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2021
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CRITICAL CARE NURSES' KNOWLEDGE OF EVIDENCE – BASED GUIDELINES FOR THE MANAGEMENT OF CENTRAL VENOUS CATHETERS

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A research report submitted to the

Faculty of Health Sciences, University of the Witwatersrand, Johannesburg

in partial fulfilment of the requirements for the degree

of

Master of Science in Nursing

Johannesburg, 2021

DECLARATION

I, Rebaeng Gaonyatsege-Thankane, declare this research report as my own work. It is being submitted for the degree of MSc Nursing at the University of the Witwatersrand, Johannesburg. It has not previously been submitted for any degree or examination at this or any other university.

Signature: 

23rd day of November 2021

Protocol Number: M200623

DEDICATION

Above all, I dedicate this piece of my work to God the Almighty for giving strength to accomplish it.

To my kids, Palesa & Patel Gaonyatsege, my source of joy and pillars of strength.

A special dedication to my husband for the love, support, and encouragement through this journey. Thank you for allowing me to leave my kids and stay in a foreign country for 2 years and being the best dad to our kids at the same time playing the motherly role on my absence.

ACKNOWLEDGEMENT

To God, be the glory and praise. My sincere gratitude goes to the following people.

- My supervisors, Ms Herbert & Ms Engelbrecht for the supervision and assistance throughout my entire study.
- Dr Fikile Klaas for her continuous support, mentorship, and outstanding advice throughout my entire study years.
- Professor Schmollgruber for the support throughout my entire study period.
- Critical care nurses who dedicated their time to participate in my study despite the challenges they were facing at the time of my data collection period.
- Statistician from Wits Biostatistics office, Mr Innocent Maposa for his assistance with data analysis
- My mother-in-law, Kelebogile Thankane for the love and support you had for my kids on my absence, “Ke a leboga, le ka moso!”
- Lastly but not least, I would like to thank my husband, Mr Gaonyatsege Thankane for the continuous support and encouragement. You made my study journey bearable, thank you!

ABSTRACT

Purpose: The purpose of this study was to determine critical care nurses' evidence-based knowledge of management of central venous catheters in four intensive care units in a central hospital in Gauteng

Background: Central Line-Associated Bloodstream infections (CLABSI) are associated with high morbidity and high medical costs. Evidence-based guidelines for the prevention of CLABSI are available to assist in the proper care and maintenance of central venous catheters. However, these infections continue to emerge in the intensive care units. This may be due to the lack of evidence-based knowledge on the management of central venous catheters by critical care nurses. Prevention of CLABSI demands proper management of central venous catheters by knowledgeable and skilled staff. Hence there is a need to establish the baseline knowledge level of critical care nurses regarding the evidenced-based practice management of central venous catheters.

Methods: A quantitative, descriptive, non-experimental cross-sectional research design was used to meet the study objective. The total sample comprised of trained critical care nurses. Data was collected in four adult ICUs using a validated questionnaire developed by Esposito et al. (2017). TIBCO Statistica software version 14.0 was used for data analysis. Descriptive and inferential statistics were used to describe the data. Non-parametric statistical tests (Mann-Whitney U-test, Kruskal-Wallis test & Spearman's correlation coefficient) were used for comparison. Testing was done at P-value <0.05 for level of significance.

Results: A total of 94 questionnaires were distributed, and 80 were returned (response rate 85.1%). The overall median score in knowledge test was 81.8% and IQR was 72.7%-90.9%. 76.25% (n=61) scored above the competency mark of 70 with only 23.75% (n=19) scoring below 70. There was no significant difference between knowledge and qualifications. There was a positive moderate correlation (r=0.41) between age and knowledge and there was a weak correlation (r=0.29) between years of experience and knowledge.

Conclusion: The study concludes that critical care nurses had good baseline knowledge of the evidence-based guidelines for the management of CLABSI. However, there were areas where this can be improved. This high level of knowledge and the presence of CLABSI lead to the question

of whether this knowledge is being applied in real clinical setting and opens a path for further research in this regard.

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LIST OF ABBREVIATIONS

BCA	BEST CARE ALWAYS
CCN	CRITICAL CARE NURSE
CDC	CENTRE FOR DISEASE PREVENTION & CONTROL
CLABSI	CENTRAL LINE-ASSOCIATED BLOODSTREAM INFECTIONS
CVC	CENTRAL VENOUS CATHETER
EBP	EVIDENCE-BASED PRACTICE
ICU	INTENSIVE CARE UNIT
SANC	SOUTH AFRICAN NURSING COUNCIL
SASA	SOUTH AFRICAN SOCIETY OF ANAESTHEOLOGIST
WHO	WORLD HEALTH ORGANIZATION

CHAPTER 1

OVERVIEW OF THE STUDY

1.0 INTRODUCTION

This chapter will provide a summary of the study process such as the background of the study, problem statement, research question, objectives of the study and the significance of the study. The research methodology is briefly explained in relation to the research design, population and sample selection, ethical considerations pertaining to the study, data collection process and data analysis.

1.1 BACKGROUND OF THE STUDY

Central venous catheters are mostly used in intensive care units (ICUs) for administration of medication, total parental nutrition, blood administration, and hemodynamic monitoring (Blot *et al.* 2014). Due to its nature of invasiveness, these catheters are a risk to the already immunocompromised patient (Salama *et al*. 2016). Central venous catheters (CVC) predispose patients to nosocomial infections such as Central Line Associated-Bloodstream Infections (CLABSI), and they are more common in intensive care units (Blot *et al*. 2014).

The Center for Disease Control and Prevention (CDC) estimated a prevalence of 30 100 CLABSI infections in intensive care units and wards of the United States of America acute care facilities each year (Centre for Disease Control and Prevention, 2020). In 2019, a CLABSI rate of 4.1 per 1000 central days was reported by the International Nosocomial Infection Control Consortium as a surveillance data of 50 countries (Haddadin and Regunath, 2019). Both Gram Negative bacteria (*Klebsiella, Enterobacter, Pseudomonas, and Acinetobacter*) and Gram-Positive bacteria (*Coagulase-Negative Staphylococci, Enterococci and Staphylococcus Aureus*) were the cultured organisms in the above-mentioned study. In Africa, a study conducted in Egypt concluded a CLABSI rate of 6 cases per 1000 central line days. The identified causative organism was Gram Negative bacteria (*Enterobacter and Pseudomonas Aeruginosa*) (Malek *et al.* 2018). A study done in South Africa indicated a 7.67% prevalence rate of healthcare associated infections of which 0.92% are primary bloodstream infections (Nair *et al*. 2018).

CLABSI's are associated with high morbidity, high mortality, and prolonged hospitalization of a patient. This further attributes to high medical costs (Blot *et al.* 2014). The CDC National Health Safety Network reported CLABSI mortality rate to be 12-25% and medical costs estimated to be $70 696 per CLABSI case annually (Centre for Disease Control and Prevention, 2018). In 2018, an Egyptian study by Malek *et al.* (2018*)* recorded a mortality rate of 16.8% among cases with CLABSI during their study period. Best Care Always campaign (BCA) in South Africa estimated a 20% mortality rate by CLABSI (Best Care Always, 2019). CLABSI is also not only a burden to the healthcare system but is also a burden to the patient as well. The prolonged hospital stay by the patient can lead to possible loss of income and inability to provide for their family needs. The patient is also liable for paying the prolonged medical bill, even though they would have had loss of income (Nair *et al*. 2018).

To prevent these infections, guidelines have been published and implementation has been emphasized, (CDC, 2017; WHO 2017). As part of the implementation process, care bundles are used as a form of auditing compliance to guidelines to improve health care quality (Resar *et al*. 2012). Care bundles are evidence-based interventions, grouped together to address a similar clinical problem, and are designed to improve the patient outcome when implemented successfully (Wasserman and Messina 2018; Resar *et al.* 2012). The care bundles are composed from evidence-based guidelines that were developed by CDC to address the prevention of intravascular catheter related infections (CDC 2017). As part of the implementation process to reduce CLABSI in South Africa, the Best Care Always, (BCA) campaign was launched in 2009. The campaign introduced the use of the CLABSI care bundle in intensive care units (Richards *et al.* 2017).

Prevention of CLABSI demands proper management of central lines according to evidence-based guidelines by knowledgeable and skilled staff. Knowledge scores can be categorized as poor with percentage scores of 0-50%, average with percentage scores of 50%-71% and good with percentage scores of 71%-100% (Ntlhokoe, 2014). A 2018 Canadian study conducted by Raynak *et al.* (2018) reported an 'average' knowledge score of 67% by intensive care nurses regarding the guidelines and scores less than 50% were regarded as indicating a significant gap in basic knowledge. A study done in China showed that 10.7% nurses were not aware of the existence of the guidelines whereas 50.7% nurses were aware that guidelines are available even though they were not formally trained on them (Chen *et al.* 2015). An Italian study by Ferrara and Albano

(2018) reflected a 20.7% knowledge score by nurses and doctors. In the African context, studies conducted have described critical care nurses' evidence-based knowledge of management of central lines as "low" (Alkubati *et al*. 2015).

In their 2018 study, Ferrara and Albano (2018) emphasize that nurses need to have in-depth knowledge of the current issues and strategies related to central venous catheters, to be able to appropriately manage the central venous catheters (Ferrara and Albano 2018). Lack of evidenced-based knowledge was identified as one of the causes for non-compliance with the guidelines as it causes misconceptions about interventions which lead to imprecise decision making (Chen *et al.* 2015).

The level of evidence-based knowledge that nurses have, has a direct impact on the quality of the procedures that are performed, and, on the decisions, that are made at the patient's bedside (Anjanaku & Mutual, 2018). The latter statement is supported by work conducted as early as 2004, when Ghosh & Scott revealed that 'Nurses' knowledge provides the basis for daily decision-making in pursuit of quality patient care' (Anjanaku & Mutual, 2018). The study by Cranley, Jeffs, and Tourangeau highlighted the significance of nurse educational level as a determinant of mortality for hospitalized patients. The latter stated that "a 10% increase in the proportion of baccalaureate prepared nurses was associated with a 5% decrease in the likelihood of patient death" (Cranley, Jeffs, and Tourangeau 2006).

Critical care nurses play a vital role in the prevention of CLABSI as they are responsible for daily care and maintenance of central venous catheters (Tolbert 2019; Aydogdu & Akgun 2020). The insertion of central venous catheters is usually carried out by doctors; however as the patients' advocate, the critical care nurse must make sure that optimal catheter site is selected as well as ensuring that aseptic technique is maintained throughout the procedure. For daily care and maintenance, nurses must ensure that proper hand hygiene practices are followed because hands are mainly the mode of pathogen transmission. They are also responsible for catheter dressing changes, daily site assessments for signs of infection, intravenous tubing changes, disinfection of catheter hubs as well as daily patient bathing with chlorhexidine (Tolbert 2019). The above measures help to prevent infections and complications related to the central venous catheters. It cannot be underestimated that proper CVC care by the nurse can prevent the development of

CLABSI, however, this can be achieved if the nurse has adequate up-to-date knowledge on the current guidelines for CLABSI prevention.

In South Africa, Mer (2007) developed intravascular catheter-related guidelines for South Africa which aimed to prevent the development of central line associated blood stream infections (Mer 2007). Several other studies done by Mer followed which focused on intravascular catheter-related infections in relation to pathogenesis, diagnosis, treatment, and recommended strategies for preventing intravascular catheter-related infections (Mer 2012). However, even with recent studies conducted in South African ICUs, none have focused on the nurses' knowledge of evidence-based management of central venous catheters in adult intensive care units. It is with this view that the researcher seeks to determine critical care nurses evidenced-based knowledge of the management of central venous catheters. Therefore, there is limited data regarding the knowledge of critical care nurses in relation to the management of central venous catheters in South Africa.

1.2 PROBLEM STATEMENT

The presence of Central Line Associated-Bloodstream Infections in ICUs remains a concern, as these infections increases the morbidity and mortality rates in ICU patients. As a result, the patients encounter prolonged hospitalizations accompanied by an increase in medical costs. Daily care and maintenance of central venous catheters are primarily nurse-driven interventions, therefore proper care given by the nurse can have an impact on the development of CLABSI. To provide proper CVC care, adequate knowledge on the available current guidelines is of utmost important. Despite the availability of prevention measures in the form of guidelines, these infections continue to emerge in intensive care units. This may be related to critical care nurses' lack of evidence-based knowledge on the management of central venous catheters. No South African studies yet have been conducted to determine the critical care nurses' evidence-based knowledge of central venous catheters management. Therefore, this study's research question is.

- What is the critical care nurses' evidence-based knowledge of management of central venous catheters?

1.3 PURPOSE OF THE STUDY

The purpose of this study was to determine critical care nurses' evidence-based knowledge of management of central venous catheters in four intensive care units in a central hospital in Gauteng.

1.4 RESEARCH OBJECTIVES

The objective of the study was:

- To describe critical care nurses' evidence-based knowledge of central venous catheters in four intensive care units in a public hospital in Gauteng.

1.5 SIGNIFICANCE OF THE STUDY

Hospital-acquired infections such as CLABSIs are preventable when proper care and implementation strategies are in place. Prevention of CLABSI requires critical care nurses to be knowledgeable about evidence-based guidelines to enable them to manage central venous catheters as per guidelines. Nurses' knowledge can be the predictor of evidence-based practice. Successful implementation of evidence-based practice requires personnel with appropriate knowledge. The level of knowledge on evidence-based guidelines on the management of central venous catheters by critical care nurses may contribute to the compliance in practice. In turn if there is compliance in practice, quality care will then be rendered to the patient. The establishment of critical care nurses' knowledge level of evidenced-based management of central venous catheters is necessary in planning continuous professional development training sessions within the units as well as the revising existing continuous professional development programs.

1.6 RESEARCHER'S ASSUMPTIONS

1.6.1 Theoretical assumptions

The following theoretical assumptions will be explained based on their specificity to the field of intensive care nursing.

- Person

  Schmollgruber (2015) describes a person as a holistic being with body, mind and spirit who can make decisions and being able to adapt to real life situations (Schmollgruber 2015). In this study a person refers to the patient, critical care nurse and doctor. A critical care nurse needs to practice a holistic patient care approach when managing patients in ICU.

