

The person

The person in this case refers to the critically ill patient in the critical care unit. The critical care patient is a person in a critical situation of life instability with precarious haemodynamic, physical and psychological balance, subject to continuous haemodynamic clinical/ care changes. (Pitacco, Silvestro & Drigo, 2001:27).

It is vitally important to the critical care nurse and entire team involved to ensure proper haemodynamic monitoring by allaying ambiguity and confusion regarding non invasive blood pressure and invasive blood pressure, in order to maintain appropriate perfusion of the major organs of the body and the entire system of the critically ill patient.

The environment

The environment in this case refers to the adult critical care unit in which critically ill patients are admitted. Healthy people may be able to control their environment but illness may interfere with their ability especially in critically ill unconscious patients who can't communicate their needs regarding their care.

Due to increase of modern medical technology in the critical care area especially in haemodynamic monitoring with many machines, cable, tubes, with the crying wolf of true or false alarms, pain, lights and excessive noise in the CCU's, which makes the environment unpleasant to critically ill patient for proper psychological and physical healing.

Much more effort is needed in reducing unnecessary alarms noise, reducing unnecessary medical monitoring equipment in the haemodynamic context, deciding which method should be used between NIBP and IBP methods. Making the environment conducive to quick and proper healing by re-orientating the patient, communicating, re-assuring, conforting, explaining the reason for different monitors and their alarms in order to allay stress, fear and anxiety that are generated by the CCU environment. Nurses must know about social customs and religious practices to assess danger and involving family in managing the problems emanating from the critical care environment and social changes.

Nursing

The critical care nurse has a unique responsibility by virtue of his Scope of Practice to help sick individuals which in this case is the critically ill patient in the attainment of their needs. In the CCU the variability of the nurse's hemodynamic decision making refers to differences in the acquisition, prioritization, and use of hemodynamic cues (NIBP or IBP); the selection and implementation of hemodynamic interventions and methods of process used in making the decisions. Hemodynamic monitoring and decisions are made by critical care nurses in dynamic environment where time and fiscal constrains are evident, some hemodynamic decision are reversible; others are not. (Currey et al., 2003:32).

With the proliferation of modern medical technology the critical care nurses must stay abreast of all the latest hemodynamic monitoring regarding NIBP and IBP in order to render appropriate nursing care with less ambiguity and confusion.

Health

Health is a quality of life, absence of illness, handicap or physical-psychological limitation; health, therefore, is being conceived as synonym of efficiency, vitality, and productivity. (Pitacco, et al., 2001:27). Health is basic to human functioning which can be promoted with adequate hemodynamic monitoring in ensuring good systemic and major organ perfusion; this can be achieved by enhancing and raising the awareness regarding the problems and challenges regarding hemodynamic monitoring (NIBP and IBP) through continuous training, education and workshops.

Preventing the patient from getting complications from poor hemodynamic management has far better reaching benefits than managing or treating the complications such as renal failure, cerebro-vascular accidents (CVAs), lungs problems, peripheral perfusion problems resulting in limb loss and many more.

Strengthening and continuous awareness, the education and training are crucial in upholding, promoting health and prevent suffering in the critical care area. It can't be acceptable to have the two conflicting parameters that are supposed to read one clinical parameter and yet show wide discrepancies. The researcher's assumption is that invasive blood pressure monitoring should be the gold standard to monitor cardiovascular system thus enabling the nurse in adjusting drug therapy, fluids and emergency intervention in the critical care unit.

1.6.2 Theoretical Assumptions

Definition of the terms for the purpose of this research refers to the operational definitions of terms used in the study

Critical care unit: A specifically designated area offering facilities for prevention, diagnosis and management of patients with more than one organ failure. For the purpose of this study critical care unit has been used to refer to the intensive care unit.
(Bersten, Soni & Oh, 2003)

Critical care nurse: A registered nurse who has undergone an accredited course in critical care nursing /intensive care nursing and who is registered with the South African Nursing Council (SANC). It may refer also to a registered nurse who has undergone an accredited basic training in general nursing and who is registered as general nurse with the South African Nursing Council (SANC) but is working in a critical care unit on permanent or part time basis. (Scribante, Muller, Lipman, 1995)

Mean Arterial Pressure (MAP): Mean arterial pressure refers to the mean pressure for tissue perfusion. It is obtained from the pressure in the aorta and major arteries during any given cardiac cycle :the formula for obtaining MAP is:

$$MAP = \frac{2\,(\text{diastolic BP}) + (\text{systolic BP})}{3}$$

(Chlochesy, Breu, Cardin, Wittaker, & Ruddy . 2000)

Patient diagnosis: For the purpose of this study, patient diagnosis refers to the medical and surgical specialization in the field of medicine and not the patient's specific diagnosis. (Chlochesy, Breu, Cardin, Wittaker, & Ruddy . 2000)

Level of illness severity: An assessment of patient illness severity a dependency on critical care providers as determined by the most marked abnormalities of twelve physiological variables, with additional weighting for pre existing chronic disease related to urgency of admission and age, using the acute physiological age and chronic health evaluation (APACHE II) Score (Knaus, Zimmerman, Wagner & Draper, 1981).