- Environment

  An environment refers to the circumstances or conditions which a person is surrounded with, which can influence a person's life, this can either be internal or external, (Cambridge dictionary, 2020). An internal environment refers to the person's response to an illness whereas an external environment refers to the surrounding in which a person works (Schmollgruber, 2015). The intensive care unit forms the environment for this study. It is an environment equipped with latest technology equipment used for monitoring, providing care, and treatment of patients with life threatening conditions (SANC, 2014). Central venous catheter management is necessary in this environment because most patients admitted have CVCs inserted for monitoring and treatment.

- Health

  Health refers to being physical, emotionally, and psychologically well without any signs and symptoms of a disease (WHO, 2020). For the current study, health refers to the ICU patients' holistic well-being. Having a central venous catheter in-situ enables ICU patients to obtain specialized treatment and management to achieve a state of complete well-being, therefore proper care, and maintenance of central venous catheters (CVCs) is critical to prevent CLABSI.

- Nursing

  Nursing involves care strategies that improves health, prevents disease, and managing those who are ill, disabled and dying people (WHO, 2020). In this study nursing relates

critical care nursing, which focuses on the care of patients admitted in intensive care units in collaboration with multidisciplinary team members on a continuum basis (SANC, 2014). Critical care nurses are regarded as advanced nurse practitioners who are skilled, competent, and knowledgeable in caring for the patient and family (SANC 2014). Guidelines are used to direct the implementation of CVC management to ensure prevention of CLABSI, therefore critical care nurses need to possess the skills, knowledge and competency related to central venous catheter management.

1.6.2 Theoretical assumptions

Theoretical assumptions are used to explain, describe, and comprehend the phenomena (De Vos *et al.* 2013). They are inclusive of concepts and operational definitions used in the study.

1.6.2.1 Operational definitions

The following definitions were used in this study:

- **Critical care nurse (CCN):** a registered nurse with additional qualification of advanced diploma or master's degree in critical care nursing and registered with the South African nursing council (South African Nursing Council, 2017). The same meaning is applied in this study.

- **Evidence-based guidelines:** these are recommended statements generated by quality research, clinical evidence and expertise that are intended to improve patient care (World Health Organization, 2017). For this study, evidence-based guidelines were recommended care strategies adopted from guidelines for the prevention of CLABSI (CDC 2017).

- **Central Line Associated-Bloodstream Infections (CLABSIs):** An infection caused by pathogens entering the bloodstream through a central line within 48 hours of having a central line in situ or removal and diagnosed based on a positive blood culture (CDC 2020). The same definition was used in this study.

- **Central venous catheter (CVC) or Central line:** it is an intravascular catheter that is inserted in one of the main blood vessels for the purpose of patient management to

administer medications, total parental nutrition, and fluids, withdraw blood and to monitor the patient's hemodynamic status (CDC 2020). The same meaning was used in this study.

- **Intensive care unit (ICU):** a unit within the hospital that is designed to admit patients with life threatening conditions for monitoring, care and treatment by nurse specialists using high technology equipment (SANC 2014). For this study, the selected ICUs were trauma, cardiothoracic, neurosurgical, and multidisciplinary.

- **Knowledge:** means having information and skills acquired through teaching, training, and experience (Cambridge Dictionary, 2020). In this study, knowledge refers all the information and skills the critical care nurses have about the recommendations of evidenced-based guidelines for preventing CLABSI.

- **Management:** this implies all interventions carried out during preparation of catheter insertion, the insertion process, maintenance until removal of a central venous catheter. The management of central venous catheter is based on recommended evidenced-based interventions from guidelines for the prevention of CLABSI (CDC 2017). Related to this study, management refers to nurse-driven interventions involved in catheter care and maintenance.

1.6.3 Methodological assumptions

Methodological assumptions describe the type and design of the study that the researcher intends to utilize. Methodological assumptions describe methods involved in the research process and the study design used (Grove, Burns & Gray 2013). In this study, a quantitative, descriptive, non-experimental research design was used to achieve the research objective. The study was conducted with the aim of describing critical care nurse's knowledge regarding the evidenced-based guidelines for the management of central venous catheters.

1.7 OVERVIEW OF THE RESEARCH METHODOLOGY

A descriptive, non-experimental, cross sectional research design was used in this study. Data was collected with the aim of determining the critical care nurses' knowledge concerning each item on the questionnaire about the management of central venous catheters to answer the research question.

The study was conducted in four adult intensive care units of one central hospital in Gauteng. The hospital has five adult intensive care units, but only four were chosen because they admit similar patients in terms of patient conditions and average length of hospitalizations. The four adult intensive care units that were used in the main study were Trauma Intensive Care Unit, Cardio-thoracic Intensive Care Unit, Neurosurgical Intensive Care Unit, and Multidisciplinary Intensive Care Unit. The fifth Intensive Care Unit known as the Acute Coronary Care unit was used in a pilot study to determine if the research questionnaire was suitable to be used for the South African context.

The study population included in this study was the critical care nurses (CCNs) who had a post graduate specialty (Master's degree/Diploma) in critical care nursing and registered with South African Nursing Council. The CCNs had to have a minimum of 6 months working experience in the intensive care unit and had to be currently working in one of the four selected intensive care units from October 2020 to January 2021. According to intensive care unit's duty rosters for February 2020 there were 94 critical care nurses working in these four adults intensive care units. The study participants were selected using a non-probability purposive sampling method. The total sample of ninety-four critical care nurses was used (N=94) in this study. Part one and two of the questionnaire developed by Esposito, Guillari and Angelillo (2017) was used to collect data. The questionnaire had five parts, the first part was about demographic data of the participants, the second part evaluated nurses' knowledge level regarding evidence-based practices for the prevention of CLABSI, the third part measured awareness about the effectiveness and usage of the guidelines, the fourth part recorded implementation practices done during catheter site management and the fifth part probed about where nurses get information about CLABSI, hence only part one and two of the questionnaire were included for the purpose of this study. Part three, four and five were excluded in this study as they addressed the practical management of the care. The original questionnaire was developed by Esposito, Guillari and Angelillo (2017). The

questionnaire was chosen because it was validated by experts prior to use in the main original study and had a cronbach alpha score of 0.765, indicating that the questionnaire was reliable. It was also previously used on a sample of 355 nurses in Italy to assess their knowledge on evidence-based practice (Esposito, Guillari & Angelillo 2017).

Ethical clearance was obtained from Human Research Ethics Committee of the University of Witwatersrand, and permission to conduct the study was obtained from the hospital authorities, Gauteng Department of health as well as operational managers in the intensive care units.

After permission was granted by relevant authorities, the questionnaire was taken to the selected ICUs by the researcher. A brief presentation of the study was done at the beginning of each shift to inform potential participants on the purpose of the research. The researcher distributed the questionnaires to the critical care nurses who volunteered to participate. Upon completion of the questionnaire, the participants posted the questionnaires in a sealed box. Permission was given from the University of Witwatersrand ethical committee in that a completed questionnaire meant the participant had consented to participate. The completed questionnaires were collected by the researcher each day for storage and locked in the nursing department in the Supervisor's office.

During data analysis, raw data was captured onto a Microsoft Excel spreadsheet. Thereafter the captured data was transferred onto a standard software package TIBCO STATISTICA version 14.0 for statistical analysis. Descriptive and inferential statistics were used to describe the data. Graphs and tables were used to present the data. A statistician from Post Graduate Support office in the University of Witwatersrand was approached to assist with data analysis.

1.8 RELIABILITY AND VALIDITY OF THE STUDY

To ensure the reliability of the study, an accurate presentation of data was obtained from the questionnaire, no data was manipulated, and this was checked by the supervisor and a statistician. To ensure consistency of the questionnaire and accuracy in recording of data, the researcher was the sole data collector and data was only accessible to the researcher and the supervisor. The questionnaire was self-administered. A validated questionnaire by Esposito, Guillari and Angelillo (2017) was used to collect data in this study, thereby ensuring validity of the study.

1.9 ETHICAL CONSIDERATIONS

The following ethical considerations were met before conducting the study.

- Ethical Clearance was obtained from Human Research Ethics Committee of University of Witwatersrand
- The permission to conduct the study was granted by Post Graduate Research committee of university of Witwatersrand.
- Permission to access the study site was obtained from Chief Executive Officer of the hospital as well as from nursing service manager and operational managers of the selected ICUs.
- The questionnaire was published as an open source therefore, permission was not asked to use the questionnaire.
- Participants were invited to participate in the study, and they were told participation was entirely voluntary.
- Names of the participants were not disclosed throughout the study period to ensure confidentiality and anonymity.
- Raw data was kept under lock and key and it was captured electronically and saved on a password protected computer, accessible only by the researcher and the supervisor.
- The critical care nurses were invited to participate, and they were handed information letters that explained the purpose of the study and procedures involved.
- By completing the questionnaire, it implied the participant had given consent to partake in the study and by leaving the questionnaire incomplete, it implied the participant has declined. Names were not written on the questionnaires.

1.10 OUTLINE OF THE STUDY

The outline of this study is as follows.

Chapter one: Overview of the study

Chapter two: Literature review

Chapter three: Research design and method

Chapter four: Data analysis and Results

Chapter five: Summary of the main findings, Limitations, recommendations, and Conclusions

1.11 SUMMARY

The chapter summarized the research process and the study outline. It highlighted the steps of the research process such as problem statement, summary of the literature pertaining to the problem statement, research question, research objectives, and significance of the study as well as the research methodology. Operational definitions were also defined. Ethical considerations were highlighted. The next chapter will focus on the literature review.

CHAPTER 2

LITERATURE REVIEW

2.0 INTRODUCTION

This chapter provides an overview of literature that is related to the study topic. Literature review describes information that is available on the topic under study as well as missing information on the topic, thereby enabling identification of gaps in the topic under study and the contribution of the present study to add knowledge in the area (Grove, Burns & Gray, 2013).

The literature review for this study will focus on an overview of the use of central venous catheters, an overview of Central Line Associated Bloodstream Infections, Evidenced-based guidelines for the prevention of CLABSI as well as critical care nurses' knowledge of evidenced-based practices in relation to management of central venous catheters to prevent CLABSI.

2.1 OVERVIEW OF CENTRAL VENOUS CATHETERS

A central venous catheter or a central line is inserted in one of the blood vessels in the body (CDC 2020). These catheters are used to offer prolonged venous access for infusions of medications, total parental nutrition, blood and blood products, fluid therapy, lipid, and fat emulsions as well as blood sampling in intensive care units (Blot *et al*. 2014).

Central venous catheters are routinely used in ICUs and are inserted in at least half of the intensive care unit patients; hence their importance cannot be underestimated (Mer 2012; Gnanarani, Venkatesan & Manikandan 2018). According to CDC estimates, 48% of ICU patients in the United States of America have a central venous catheter in situ, accounting to 15 million central venous catheter days each year (CDC 2017). A South African study by Lowman (2016) showed an increase in the central venous catheter utilization ratio of 0.52 in the year 2012 to 0.67 for the years 2013 and 2014 in ICUs, which is an indication of increased catheter utilization in ICUs of South Africa (Lowman, 2016).

Due to the nature of their invasiveness, CVCs predispose patients to Central Line-Associated Bloodstream Infections because they disrupt the skin integrity (Salama *et al*. 2015; Blot *et al.* 2014). A study by Mer (2012) reported that CVCs account for 90% of cases of CLABSI and serves as a risk factor for catheter-related infections in South Africa specifically (Mer 2012).

2.2 CENTRAL LINE ASSOCIATED BLOOODSTREAM INFECTIONS

Central Line-Associated Bloodstream Infection (CLABSI) is a bloodstream infection which is diagnosed based on laboratory findings of a positive blood culture (CDC 2020). Within 48 hours of having a central venous catheter in-situ, pathogens can enter the bloodstream either through the CVC incision site or the various parts that open in the CVC. The pathogens are also known to enter the bloodstream within 24 hours after the CVC has been removed (CDC 2020).

2.2.1 INCIDENCES

Based on surveillance data of fifty (N=50) countries, a CLABSI rate of 4.1 cases per 1000 central line days were reported by International Nosocomial Infection Control Consortium (INICC) (Haddadin and Regunath, 2019). On other reports, 80 000 cases of CLABSI were reported in the intensive care units of USA per year, which makes it to be the highest healthcare associated infection (CDC 2017). In Africa, a study conducted in Egypt concluded a CLABSI rate of 6 cases per 1000 central line days (Malek *et al.* 2018). In 2018 Nair *et al* in South Africa reported a total of 326 patients as a proportion of individuals with healthcare associated infections, accounting for a 7.67% prevalence rate of which 0.92% are primary bloodstream infections inclusive of CLABSI (Nair *et al.* 2018).

2.2.2 CAUSATIVE ORGANISMS

The causative organisms for CLABSI are gram negative, gram positive and candida species (Haddadin & Regunath, 2019). Gram positive organisms associated with CLABSI are *Coagulase-negative Staphylococci, Enterococci and Staphylococcus Aureus*, whereas the identified gram-

negative organisms are *Enterobacter, Klebsiella, Pseudomonas Aeruginosa and E. Coli* (Haddadin & Regunath, 2019; Malek *et al.* 2018; Nair *et al*. 2018; Lutwick *et al*. 2019). Lack of hand hygiene by nursing and medical personnel is known to lead to infections associated with *Pseudomonas Aeruginosa, Klebsiella and Acinetobacter* species (Mer 2012). These are healthcare associated infections. Hands are the source of infections therefore proper hand hygiene can prevent transfer of infections from one person to another thereby breaking the chain of infection. In this way, infections will not be introduced to catheter insertion sites. With proper hand hygiene, healthcare associated infections are preventable.

2.2.3 PATHOPHYSIOLOGY OF CLABSI INTO THE BLOODSTREAM

Pathogens enter the bloodstream through contaminated skin insertion sites, catheter hubs and infusates. This contamination can be due to patient's endogenous skin flora or exogenous poor infection practices (Mer 2012; Percival & Kite 2007). Usually within 24 hours of catheter insertion, proteins from the host (patient) coats both the internal and external surfaces of a catheter lumen and a fibrin sheath called biofilm forms (Percival & Kite 2007). This biofilm facilitates the adhesion of bacterial organisms and candida species both on the inside and external surfaces of a catheter. As a result, a complex structure known as biofilm-embedded bacteria is formed. The biofilm-embedded bacteria on the internal catheter surface detaches and become some sessile organisms that may become planktonic cells. These cells enter the patient's bloodstream and leads to bacteremia and possible septicemia (Mer 2012; Percival & Kite 2007).

The presence of biofilm around the catheter surfaces is a challenge during the use of antibiotics to treat bloodstream infections. The bactericidal properties of the antibiotics and the body' s immune response to infections is inhibited by the biofilm to penetrate and fight the bacterial organisms (Mer, 2012).

2.2.4 CLINICAL PRESENTATION

There is no standard clinical presentation for a patient with CLABSI, the onset of symptoms is based on the patient's condition (Lutwick *et al*. 2019). CLABSI is suspected in patients with CVCs

in situ and presenting with fever which cannot be explained or attributed to any cause (Lutwick *et al.* 2019). A patient may also present with inflammatory signs such as pain, swelling around the insertion site or there may be a exudates and redness on the catheter site (Haddadin & Regunath 2019). The above signs and symptoms alone do not conclude the presence of CLABSI, further laboratory investigations such as blood culture need to be done to confirm the presence of an infection arising from a CVC (Mer 2012; Lutwick *et al.* 2019). According to CDC (2020), CLABSI is suspected in anyone with a central venous catheter in situ for 2 days or 24 hours after removal of a central venous catheter and presenting with at least a fever of above 38'C, chills or hypotension.

2.2.5 RISK FACTORS FOR THE DEVELOPMENT OF CLABSI IN INTENSIVE CARE UNITS

Intensive care units admit critically ill patients with different medical conditions, which are already a burden to their immune systems. Patients having central venous catheters in-situ are predisposed to CLABSI and different risk factors play a role. These risk factors can be identified as either intrinsic or extrinsic. Intrinsic factors involve the patient's non-changeable characteristics whereas extrinsic factors are those associated with the care and maintenance of a CVC as well as the environment that the patient is receiving care in (The Joint Commission 2012).

According to the Joint Commission, the intrinsic risk factors are age and pre-existing medical conditions (diabetes, hypertension, and cancer). Based on the latter factors, the CLABSI rates were found to be increased in the younger generation as compared to the older generation. In this study, increased CLABSI rates were found in patients with pre-existing medical conditions, which is a consistent finding with the results of the study by Malek *et al*. 2018, who identified a statistically significant association between the development of CLABSI and underlying chronic conditions. In their study, a higher rate of CLABSI was recorded in patients with chronic heart conditions as compared to patients with no chronic conditions.

The extrinsic factors that cause a patient to be predisposed to CLABSI are patients with long duration of CVC use, patients with multiple CVCs and patients receiving Total Parental Nutrition (The Joint Commission 2012; Malek *et al.* 2018; Nair *et al.*2018; Haddadin & Regunath 2019). A

patient can have prolonged hospital stay without CVC in situ and as such this does not predispose him/her to CLABSI.

Haddadin and Regunath (2019) further reported catheter location, catheter site care, skills of the health care provider who inserts a CVC and insertion of a CVC during emergency conditions as other extrinsic risk factors for CLABSI. The use of femoral vein for catheter insertion has been identified to be associated with increased risk of CLABSI as compared to jugular and subclavian veins (Mer, 2012: Haddadin & Regunath 2019). The latter authors highlighted that improper catheter site care can be a source of infection and catheters placed during emergency situations predisposes to infections because aseptic techniques are not always adhered to (Haddadin & Regunath 2019).

The use of an open intravenous infusion system is also associated with the risk of CVC contamination, thereby predisposing the patient to catheter-related infections due to microbial entry through such openings (Lutwick *et al.* 2019). A central venous catheter with more hubs/ports is considered a risk factor for development of CLABSI because of multiple manipulations which can lead to contamination (Best Care Always 2019); The Joint Commission 2012).

2.2.6 DIAGNOSTIC PROCEDURES FOR CLABSI

To diagnose a CLABSI, the patient's presentation (Clinical aspect) and laboratory results are taken into consideration (Mer 2012). The clinical aspect of diagnosing a CLABSI is non-specific and involves suspicion of an infection according to patient' s presenting signs and symptoms, and then confirmed by laboratory results (Mer 2012). A blood culture is the main test that is done to confirm the diagnosis of a CLABSI (Mer 2012; Lutwick *et al.* 2019). Positive blood cultures from a CVC without another identified source of infection prompts the diagnosis of CLABSI (Lutwick *et al.* 2019). The diagnosis of CLABSI is confirmed when there is an identified organism from blood culture drawn from a CVC that has been in-situ for more than two days or 24 hours after removal of a CVC (CDC 2020). The blood samples must be collected from at least two separate blood draws either on the same or consecutive days (CDC 2020).

2.2.7 TREATMENT

Treatment for CLABSI with antibiotics is initiated immediately after blood is drawn for culture (Lutwick *et al.* 2019). A broad-spectrum antibiotic is advisable to be administered while awaiting culture results (Haddadin & Regunath 2019). According to Lutwick *et al* (2019), the most common broad-spectrum antibiotics used are vancomycin, carbapenem (meropenem), cephalosporin (cefepime) and extended spectrum penicillin (Tazocin) (Lutwick *et al.* 2019). Once blood culture results are received, treatment is adjusted accordingly based on the identified organism. It is advised to promptly remove the short-term CVC that has caused the CLABSI (Lutwick *et al.* 2019).

2.3 EVIDENCE-BASED PRACTICE IN NURSING CARE

Evidence-based practice (EBP) means implementation of proven clinical interventions that are derived from research findings, clinical expertise, and patient values (Stevens 2013; Jeffs *et al*. 2013).

Since its inception, EBP has proven to yield positive outcomes for patient care, healthcare system and individual nurses. Increased job satisfaction, individual empowerment and acquisition of clinical skills were identified as the outcomes of EBP in nurses (Chiwaula *et al.* 2018). These EBP outcomes serve as motivation for nurses to be the drivers of change in their practice environments. Hence, it is important that nurses are familiar and aware of the current evidence-based guidelines, so that they can continuously incorporate them into their nursing care. In this way, nurses will be at the forefront to lead the implementation process of evidence-based guidelines. EBP delivery encompasses patient-centered care, patient safety, and informed patient care, which can yield improved quality patient care and better patient outcomes (Mthiyane & Habedi 2018; Chiwaula *et al.* 2018). The delivery of quality patient care attributes to decreased health care costs due to the shortened length of hospital stay (Mthiyane & Habedi 2018).

Prevention of CLABSI in intensive care units requires the application of evidence-based practice. Nurses being one of the frontline health care providers in prevention of these infections need to be

up to date with new evidence-based guidelines. This is emphasized by Vollman, Lan and Schmollgruber (2015) who stated that nurses need to explore new and best evidence and incorporate it into their daily patient care, to improve patient care standards. These authors further indicated that the prevention of nosocomial infections is a patient safety measure (Vollman, Lan & Schmollgruber 2015). To improve care and prevent nosocomial infections, nurses need to go back to basics and make patient safety their paramount principle (Vollman, Lan & Schmollgruber, 2015).

The acquisition of evidenced-based knowledge in prevention strategies for CLABSI can enable CCNs to make clinically sound decisions and improve their clinical skills for better patient outcomes. Nurses are the front-liners for catheter care and maintenance. Each time a CVC is manipulated, or its dressing is changed, it is the responsibility of the nurse to ensure that effective infection control measures are adhered to. Nurses play a vital role in reducing the incidences of CLABSI hence their knowledge in evidenced-based guidelines for the prevention of CLABSI is key to a successful CLABSI prevention.

2.4 EVIDENCE-BASED GUIDELINES FOR THE PREVENTION OF CLABSI

Evidence-based guidelines were formed based on recommended interventions generated by quality research, clinical evidence and expertise and they were intended to improve patient care (World Health Organization, 2017). Guidelines for the prevention of Intravascular Catheter-Related Infections were composed by different health disciplines in 2011 and later reviewed in 2017. These guidelines were made to improve management of central venous catheters, consequently preventing catheter -related bloodstream infections (CDC, 2017).

The following paragraphs are the recommended interventions for the management of CVCs as per the “Guidelines for the prevention of intravascular-related Infections, 2011” which were updated in 2017.

2.4.1 Education, Training and Staffing

Every health care worker who is involved in the catheter care should be competent and have relevant skills, (CDC, 2017). Catheter care and maintenance requires the use of aseptic technique

skills because maintaining of sterility throughout the procedure is the cornerstone for infection control. The doctor who inserts the catheter should also possess the relevant skills for proper insertion. Although nurses do not insert the catheters, having knowledge and skills in insertion techniques will help them to be able to advocate for patients in their care if something is not done properly. Several studies have indicated regular staff education and training to be associated with improvement in the management of CVCs, as evidenced by reduction in CLABSI rates and improved CLABSI bundle compliance (Salama *et al.* 2016; Blot *et al.* 2014; Richard *et al*. 2017). Therefore, the importance of regular education and training is emphasized to keep up to date with current issues and skills related to CVC management.

Regarding staffing, a patient-nurse ratio of 1:1 is also recommended as it gives nurses enough time to holistically care for a patient (CDC, 2017). Lee *et al.* (2018) reports that when workers have enough workload that can be done in a stipulated time, they are more likely to take time to perform all the tasks but when the workload is excessive, they tend to forget steps and take shortcuts to accomplish their total work faster and within the expected time frame. An excessive workload is expected when there is shortage of nursing staffing. Care and maintenance of a central venous catheter needs enough time to be adequately performed. Therefore, a staffing ratio of 1:1 will allow a nurse to give sufficient time to the patient on his/her care, thereby enabling him/her to thoroughly assess the CVC insertion site, clean it aseptically and dress it. As per the Guidelines for intensive care in South Africa, there should always be one registered nurse with each patient all the time in ICUs for tertiary hospitals, (South African Society of Anesthesiologist (SASA) 2013).

2.4.2 Selection of catheter site

To minimize infections in patients, CDC suggests the use of the subclavian vein for catheter insertion in adults and femoral vein should not be used. The groin area is associated with higher bacterial colonization due to skin folds around it. Therefore, catheters placed in the femoral vein have increased colonization rates as compared to subclavian, and as such they predispose the patient to CLABSI (CDC, 2017). Insertion of central venous catheters should be done under the guidance of ultrasound to avoid many cannulation attempts.

Although nurses do not insert CVCs, it is important to know the recommended catheter site selection so that they are able to advocate for the patients and advice doctors accordingly before the insertion procedure begins.

2.4.3 Hand Hygiene and Aseptic Technique

It is recommended that hands should be washed before any contact with the insertion site and after contact with the insertion site using clean water and soap (CDC 2017). According to WHO 2009, improved hand hygiene can decrease healthcare associated infections rates, including CLABSI, coupled with reduction in the incidence of multidrug-resistant bacterial isolates and patient colonization (WHO 2009). The use of the 5 moments for hand hygiene in health care can be beneficial as a prevention measure for CLABSI during care of central venous catheters. The 5 moments of hand hygiene in healthcare includes washing hands before touching a patient, washing hands before a clean/aseptic procedure, washing hands after body fluid exposure, washing hands after touching a patient and washing hands after touching a patient surroundings (WHO 2009). Performing proper hand hygiene consistently is an important effective way a critical care nurse can do to prevent the development of CLABSI among the patient under his/her care. The critical care nurse must perform hand hygiene before and after assessment of insertion sites, manipulation of the line or ports and with dressing changes.

Maintenance of aseptic technique and donning of sterile gloves is mandatory during the catheter insertion (CDC 2017). Aseptic technique in emergency situations may not be always adhered to, as such, catheters placed under those situations should be replaced within 48 hours (CDC, 2017).

2.4.4 Skin Preparation

The skin should be cleaned with >0.5% chlorhexidine with alcohol solution when preparing for catheter insertion and when doing dressings on the insertion sites (CDC 2017). However, iodine or 70% alcohol preparation can also be used in case there is contraindication for chlorhexidine use. Lower rates of catheter colonization with infectious organisms were reported with the use of >0.5% chlorhexidine (CDC 2017). Cleansing of the catheter insertion sites prevents contamination

thereby reducing the risk of catheter colonization. Therefore, proper skin antisepsis may reduce development of CLABSI.

2.4.5 Catheter Site Dressing Regimens

The type of dressing used on the insertion site and the frequency of how it should be changed serve as one of the infection control measures for CLABSI. Transparent dressings (chlorhexidine-impregnated dressings), and sterile gauze dressings can be used to dress the catheter site (CDC 2017). The sterile gauze dressings are used on insertion sites that are bleeding, oozing and diaphoretic patients until the situation subsides (CDC 2017). This allows the gauze to absorb the blood and the fluids, thereby allowing the insertion site to dry. A dry insertion site reduces chances of skin colonization thereby further preventing the development of CLABSI.

The frequency for dressing changes is based on the dressing type as well as the status of the insertion site as per evidenced-based guidelines. It is advisable to change a damp dressing, a loosened dressing, and a dirty dressing immediately as these may contribute to bacterial colonization. Sterile gauze dressings should be changed every 2 days whereas transparent dressings should be changed on weekly basis (CDC, 2017). The transparent dressing allows the nurse to perform catheter site inspection to identify any infection signs.

2.4.6 Patient cleansing

Daily bathing of ICU patients using 2% chlorhexidine is recommended as it is associated with reduction in the rate of CLABSI (CDC, 2017). A study by Afonso, Blott K and Blott S (2016) indicated that daily chlorhexidine bath for the patient reduced the incidence of CLABSI. The reduction in CLABSI rates was due to chlorhexidine's ability to eradicate gram-positive skin commensals (Afonso, Blott k & Blott S 2016).

2.4.7 Replacement of CVCs

Critical care nurses play an important role in patients' advocacy, therefore they should have evidenced-based knowledge regarding how often to change the central venous catheters. The CDC does not recommend routine changing of central venous catheters and use of guidewires to prevent CLABSI, however guidewires may be used to replace non-working catheters in the absence of signs of infection (CDC 2017). Based on the above recommendation, the South African guidelines recommend CVCs to be changed every 14 days unless there is an indication, and the use of guidewires is not recommended (Mer 2007).