Assessment of agreement: For the purpose of this study, the assessment of agreement is defined as statistical terms, based on comparison between methods of clinical measurements namely : invasive and non invasive blood pressure, this will involve calculating the mean difference, the standard deviation of the differences (precision) between the invasive and non invasive blood pressure measurements and the limits of agreement. The reproducibility of the difference will be analyzed graphically using a linear progression model **(**Bland & Altman, 1986).

Invasive blood pressure measurement: Refers to a method of measuring blood pressure via a catheter or probe placed in the artery (only radial artery in this study) which is connected to

	the cardiac monitor via a biomedical transducer system and provides a continuous display of a waveform and systolic, diastolic and mean blood pressure measurements.(Bur, et al., 2003)
Non invasive blood pressure measurement:	Refers to a method of measuring blood pressure using an automated device consisting of an electronic monitor with a pressure sensor, a digital display and an upper arm cuff which provides an intermittent systolic, diastolic and mean blood pressure readings based on the oscillation methods at the predetermined time methods. (Kircheva & Krivoshiev, 2005 ; Kortokoff, 1990).

1.6.3. Methodological Assumptions

The researcher ascribes to the functional approach to nursing whereby nursing research is carried out to better the practice by giving prescriptions for actions (Botes 1991). In line with this author, the researcher views the functional approach to be the correct approach to nursing as a science because:

- It is practice orientated (the research problem was obtained after observing the trend in the performance of arterial invasive blood pressure and non invasive blood pressure simultaneously in critical care units).

- It advocates the involvement (the researcher observed and noted the problem to be a reality during practical experience while rotating through the different critical care units. During this period the researcher observed the trend of nursing practice with regard to the performance of arterial invasive and non invasive blood pressure monitoring techniques in critical care units).
- It accommodates basic characteristics of the nursing practice (characteristics of the nursing practice within the context of the critical care unit where the research was conducted were taken into consideration). These included attributes of the research field such as one to one patient care, accessibility and availability of invasive blood pressure set up and equipments that go along with it and the non invasive blood pressure machine with different cuff sizes. The qualification of the nurses in practice together with the current problem of having unqualified critical care nurses working in the critical care units, without forgetting the global phenomenon of critical care nurse shortages.

1.7 OVERVIEW OF THE RESEARCH METHODOLOGY

1.7.1 Research Design

In part one of the study, a non experimental, descriptive, comparative prospective two part study design was used to assess the limits of agreement between invasive and non invasive blood pressure measurements. Prior to the inception of the research, ethical clearance and permission to conduct the study were obtained from the participating hospital and the relevant university committees. The population consisted of the patients

admitted to the adult critical care units (n=5) of a large tertiary teaching hospital. Initially the sample was (n=100) but it was reduced to (n=80) patients, following the consultation with statistician from the Medical Research Council.

Non probability, purposive sampling method was used to select participants in part one of the study in order to assess the limit of agreement between the invasive and non invasive blood pressure monitoring as non probability, purposive sampling method involves conscious selection by the researcher of certain subjects or elements to include in study according to inclusion criteria (Burns & Grove, 2001)

In part two of the study fifty (n=50) clinical practitioners (Doctors and Nurses) were selected. Convenience sampling method was used in part two until the desired sample size was reached. In convenient sampling subjects are included in the study because they happened to be in the right place and the right time, available subjects are simply entered into the study until the desired sample size is reached (Burns & Grove, 2001)

1.7.2 Research Method

In part one of the study, a prospective record review of patients enabled the researcher to establish the patients who met the inclusion criteria. Hospital maintenance and service records with the direct observation by the researcher was the technique used to perform the reliability and the validity checks on blood pressure monitors and the blood pressure machines.

A pilot study was also carried out to refine the methodology of the research and the data collection instrument.

Data collection was based on the statistical methods of assessing agreement between two methods of clinical measurements as described by Bland and Altman (1986).

In part two of the study, a random sampling method was used by means of open-ended questionnaires which were handed out to clinical practionners who met all of the inclusion criteria.

1.8 VALIDITY AND RELIABILITY

Validity and reliability of the data collecting instrument was established by discussions with medical and critical care nursing specialists in the field as well as literature review on related studies.

Validity and reliability of the arterial invasive blood pressure monitors and non invasive blood pressure machines from which measurements were obtained was established by the inclusion of reliability and validity checks that were recorded by researcher.

1.9 SUMMARY

This chapter of the research report introduced the reader to the study. The problem statement, the research questions, the purpose, objectives and significance of the study were stated. Meta-theoretical assumptions including relevant definitions were also

described. In addition, overview of the research methodology, validity and reliability were provided.

The following chapters will include a review of the literature related to the topic under study, research design and research methods, data analysis and results and finally summary, discussion of results, conclusions, and recommendations will be given.