2.4.8 Replacements of Administration Sets

Changing of intravenous fluid administration sets routinely is associated with a decrease in the development of CLABSI (CDC 2017). The administration sets used for blood, blood products or fat emulsions should be changed within 24 hours of the infusion because these products enhance microbial growth. For propofol infusions, the administration sets should be changed every 12 hours or when the vial is changed (CDC, 2017). It is recommended to change administration sets for inotropes and antibiotics within 72 hours.

By being familiar with these evidence-based guidelines, critical care nurses will be in a better position to prevent CLABSI in the ICU settings.

2.4.9 Needleless Intravascular Catheter Systems

Needleless Intravascular catheter systems are the devices that connect to the end of the vascular catheters to enable catheter access without using needles (Mer 2012). Needles are only used during catheter insertion and then removed. These are also called needleless connectors and they include stopcocks used for injections of medications, blood sample collections and IV infusions (CDC 2017). If not properly handled, the needleless connectors impose a risk for microbial entry into the CVCs (Mer 2012). To minimize the risk, they should always be capped, and disinfected with chlorhexidine antiseptic prior to manipulation of the port. Sterile gloves should be used when accessing the port (CDC 2017). In ICUs, central venous catheters are frequently accessed to give medication and to take blood samplings, therefore this increases the risk of contamination and risk

of CLABSI. Critical care nurses must strictly adhere to infection prevention techniques such as cleaning the access port with antiseptic solution and wearing sterile gloves to minimize the risk of contamination in the needleless connectors. The connectors should be cleaned before and after using the CVC.

2.5 CRITICAL CARE NURSES' KNOWLEDGE OF EVIDENCED-BASED GUIDELINES FOR THE PREVENTION OF CLABSI

The prevention of Central Line-Associated Bloodstream Infections is vital in the intensive care units because patients who are admitted in these units are already immunocompromised and critically ill, therefore they cannot endure the additional burden brought by CLABSI. For effective CLABSI prevention, correct implementation, and compliance to evidenced-based guidelines by critical care nurses remain a corner stone (Wasserman & Messina 2018). To carry out this role diligently, critical care nurses should be knowledgeable about evidence-based guidelines and know the contents of such guideline.

The acquisition of current knowledge and skill is crucial for CCN as it can enable them to be clinically competent. Having knowledge about the current practices, empowers critical care nurses and boost their confidence when performing clinical skills, which can render competence thereby increasing the likelihood of compliance to practice. Although knowledge does not guarantee compliance, it is important for nurses to be knowledgeable about current practice as it can help them to make better clinical judgement based on proven knowledge rather than misconceptions (Chen *et al.* 2015).

Despite the availability of evidenced-based guidelines to manage central venous catheters in ICU settings, critical care nurses still lack knowledge to effectively manage central venous catheters to prevent CLABSI. This is evidenced by results from various studies that were conducted across the globe. In a study done by Bianco *et al*. (2013) nurse's evidenced-based knowledge in CLABSI reduction ranged from 43% to 72.9%. The level of knowledge was described as "lacking" on the frequency of changing administration sets after infusion of blood products and lipid emulsions as they had a knowledge score of 43% (Bianco *et al.* 2013). Ntlhokoe (2014) categorizes knowledge scores as poor (0-50%), average (51%-70%) and good (71%-100%), therefore based on these

categories, 43% depicted poor level of knowledge. Regarding skin cleansing for catheter insertion sites, hand hygiene, and the frequency of CVC change, the knowledge of nurses ranged from 63.9% to 72.9%. It is known that practices based on evidenced-based knowledge can yield better patient outcomes (Mthiyane & Habedi 2018).

In a cross-sectional study carried out in Chinese intensive care units, the nurses' knowledge score for updated guidelines for the prevention of CLABSI was described as "quite low" (Chen *et al*. 2015). Of all the nurses who participated in the latter study, none of them answered all the questions correctly. 10.7% of nurses were not aware of the guidelines and 50.7% knew about the guidelines though they did not receive training on them (Chen *et al.* 2015). Nurses who were trained on evidence-based guidelines scored higher marks than nurses who were not trained on the guidelines, which indicates that adequate knowledge on evidenced-based guidelines can lead to improved knowledge on prevention measures (Chen *et al.* 2015).

Chen *et al*. (2015) further reported that 3.5% nurses knew the frequency of changing blood and lipid infusions sets, 10.3% nurses knew the frequency of changing pressure transducers and tubing, 15.6% knew how often to change a catheter dressing and 18% knew that >0.5% chlorhexidine solution is used to disinfect insertion site. Chen *et al*. (2015) described these results as very low.

In an Egyptian study by Alkubati *et al.* (2015), the percentage of correct answers for critical care nurses ranged between 9.16% and 58.3%. The mean of the CCNs total knowledge about prevention of CLABSI was 32.72% and was labelled as "low" (Alkubati *et al*. 2015). In this study, critical care nurse knowledge scores were 58.3% for frequency of CVC changes, 10% correct for frequency of CVC dressing changes, 40.8% correct for the dressing type to be used on CVC and 9.16% for the knowledge on use of antibiotics and antiseptic ointments on the CVC insertion site (Alkubati *et al.* 2015). Dressing changes for central venous catheters are the nurse's responsibility, and as such, it is expected that nurses should have evidenced-based knowledge on the management of CVCs (Alkubati *et al*. 2015). Contrary to the above statement, this study showed nurses lacked evidenced-based knowledge on the frequency of central venous catheter dressing changes with only 10% of nurses having answered correctly (Alkubati *et al.* 2015).

Another Nigerian study by Ibrahim *et al.* (2017) reported an overall level of awareness of CLABSI bundle by ICU nurses as "low" (46%). Among the study participants, 61.1% reported that they

were unfamiliar with the central venous catheter bundle. It is an issue of concern that most critical care nurses in Nigeria are unfamiliar with CLABSI bundle because they are the frontline health care workers in the central venous catheter care and maintenance (Ibrahim *et al.* 2017). It requires skills and knowledge to be competent with a certain procedure.

Central Line-Associated Bloodstream Infections can be prevented through implementation of evidence-based strategies, and this can be achieved if nurses are trained and aware of such evidence-based strategies (Esposito *et al*. 2017). Critical nurses need to be empowered to take ownership of evidence-based practice so that they can be the drivers of change in intensive care units. By having knowledge of the evidence-based strategies, it can make them understand the need of putting such strategies into good practice. Empowered critical care nurses can bring positive results in the workplace thereby ensuring provision of high-quality care standards (Gnanarani, Venkatesan & Manikandan 2018).

2.6 BARRIERS TO COMPLIANCE TO EVIDENCE-BASED GUIDELINES

Proper implementation of guidelines for the prevention of Central Line-Associated Bloodstream Infections has proven to reduce CLABSI incidences and their effects on both the individual patient, family as well as the healthcare facility (Blot *et al.* 2014; Nair *et al.* 2018). However, non-compliance to these guidelines remains a challenge in the clinical care settings due to several factors which will be explained below.

2.6.1 Lack of a safety culture

A safety culture can be explained as an environment that is conducive to patient safety through commitment from senior leadership and health care workers at the patient's bedside (The Joint Commission, 2012). A conducive environment can bring staff motivation and commitment which are vital for optimum patient care.

Coetzee *et al.* (2013) defined a favorable practice environment as the environment with structured polices and guidelines in place that involves nurses, with adequate staff and resources to provide

care and a positive working relationship between the staff within a particular unit. Therefore, an unfavorable practice environment can lead to high levels of job dissatisfaction and burnout among nurses, which are a hinderance to quality of care and patient safety (Coetzee *et al.* 2013). By having a favorable practice environment in ICUs, critical care nurses will be able to provide best quality care possible which will render patient safety in the form of preventing CLABSI. According to Lee *et al*. (2018) high quality staff relationships are part of the requisites for positive practice environment that can ensure job satisfaction. These include trust, cooperation, and interpersonal relations among nursing staff. Staff with high quality relationships are willing to behave in ways that support colleagues and their task completion thereby enabling easy communication amongst themselves (Lee *et al.* 2018). Therefore, comfort in communication enables others to feel safe reminding others about practices and asking for help to perform them which can help in CLABSI bundle compliance.

2.6.2 Lack of available resources

Compliance to evidence-based practice requires availability of both human personnel and facility supplies (The Joint Commission, 2012). Studies have reported the lack of supplies such as hospital consumables as a hindrance factor for compliance to CLABSI prevention guidelines (Ibrahim *et al*. 2017; Aloush & Alsaraireh 2018). The availability of skilled health care providers is also important for CLABSI bundle compliance. Furuya *et al.* (2016) found that Infection Control and Prevention departments who were resourced with Infection Preventionists had lower CLABSI rates as compared to departments without Infection Preventionists. It is a challenge to prevent infections without adequate resources in the form of both personnel and hospital consumables such as chlorhexidine solutions, large sterile drapes, and chlorhexidine impregnated transparent dressings (The Joint Commission 2012).

2.6.3 Inadequate staffing

Nurses provide uninterrupted nursing care to patients daily, and as such, it is of utmost important to ensure that they are adequately staffed. A good nurse-to-patient ratio may enable nurses to have

adequate time to provide holistic, individualized care to patients, therefore nurse-to-patient staff ratio is a determinant factor in provision of quality nursing care (The Joint Commission, 2012). Shortage of staff increases risk of errors and injuries in patient care, including the development of Hospital Acquired Infections (The Joint Commission, 2012).

According to Aloush & Alsaraireh (2018) adequate staffing is associated with increased CLABSI bundle compliance. In this study, nurses with 1:1 patient ratio were more compliant to CLABSI guidelines as compared to their colleagues with high patient ratios. These results are in line with Lee *et al*. 2018 who found out that reasonable nurse workload was positively associated with maximal CLABSI bundle compliance. Lee *et al*. (2018) further stated that time is critical to perform a skill to its highest level, as such workload affects time and attention to compliance, which ultimately limits the degree to which staff comply to CLABSI guidelines.

In a study by Salama et al. (2016), low compliance to CVC insertion bundle was recorded during periods of shortages of nursing staff in ICU, as nurses were caring for more patients hence, they were not giving them full attention in the constraints of time.

2.6.4 The use of non-permanent staff (Floating nurses)

Floating means shifting from one nursing unit to any other, therefore, float nurses are non-permanent staff in the unit which are usually called when there is a shortage. According to the Joint Commission (2012) the use of float nurses is associated with increased rates of Health Care-associated Infections including CLABSIs. The Joint commission 2012 reported that the risk of developing CLABSIs was 2.6times greater in patients who were nursed by float nurses more than 60% of the time (The Joint Commission 2012). This implies that the longer a float nurse cares for a patient, the more that patient is likely to develop CLABSI. This was attributed to unfamiliarity with unit policies and guidelines and unawareness of evidence-based practices for that unit because these nurses come and go on regular basis (The Joint Commission, 2012).

2.6.5 Lack of education, training, experiences, and competence of staff

It is the nurses' role to care for central venous catheters, and as patients' advocates, to ensure that skilled personnel insert and manage these catheters. Therefore, nurses must understand the indications for use and potential complications imposed by central venous catheters. Nurses should be familiar with current practices of evidence-based recommendations to ensure proper management (the Joint Commission 2012).

Lack of knowledge guidelines for the prevention of CLABSI by nurses has been identified as one of the barriers for compliance to guidelines (Ibrahim *et al*. 2017; Chen *et al.* 2015; Raynak *et al.* 2018). In a descriptive cross-sectional study by Abuejheisheh *et al.* (2020) nurses' knowledge was found to be the predictor of evidence-based practice (Abuejheisheh *et al.* 2020). If nurses are knowledgeable of current evidence-based interventions, it may enhance nursing care provided yielding quality care and ensuring patient safety.

2.7 INTERVENTIONS TO IMPROVE ADHERENCE TO EVIDENCE-BASED GUIDELINES

Promotion, sustainability, and adherence to evidence-based guidelines can be endorsed through awareness raising, training and education of all healthcare workers who are involved in the central venous catheter management (Wasserman & Messina, 2018). Nurses need to have knowledge and practical experience/skill on evidence-based practice. It is important that nurses understand the impact CLABSI have on the patients as well as the healthcare system. With proper management of central venous catheters, CLABSI can be prevented, and this can be achieved if all nurses know and understand the prevention strategies surrounding them (Mer, 2007).

In a quasi-experimental study to assess the impact of Nursing Education on CLABSI rates, there was an improved CLABSI guideline compliance among nurses in ICU coupled with reduction of CLABSI rates in ICU following an educational program for hand hygiene (Acharya *et al.* 2019). The increase in CLABSI guideline compliance was attributed to an increase in knowledge among CCN post an educational program, which increased CCN's awareness of the current guidelines (Acharya *et al.* 2019).

According to Bianco *et al.* (2013) the presence of written policies and active formal training programs increase knowledge and practice in CLABSI prevention. The written policies serve as a reference and reminder to CCN of CLABSI guidelines to be followed in CVC management. Ferrara and Albano (2018) also emphasized the importance of having internal protocols about CVC management. They highlighted that the availability of internal protocols can serve as a predictor for knowledge of evidence-based recommendations. In this study, nurses who worked in units with internal protocols were more knowledgeable of the current evidence-based guidelines than nurses who were working in units without internal protocols (Ferrara & Albano, 2018). Knowledge can serve as a source of empowerment that can enable nurses to make clinically sound decisions in patient care.

Nurses' knowledge is the cornerstone for better nursing practice and patient outcomes. Gaining knowledge on the CVC care enhances nurses' practice thereby resulting in compliance to interventions and ultimately improved quality patient outcomes (Gnanarani, Venkatesan & Manikandan, 2018).

Prevention of Central line-associated Bloodstream Infections is the responsibility of any healthcare worker who is hands-on patient care. As front liners in patient care, critical care nurses should be accountable for complying with management of CVCs and ensure protocols are followed during their care. The unit managers should be accountable for monitoring compliance to guidelines (The Joint Commission, 2012). This practice can ensure that everyone is responsible for her/his own actions and can promote a successful implementation process.

Raising awareness about new evidence-based practice among critical nurses is the first step in empowering them with knowledge. This will ensure that everyone understands the current and up-to date information on the management of central venous catheters and on the incidence of CLABSI. Although knowledge of guidelines does not imply compliance, it cannot be underestimated because a critical care nurses can only practice and follow the protocols that they are aware of (Chen *et al*. 2015). The importance of having well-informed critical care nurses cannot be unrecognized. It takes competent, trained, and knowledgeable nurse to yield quality nursing care. Critical care nurses need to have current knowledge of evidence-based practice to enable them to identify areas they are lacking in. This may ensure that interventions that addresses the educational needs of the nurses are directed towards that area.

2.8 SUMMARY

The emergence of Central Line-Associated Bloodstream Infections in intensive care units remain a concern worldwide. These Infections complicate the already compromised body of a critically ill patient leading to prolonged hospitalization duration which further leads to increased medical costs on both the individual patient as well as the healthcare system. Other effects related to CLABSI include increased mortality. However, these infections are preventable. Guidelines for the prevention of CLABSI are available to direct the care and management of central venous catheters in ICUs. These guidelines bring evidence-based practice into the clinical care settings. Evidence-based practice involves the use of best available research findings and assists in making clinically sound decisions. Knowledge of guidelines for the prevention of CLABSI may have an impact on the implementation and compliance by the nurses. This study will focus on critical care nurses' knowledge of evidence-based guidelines for the management of central venous catheters.

This chapter summarized literature regarding critical care nurses' knowledge of evidence-based guidelines for the management of central venous catheters. Results and recommendations of previous studies were examined and highlighted.

The next chapter will discuss the research methods and design used in the study.

CHAPTER THREE

RESEARCH DESIGN AND METHODS

3.0 INTRODUCTION

This chapter describes the research design and methods used in this study. It elaborates more on the study design, setting, population, sampling methods used, data collection techniques, data analysis and ethical considerations of the study.

3.1 PURPOSE AND OBJECTIVES OF THE STUDY

The purpose of the study was to determine critical care nurses' evidence-based knowledge of management of central venous catheters in four intensive care units in a central hospital in Gauteng.

The objective of the study was.

- To describe critical care nurses evidenced-based knowledge of management of central venous catheters in four intensive care units in a central hospital in Gauteng.

3.2 RESEARCH DESIGN

Polit, Beck and Hungler (2001) describe a research design as a researcher's plan of answering the research question which involves describing how, when and where data is to be collected and analyzed. This plan needs to be customized to the study conducted to meet its aims and objectives (Grove, Burns & Gray 2013). The approaches and procedures for data collection, data analyses and data interpretation are clearly outlined and reflected in the study design (Grove, Burns & Gray 2013).

The research design used in this study was a quantitative, descriptive non-experimental cross-sectional design.

3.2.1 Quantitative research

Quantitative research is an organized process of acquiring an answer to a posed question (Polit, Beck & Hungler 2001). It focuses on the measurable and quantification of the phenomena, with data collected using planned procedures and a recognized instrument/questionnaire (Grove, Burns & Gray 2013). This research study was quantitative in nature as it aimed to determine and describe the level of critical care nurses' knowledge regarding evidence-based guidelines for the management of central venous catheters.

3.2.2 Descriptive design

A descriptive design entails extensive data collection on the phenomena to answer the research question with the aim of observing, describing, and documenting phenomena on its natural existence (Grove, Burns & Gray 2013). Through this design, new concepts are identified, existing concepts are described, and the gathered data is used as a representative sample of the population (Grove, Burns & Gray 2013). A descriptive design was used to describe critical care nurses' evidence-based knowledge of management of central venous catheters in this study. This design was chosen as suitable for this study as it described the current knowledge that the critical care nurses have without introduction of any interventions to form as a baseline data.

3.2.3 Non-experimental design

A non-experimental design is a design whereby data is collected without an influence on the study setting, the participants or the object under study, it aims to explore the occurrences of events and phenomena in their natural existence (De Vos *et al*. 2013). In this study, the researcher described the phenomena as it occurred naturally.

3.2.4 Cross-sectional design

Polit, Beck and Hungler (2001) describes a cross-sectional design as a tool whereby data is collected from multiple subjects during one data collection period. There is no follow-up of

subjects thereafter. In this study, data was collected from November 2020 till January 2021, and no follow ups were made thereafter.

3.3 RESEARCH SETTING

The research setting is the place where the study takes place, which can either be natural, partially controlled or highly controlled (Grove, Burns & Gray 2013). A natural setting means the environment is not changed/manipulated, a partially controlled setting describes an environment that is modified by the researcher and a highly controlled setting means an environment that is manmade for that study (Grove, Burns & Gray 2013). This study was conducted in a natural setting of four adult intensive care units in a central hospital in Gauteng province.

An intensive care unit is a unit within the hospital that is designed to admit patients with life threatening conditions for monitoring, care and treatment by nurse specialists using high technology equipment (SANC 2014). These are designated areas with advanced equipment and services to provide the highest level of patient care. Each ICU is staffed with a certain number of trained critical care nurses in accordance with the type of patients they receive, how critical the patients are as well as the level of care rendered in that ICU, (South African ICU guidelines 2012). SANC recommends a 1:1 nurse to patient ratio in ICUs (SANC, 2014).

The central hospital utilized in this study comprises of five adult intensive care units but only four) adult intensive care units were selected to be used in the main study. The selected units were the multidisciplinary, trauma, cardiothoracic and neurosurgical intensive care units. These Intensive care units were selected because they admit similar patients in terms of the severity of their illness and the length of stay of these critically ill patients. In these ICUs, the average bed capacity is between 8-12 beds and the nurse-to-patient ratio is one nurse to one patient (Schmollgruber 2015). The coronary care unit was only used for the pilot study to check if the questionnaire was suited for the South African environment. Coronary care nurses were not included in the main study as they have previous knowledge of the instrument, and therefore may change the score because they have been previously involved.

Almost every patient admitted in these ICUs has a central venous catheter in-situ for daily management. CCNs need to be aware of recent and upgraded evidence-based interventions in their area of specialty such as guidelines for the prevention of CLABSIs.

3.4 RESEARCH METHODS

Research methods refer to steps and procedures that are used to gather and analyze data in the study (Polit, Beck & Hungler 2001). The latter steps and procedures are described below.

3.4.1 Population

A population is a group of persons or objects with common characteristics that the researcher focuses on (De Vos *et al*. 2013).

The population for this study was critical care nurses who have a postgraduate diploma or master's degree in critical care nursing which has been registered by the South African Nursing Council. There was a total population of ninety-four trained critical care nurses and registered with South African Nursing Council within the 4 adult intensive care units, (N=94). This was obtained from staffing registers from the respective units in February 2020.

This population was selected based on being advanced nurse practitioners with a specialty in critical care nursing, thus it is believed they have in-depth, expert knowledge and additional skills in critical care (SANC, 2014). By having this knowledge, it is expected of them to be aware of the current evidence-based practices in ICUs, which includes evidence-based guidelines for the prevention of CLABSIs. These specialized ICU nurses are also regarded as the frontline healthcare workers due to their knowledge and expertise and as such they mentor, orientate and supervise other registered nurses without training.

3.4.2 Sample and sampling methods

A sample is defined as a portion or part of the population under study, whereas sampling is selecting part of the population which is used as a representation of the entire population (Polit, Beck & Hungler 2001). In this study, a non-probability purposive sampling method was used because only ICU nurses with specialty in critical care nursing were needed to be participants. In non-probability sampling, chances of inclusion in the sample are not known because the non-random methods are used to choose the sample (De Vos *et al.* 2013). Since there were ninety-four (N=94) critical care nurses in the selected ICUs, all these were used in the study as the study sample.

The inclusion criteria for this study were.

- All critical care nurses registered with South African Nursing Council with a post graduate qualification in critical care nursing (master's degree/diploma).
- All registered critical care nurses to have worked for more than 6 months in the central hospital in one of the 4 ICUs (Multidisciplinary, cardiothoracic, neurosurgery and trauma).

After completion of data collection, 80 critical care nurses who met the inclusion criteria responded to the questionnaires out of the entire population of 94 critical care nurses (N=94), making a total sample of 80 (n=80). The response rate was calculated as 85%.

3.5 Data collection

Data collection is collection of data using a tool to gatherer information from study participants (Grove, Burns & Gray 2013). In this study, data was gathered using a questionnaire as a data collecting tool.

3.5.1 Questionnaire

In this study, the original questionnaire developed by Esposito, Guillari and Angelillo (2017) was used. The original questionnaire was published as an open access article, therefore permission to use it was not requested.

Esposito, Guillari and Angelillo (2017) study aimed to assess knowledge, attitudes, and practices among nurses on the prevention of central line-associated infections and the original questionnaire consisted of 5 five parts. The first part was about demographic data of the participants, the second part assessed nurses' knowledge level regarding evidence-based practices for the prevention of CLABSI, the third part measured awareness about the effectiveness and usage of the guidelines and the fourth part recorded implementation of catheter care practices and the last part probed about where nurses get information about CLABSI. However only sections one and two of the questionnaire were included for the purpose of this study. Section three, four and five were excluded in this study as they addressed the practical management of the care.

For this study, only part one and two of the original questionnaire was used to answer the research question. Thus, the questionnaire for this study consisted of two sections namely section A and Section B (See Appendix A**).** Section A consists of the demographic data and professional characteristics of the participants. This includes age, qualification type, years of experience as well as ICU bed capacity. Section B consists of the knowledge assessment of evidence-based guidelines for the management of central venous catheters to prevent CLABSI and 11 strategies were assessed. The response options were "yes", "no" and "I do not know" to the above knowledge assessment.

3.5.2 Validity and reliability of the questionnaire

In their 2013 publication, Grove, Burns and Gray (2013*)* define validity as whether the research instrument measures what it is intended to measure. To assess for the original questionnaire's validity, a pilot testing was done to check for readability of the questionnaire, and it was further used on a study with a sample of 355 nurses in Italy (Esposito, Guillari & Angelillo 2017).

To ensure that the questionnaire was valid and applicable to the South African context, the questionnaire was assessed by 3 subject experts. The 3 subject experts were nurse specialists in intensive care units and nursing educators in the University of Witwatersrand. All the items of the questionnaire were found to be relevant to be included. The original questionnaire consisted of five parts, therefore, to ensure it is applicable to the study, it was modified to consist of only two

parts which was the section for demographic details of the participants and the section for assessing knowledge.

De Vos *et al.* (2013) define reliability as the extent to which a research instrument can yield consistent results if used on the same population at different point in times. To ensure consistency of the questionnaire and accuracy in recording of data, the researcher was the sole data collector, and the data was analyzed by a statistician.

3.5.3 Procedure

Ethical clearance to conduct this study was granted by the University of Witwatersrand Human Research Ethics Committee, see appendix C. To have access to the clinical site, permission was granted by the Hospital CEO as well as the Nursing Services Manager, see appendix D. Operational managers of the selected ICUs were also approached for permission to collect information. Upon receiving permissions from the above departments, the researcher went to the study settings to begin the process of data collection.

Critical care nurses were approached in their respective ICUs and invited to participate in the study. A brief presentation about the study was done at the beginning of a shift, where the researcher explained the purpose and procedures of the study to participants. Voluntary participation in the study was emphasized throughout the discussion. Information Sheets and questionnaires see appendix A & B were distributed to the CCNs who met the inclusion criteria, and they were encouraged to ask questions for clarifications. By completing the questionnaire, it meant the participant had given permission to be part of the study. Upon completion of the questionnaire, the participants posted them in a sealed envelope which was provided and put in a designed area in the units. The completed questionnaires were collected by the researcher the following day and were taken to secure a place for storage in the office of the supervisor in the nursing department behind closed doors. This was to give participants enough time to complete the questionnaires. Data collection ran for a period from November 2020 to January 2021.

3.7 Data analysis

Data analysis involves the process of transferring raw data into a statistical software package and using various descriptive statistics to convey this data (De Vos *et al*. 2013). The descriptive statistics describe characteristics of the sample and study variables and entails use of frequency distributions, mode, median, mean, range, and standard deviations (Grove, Burns & Gray 2013).

The raw data was captured onto a Microsoft Excel spreadsheet and data management carried out, after which it was transferred into a standard software package TIBCO STATISTICA version 14.0 for statistical analysis. Demographic data was described using descriptive statistics. Data was reported as percentages and frequency. Inferential statistics were used to describe total scores. Total scores for the questionnaires were further analyzed for statistical significance in relation to selected demographic data. Total scores were checked for distribution to decide on which statistical tests to use. Non-parametric statistical tests were used since the data was skewed. The following statistical tests were used.

- Kruskal-Wallis Anova test was used to compare knowledge scores of multiple independent variables such as age and years of experience.
- Mann-Whitney test was used to compare scores of 2 independent variables which were qualifications.
- Correlation between scores, age groups and years of experience was assessed using Spearman's rank correlation coefficient.

In this study, a biomedical statistician was consulted for assistance from Post Graduate Support office in the University of Witwatersrand to help with the data analysis process.

3.8 PILOT TESTING THE QUESTIONNAIRE

A pilot study is a small study which mimics the main study with the aim of assessing the feasibility of the main study (Grove, Burns & Gray. 2013). The modified questionnaire was pilot tested in the acute coronary care unit before commencement of the main study. The modified questionnaire included part one and two only as compared to the original questionnaire which had five parts (Parts1-5). There was no change made to the methodology, only parts 3, 4 and 5 of the original

questionnaire were omitted in order to answer the research question. There were four respondents (N=4) during the pilot testing process. Based on the results of the pilot testing, no changes were made to the questionnaire.

3.9 ETHICAL CONSIDERATIONS

These entails necessary steps to ensure that the researcher protects the human participants from any form of harm, ensure their dignity and privacy throughout the researcher process (Polit, Beck & Hungler 2001). Researchers need to take the following into consideration to safeguard the rights of the participants.

3.9.1 Permission to conduct research.

The study protocol was first presented to the department of nursing education at the University of the Witwatersrand, followed by the submission to the University Postgraduate committee for approval, see appendix E. After approval from the post graduate committee, an ethical clearance certificate was granted by the Human Research Ethics Committee of the university of Witwatersrand, see appendix C. Permission to commence the study at the central hospital was granted by the Hospital Chief Executive Officer, see appendix D. Upon receiving the above approvals, commencement for data collection started.

3.9.2 Permission to use the questionnaire.

The questionnaire was published as an open access article, therefore written permission to the author was not necessary.

3.9.3 Informed consent

Informed consent is defined as a process of informing a participant about the pro and cons of participating in a research study to assist participants to make an informed decision (Polit, Beck & Hungler 2001). The process involves highlighting the voluntary part of participating. In this study,

critical care nurses were given an information sheet which highlighted the study procedures as well as the aims of the study. The participants were informed of their right to volunteer in the study and as such they would not be penalized in any way for the refusal to participate. Potential risks and benefits for participation were explained.

3.9.4 Confidentiality

Confidentiality involves the managing of the information shared by the study participants in such a way that it cannot be shared without authorization (Grove, Burns & Gray 2013).

Completed questionnaires were posted in envelopes which were placed in a neutral, designated position in the various ICUs. Collected questionnaires were locked in the supervisor' s office and only accessible to the researcher and the supervisors. Raw data was captured and was password protected for computer access and only the researcher and the supervisors knew the access code. This was done to ensure the participants' confidentiality.

3.9.5 Anonymity

Anonymity is when the data collected cannot be linked to any participant's identity (Grove, Burns & Gray 2013). The questionnaires did not bear any participants' names and questionnaires were coded using numbers.

3.10 VALIDITY AND RELIABILITY OF THE STUDY

A validated questionnaire was used in this study. The questionnaire was reviewed by subject experts, and it was further pilot tested in the coronary care unit. To ensure reliability of the study, the researcher was the sole data collector. Data was verified by a biomedical statistician.

3.11 SUMMARY

This chapter described the research methodology and ethical considerations used in this study. An in-depth overview of the study procedure as well as the research questionnaire was highlighted.

The next chapter focuses on data analysis and research results.

CHAPTER 4: DATA ANALYSIS AND RESULTS

4.0 INTRODUCTION

This chapter describes the data analysis and results of the study. The study was descriptive, non-experimental, and quantitative in nature. The population for the study was trained critical care nurses working in ICUs of a central hospital in Gauteng. At the end of data collection period, eighty questionnaires were returned, making a sample size of eighty (n=80). This was reached through a purposive sampling. A questionnaire (**see appendix A**) was used as a data collecting tool. Tables and graphs were used for data presentation whereas descriptive and inferential statistics were used to describe the data. Non-parametric statistical tests were used for comparison of data with testing was done at P-value <0.05 for level of significance (p-value<0.05).

4.1 RESULTS AND FINDINGS

4.1.1 DESCRIPTIVE RESULTS

The descriptive results were described as the response rate, biographic and workplace data as well as knowledge assessment results.

4.1.1.1 Response rate

Data collection took place over a period of three months from November 2020 to January 2021. A total of eighty (80) questionnaires were returned out of an expected population of ninety-four (N=94), making a response rate of 85.1% which is a satisfactory response rate to represent the entire population. According to Fincham (2008), response rates of 60% should be the goal of every research, however if the study intends to represent the entire population in the country, a response rate of 80% or more should be expected.

4.1.1.2 Biographical data & workplace data

Section A of the questionnaire contained the participants demographic data such as age of participants, qualification level, years of experience and number of ICU beds where they are working, see Appendix A. The results are summarized in the following table 4.1.

TABLE 4.1 Demographic data of the participants

Item	Variables	Frequency	Percentage
A1	**Age**		
	20 – 29yrs	**7**	**8.8%**
	30 – 39yrs	**13**	**16.3%**
	40 – 49yrs	**29**	**36.3%**
	50 – 59yrs	**25**	**31.3%**
	60 – 69yrs	**6**	**7.5%**
A2	**Highest nursing qualification**		
	Diploma in Critical Care	**73**	**91.3%**
	MSc Nursing (Critical Care)	**7**	**8.8%**
A3	**Years of ICU Experience**		
	6 – 11mnths	**1**	**1.3%**
	1 – 5yrs	**27**	**33.8%**
	6 – 10yrs	**20**	**25.0%**
	>10yrs	**32**	**40.0%**
A4	**Number of ICU Beds**		
	<8 beds	**10**	**12.5%**
	8 – 15 beds	**62**	**77.5%**
	>15 beds	**8**	**10.0%**

Out of a total population of 80 (n=80), the largest group of participants were aged between 40-49 years with 36.3% (n=29), followed by age group of 50-59 years with 31.3% (n=25). The smallest group was aged 60 years and above with a 7.5% (n=6). The following figure displays these results.

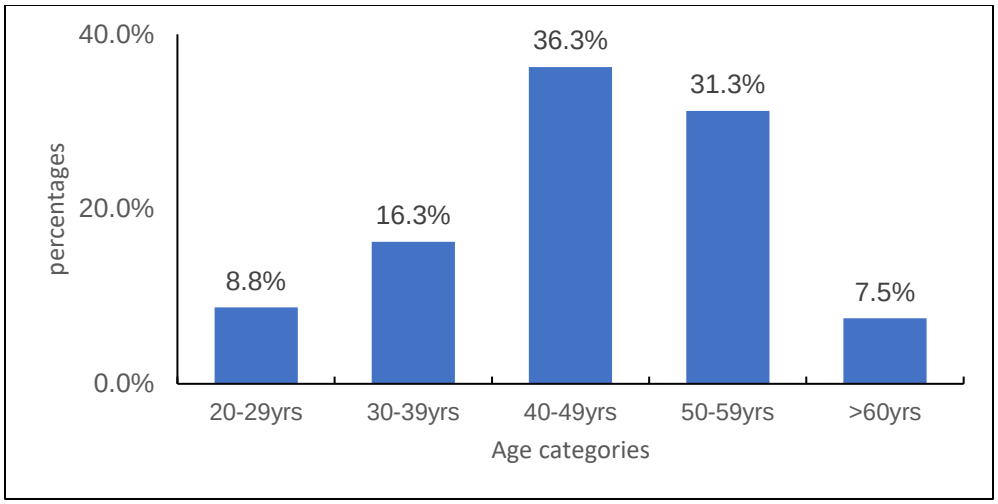


FIGURE 4.1 Frequencies for Age distribution of participants

Most critical care nurses working in the selected four ICUs had a diploma in critical care nursing, 91.3% (n=73) and 8.8% (n=7) had masters' degree in critical care nursing. Figure 4.2 below displays the results.

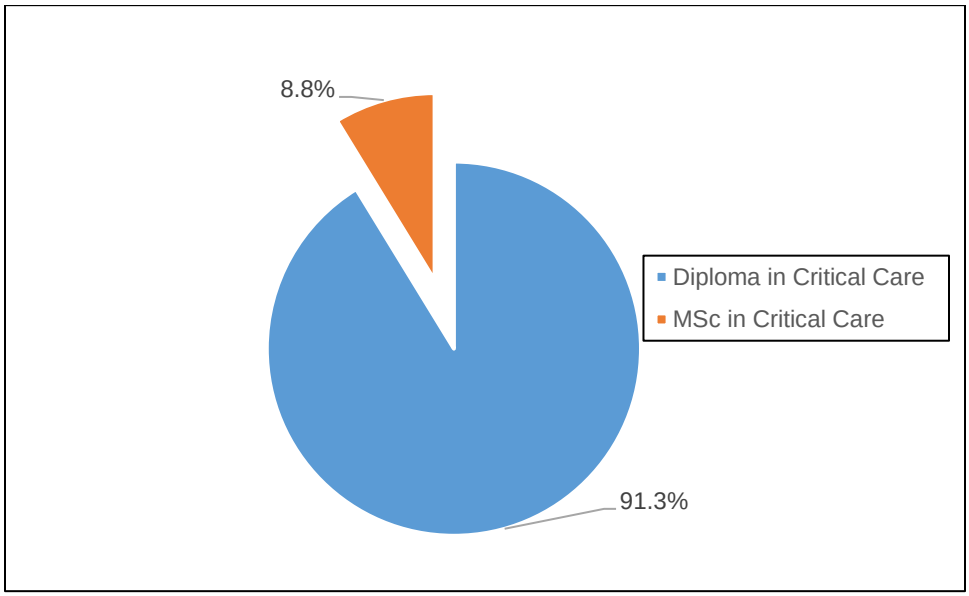


FIGURE 4.2 Frequencies for distribution of ICU nursing qualification

The following Figure 4.3 displays the results for participants' s ICU years of experience. It depicts that most critical care nurses had worked in ICU for more than 10 years accounting for 40% (n=32), followed by those who have 1-5 years' experience with 33.8% (n=27), 6-10 years with 25% (n=20) and only 1.3% (n=1) had worked for 6-11 months.

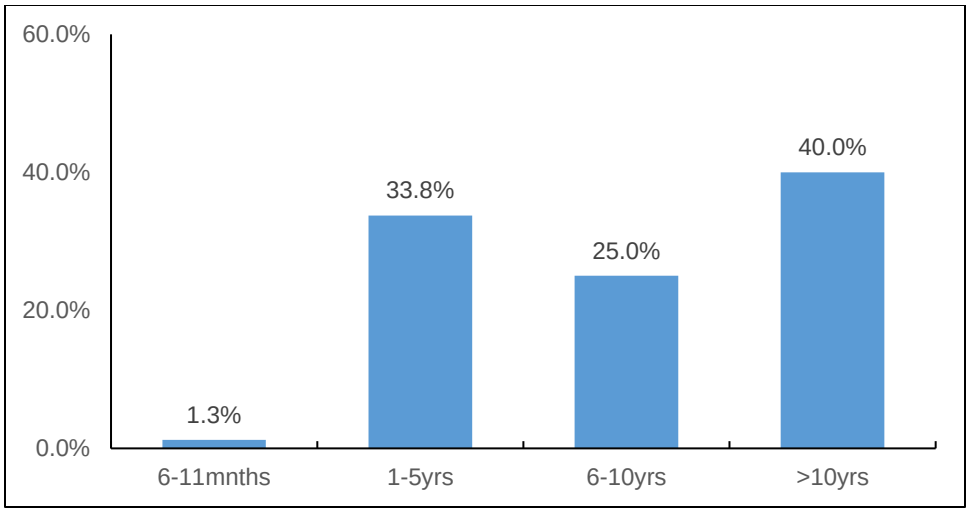


Figure 4.3 The frequencies for distribution of years of ICU experience

In this study, most intensive care units have a bed capacity of 8-15 beds with 77.5% (n=62), followed by intensive care units having less than 8 beds with 12.5% (n=10) and only minority of intensive care units had bed capacity of more than 15 beds accounting to 10% (n=8). These results are depicted in the following figure 4.4.

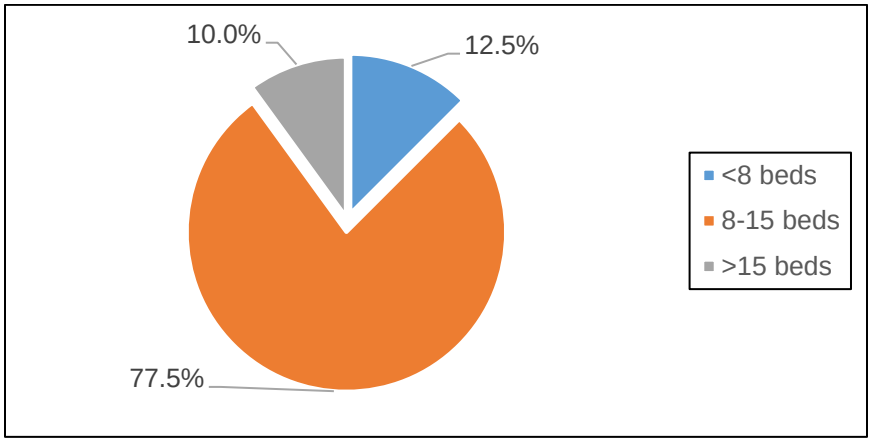


FIGURE 4.4 Frequencies for number of ICU beds per unit

4.1.1.3 Individual questions result on Evidenced-based knowledge assessment.

This formed section B of the questionnaire (Appendix A). It comprised of the assessment of 11 evidenced-based practices for the management of central venous catheters to prevent CLABSI. A questionnaire was used to obtain responses from the participants. The responses to the questions

included yes option which affirms the practice of evidence-based intervention, no option to disagree that the mentioned practice is not evidence-based, and I do not know option to prevent the participants from taking chances in guessing the evidence-based intervention. A total sample of 80 critical care nurses responded to the questionnaire. Figures 4.5-4.15 below display the results obtained per each question.

4.1.1.3.1. Flush the lumen with saline after administration of medication or fluid.

Question 1 discusses the maintenance of CVCs after use according to evidence-based guidelines for the prevention of CLABSI. According to evidence-based practice after fluid administration or medication administration, lumen should be flushed with saline. The correct response for this question was yes. 92.5% participants responded correctly to this question, 6.25% of participants responded that lumen should not be flushed after administration of medication while 1.25% of participants do not know. The results are displayed in the following figure 4.5.

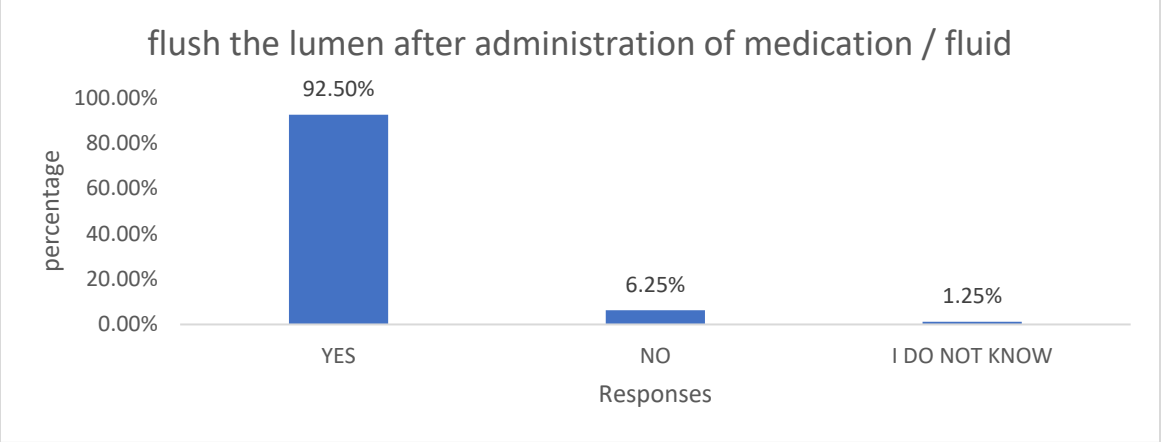


Figure 4.5 The frequencies for flushing the lumen after administration of medication/fluid (n=80)

4.1.1.3.2 Catheter Site Dressing Regimens

Question 2 focused on the type of dressing to be used on catheter insertion site. CDC (2017) recommends that the catheter site should be dressed with sterile gauze and sterile, transparent, semi-permeable dressing. The statement for the question read “Use sterile gauze or sterile

transparent semi-permeable dressing to cover the catheter site" and responses were 'yes', 'no' and 'I do not know'. The correct answer for this question was 'yes'. Majority of the participants, 95% (n=76) answered correctly to this question, 3.75% (n=3) responded incorrectly and only 1.25% (n=1) do not know the answer to this question. Figure 4.6 displays the results for question 2.

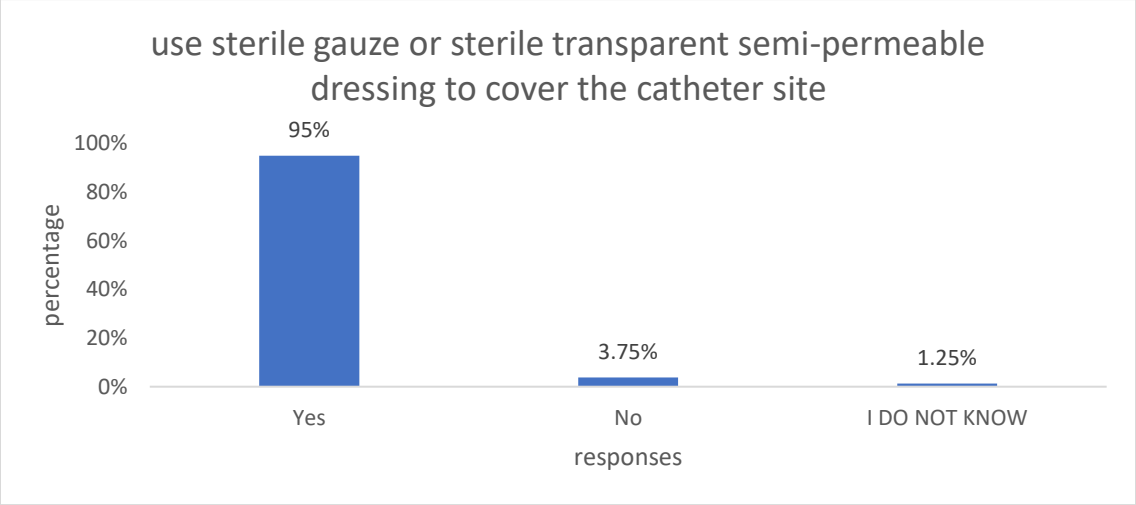


Figure 4.6 Using sterile gauze or sterile transparent semi-permeable dressing to cover the catheter site (n=80)

4.1.1.3.3 Needleless Intravascular Catheter System

Question 3 focused on the use of needleless connectors on the CVC. The use of stopcocks to administer medication, fluids and collect blood samples poses risk of entry of micro-organisms into the CVC system, therefore proper management should be exercised, (CDC, 2017). As per the evidence-based practice, the needleless connectors should be disinfected prior to the administration of medication/fluids and collection of blood samples. The statement for this question read "Disinfect the needleless connectors before administering medication or fluid" and the correct response to this question was yes. According to the results, 85% (n=68) of the participants answered correctly to this question while only 15% (n=12) answered incorrectly. Figure 4.7 below depicts the results.

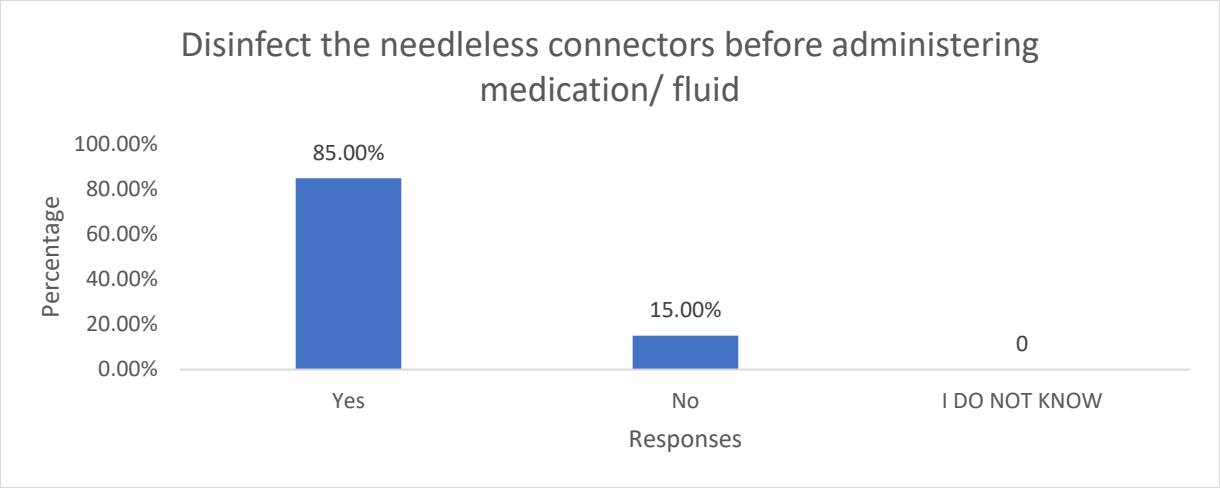


Figure 4.7 Disinfecting the needleless connectors before administering medication or fluid.

4.1.1.3.4 Frequency of catheter dressing changes

According to evidence-based interventions, the dressing for the CVC insertion site should be replaced on weekly basis for sterile semi-permeable dressing and the dressing should be changed immediately if it is damp, loose, or dirty (CDC, 2017). The correct response for this question was yes. As per the results obtained from the study, 83.75% (n=67) of the participants responded correctly to this question, 10% (n=8) responded incorrectly and 6.25% (n=5) did not know the answer to the question. Therefore, majority of the study participants responded correctly. The following figure 4.8 displays the results.

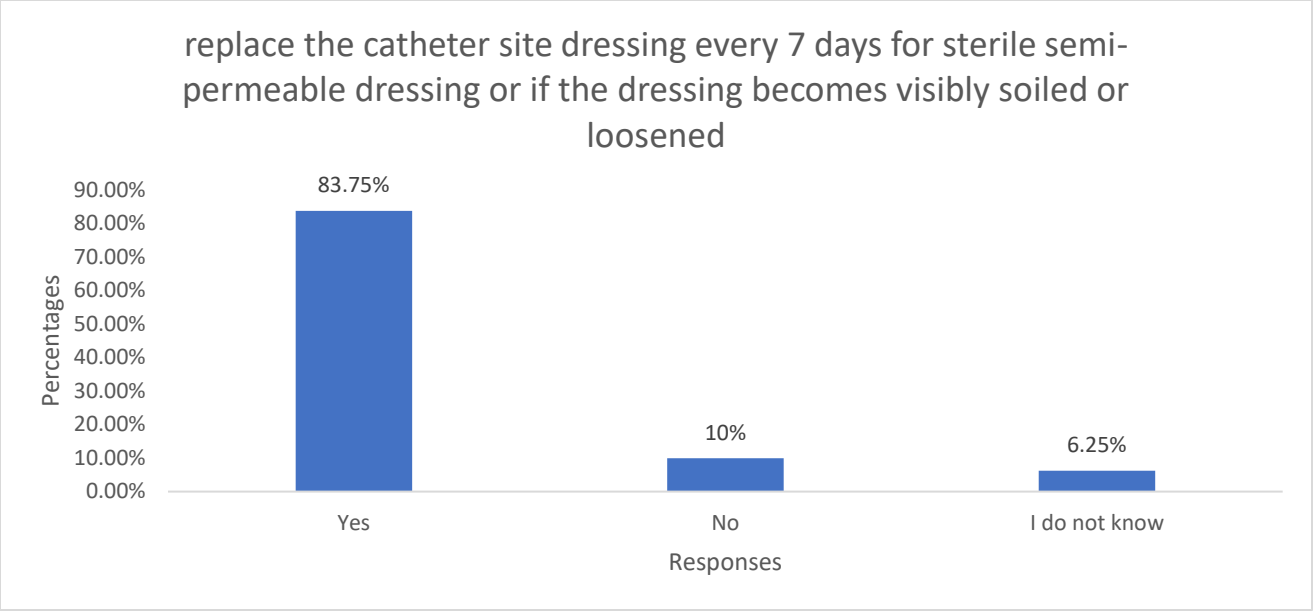


Figure 4.8 frequency of catheter dressing changes

4.1.1.3.5 Antibiotic/antiseptic ointments

Question 5 of the questionnaire focused on the use of antibiotic or antiseptic ointments on the catheter insertion sites. According to the evidence-based interventions to prevent CLABSI, topical antibiotic ointments should not be used on catheter insertion sites as they cause fungal infections and antibiotic resistance, (CDC, 2017). Therefore, the correct answer for this question was 'no'. Majority of study participants responded correctly with 73.75%, (n=59), 22.5% (n=18) responded incorrectly and only 3.75% (n=3) did not know the answer to the question. From this result, it can be deduced that most critical care nurses are knowledgeable about the use of antibiotic ointments on catheter sites. Figure 4.9 below shows the above results.

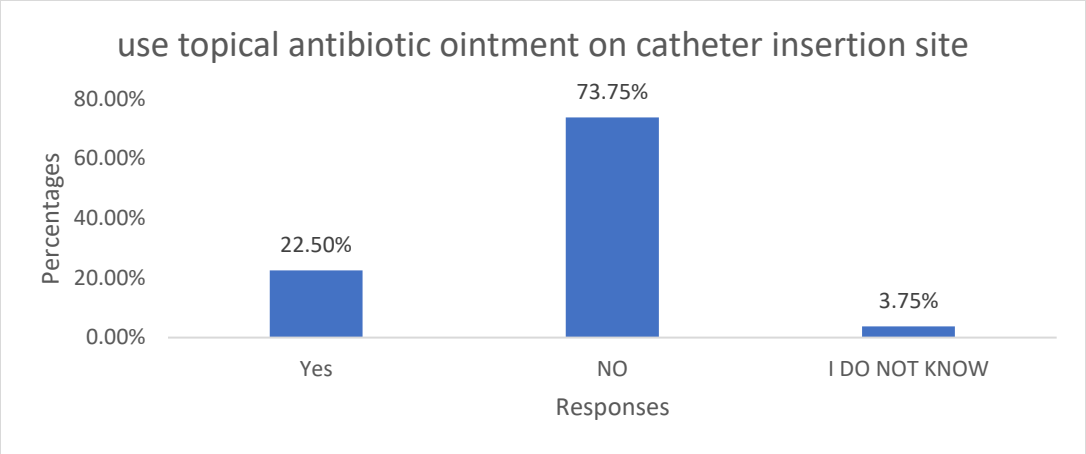


Figure 4.9 Use of antibiotic/antiseptic ointments on catheter insertion site

4.1.1.3.6 Replacement of administration sets

Regular replacement of IV administration sets had been associated with decreased risk of CLABSI, and it is recommended that administration sets used for inotropes as well as antibiotics be changed every 72 hours as per the evidence-based guidelines (CDC 2017). Based on this recommendation, the correct answer for question 6 was yes. 85% (n=68) of participants answered this question correctly, 12.5% (n=10) answered incorrectly and only 2.5% (n=2) did not know the answer. Majority of critical care nurses are knowledgeable about frequency of replacing IV administration sets. The below figure 4.10 displays summary of the results.

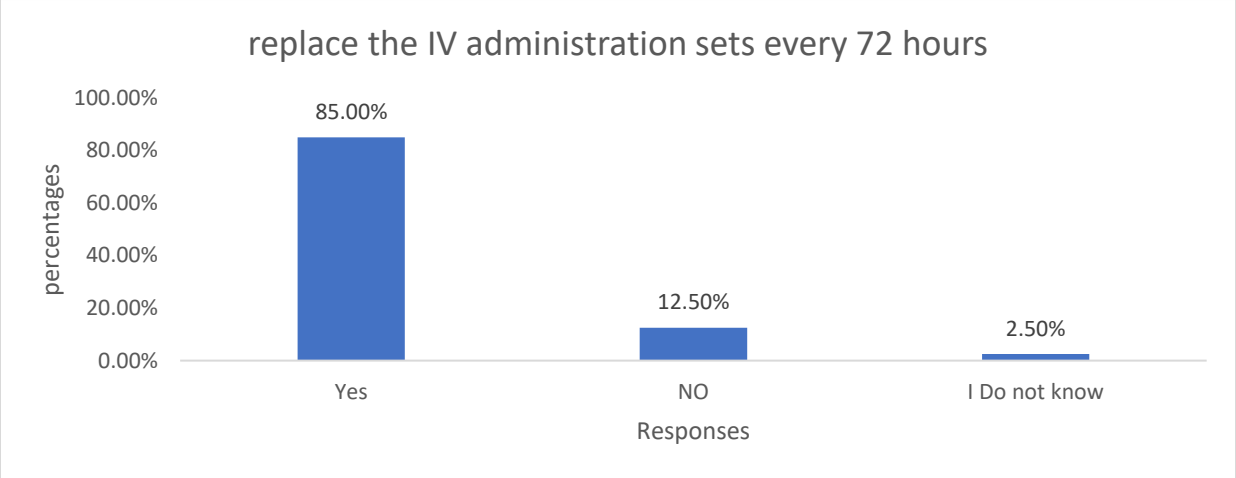


Figure 4.10 Replacement of IV administration sets

4.1.1.3.7 Disinfection of Catheter Insertion Sites

This question focused on the disinfectant that should be used on catheter insertion site. As per the evidence-based interventions, it is recommended to use >0.5% chlorhexidine with alcohol solution to clean the skin when inserting a catheter and when doing dressings. Iodine or 70% alcohol preparation can also be used in case there is contraindication for chlorhexidine use, (CDC 2017). Therefore, the correct answer for this question was 'no'. Based on the results obtained, 63.75% (n=51) responded accurately to the question where as 27.5% (n=22) responded incorrectly and the minority 8.75% (n=7) did not know the answer. Most critical care nurses are aware of the type of disinfectant that should be used on the catheter insertion sites. Figure 4.11 below displays summary of the responses for this question.

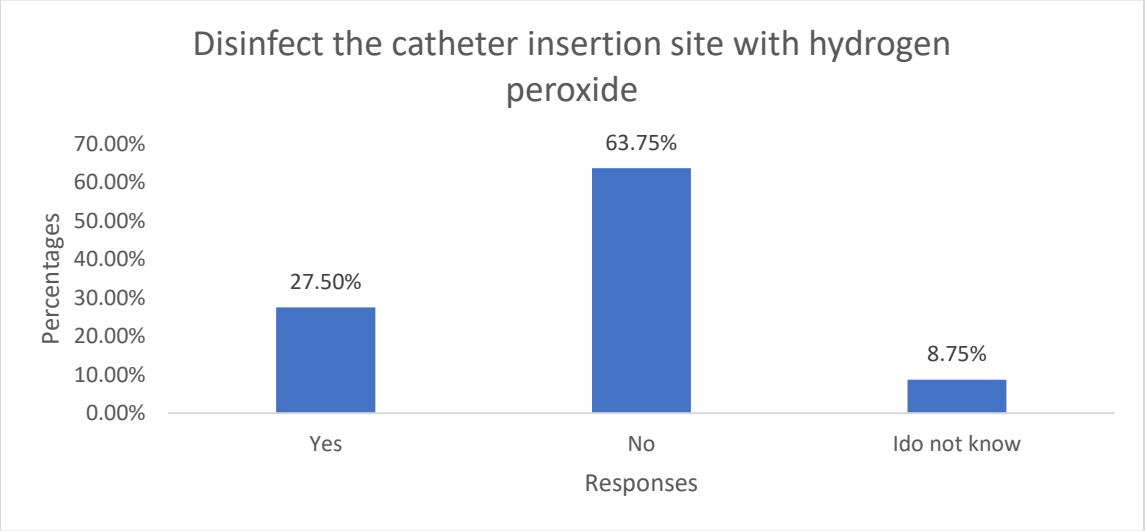


Figure 4.11 Disinfection of catheter insertion sites

4.1.1.3.8 Anticoagulants

Question 7 of the questionnaire focused on the routine use of anticoagulants solutions on CVC. It is recommended that anticoagulants should not be routinely used to decrease CLABSI on general patient population (CDC, 2017). Therefore, the correct response for this question was 'no'. According to the results obtained, majority of participants answered correctly with 51.25% (n=41), followed by incorrect responses of 45% (n=36) and minority of participants did not know the answer with 3.75% (n=3). Figure 4.12 displays the summary of responses to the above question.

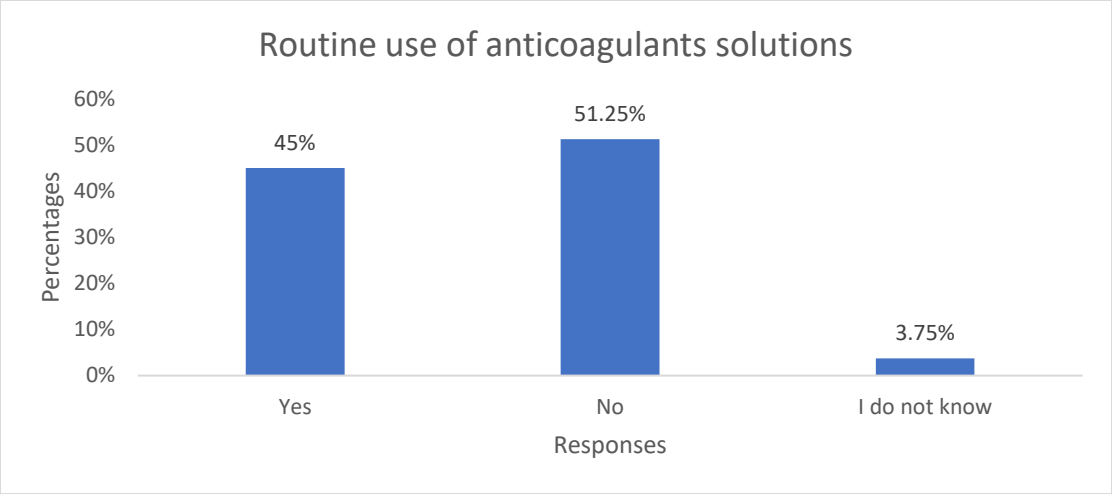


Figure 4.12 Routine use of anticoagulants solutions (n=80)

4.1.1.3.9 Monitoring catheter insertion sites

It is recommended to observe any signs and symptoms for infections on the catheter sites after removal of dressings. Palpation through an intact dressing is also recommended to assess the catheter site (CDC, 2017). Based on this evidence-based intervention, the correct answer to this question is 'yes'. The results obtained in this question showed 87.5% (n=70) responded correctly, 8.75% (n=7) responded incorrectly and only 3.75% (n=3) did not know the answer. Therefore, most critical care nurses are knowledgeable about management of CVC insertion sites. The following figure 4.13 depicts summary of the result.

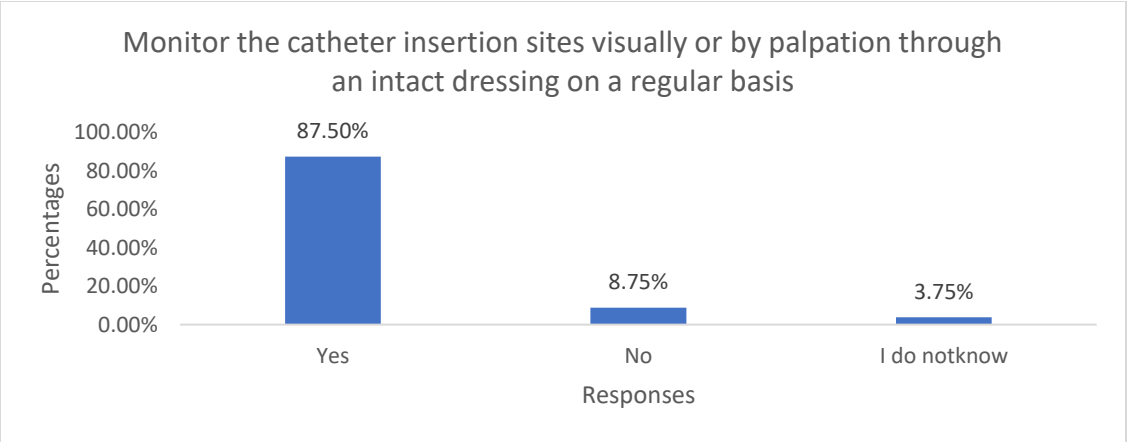


Figure 4.13 Monitoring catheter insertion site

4.1.1.3.10 Skin preparation during CVC insertion

Question 10 focused on skin disinfection when inserting a catheter. When inserting a catheter, the skin should be cleansed with Chlorhexidine 0.5% prepared solution and allowed to dry before a catheter can be inserted (CDC, 2017). Based on the latter statement, the correct answer for this question is 'yes'. 85% (n=68) of participants answered correctly, 8.75% (n=7) answered incorrectly and 6.25% (n=5) did not know the answer. Based on the above results, that majority of participants are aware of the correct skin preparation interventions during CVC insertion. The latter results are depicted in figure 4.14 below.

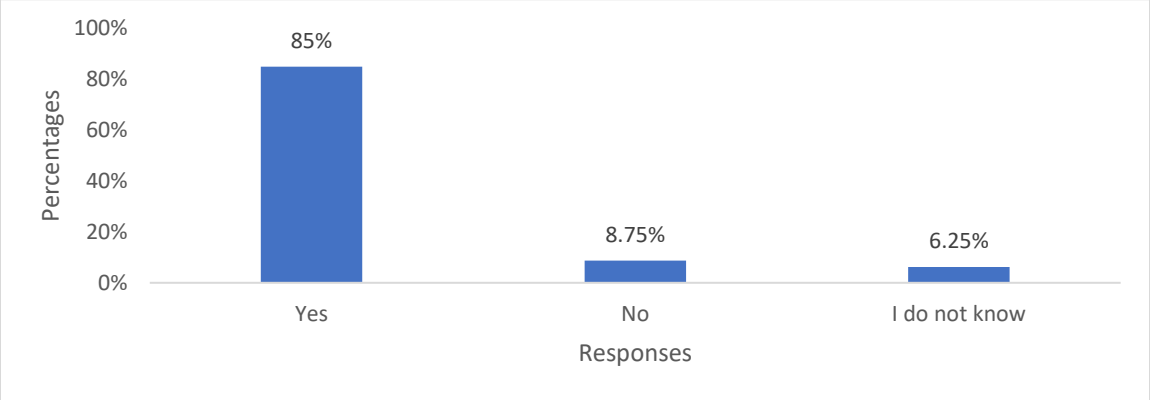


Figure 4.14 Skin preparation during CVC insertion

4.1.1.3.11 Hand hygiene

Question 11 of the questionnaire focused on hand hygiene and donning of gloves when accessing infusion ports. Hand washing should be done with clean water and water before any access to a central venous catheter which can be palpation of the catheter insertion sites, replacement of a CVC, accessing infusion ports, or dressing of a catheter, (CDC, 2017). Donning of gloves follows hand hygiene. Therefore, the correct answer for this question is 'no'. According to the results, 58.75% (n=47) responded correctly by answering NO to this question and 41.25% (n=33) responded incorrectly by answering YES. Based on these responses most critical care nurses are aware of the need for hand hygiene before accessing the infusion ports. The results of this question are shown in the below figure 4.15.

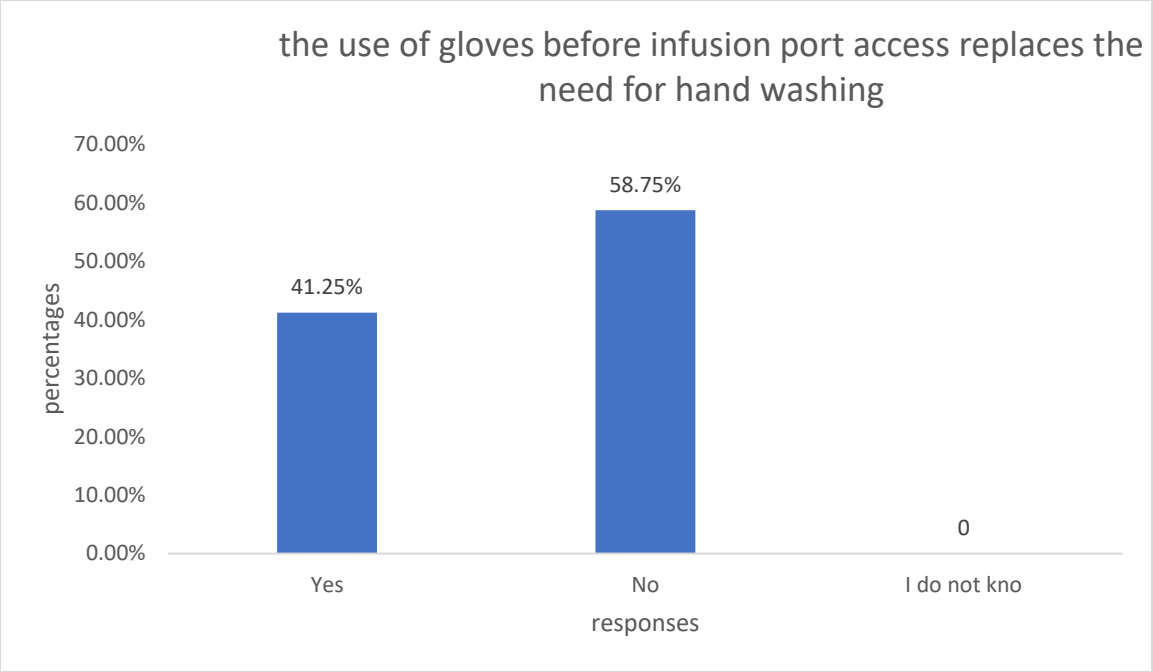


Figure 4.15 Frequencies for Hand Hygiene practices.

The following table indicates summary of the correct and incorrect responses regarding evidence-based practices for the prevention of CLABSI. The percentage for the correct answers ranged from 51.25% up to 95% per question. These results indicate that there is no 100% score for each question.

TABLE 4.2 Summary of correct and incorrect responses for evidence-based knowledge questions

Q.	ITEM	CORRECT RESPONSES	INCORRECT RESPONSES	I DO NOT KNOW
1	Flush the lumen with saline after administration of medication or fluid	**92.50%**	**6.25%**	**1.25%**
2	Use sterile gauze or sterile transparent semi-permeable dressing to cover the catheter site	**95%**	**3.75%**	**1.25%**
3	Disinfect the needless connectors before administering medication or fluid	**85%**	**15%**	**0**
4	Replace the catheter site dressing every 7 days for sterile semipermeable dressing or if the dressing becomes visibly soiled or loosened	**83.75%**	**10%**	**6.25%**

5	Use topical antibiotic ointment on catheter insertion sites	**73.75%**	**22.5%**	**3.75%**
6	Replace the IV administration sets every 72 hours	**85%**	**12.75%**	**2.5%**
7	Disinfect the catheter insertion site with hydrogen peroxide	**63.75%**	**27.5%**	**8.75%**
8	Routinely use of anticoagulants solutions	**51.25%**	**45%**	**3.75%**
9	Monitor the catheter sites visually or by palpation through an intact dressing on a regular basis	**87.5%**	**8.75%**	**3.75%**
10	Allow the skin antiseptic on the insertion site to dry before catheter insertion	**85%**	**8.75%**	**6.25%**
11	The use of gloves before infusion port access replaces the need for hand washing	**58.8%**	**41.3%**	**0**

4.1.1.4 Total Knowledge scores for the questionnaire

Overall, critical care nurses had good baseline knowledge for evidence-based guidelines for the management of central venous catheters with median knowledge score of 81.8% (median=81.8%) and IQR 72.7-90.9% (IQR 72.7%-90.9%). The lowest mark achieved was 18.2% and highest mark achieved was 100%. The following figure 4.16 displays the results.

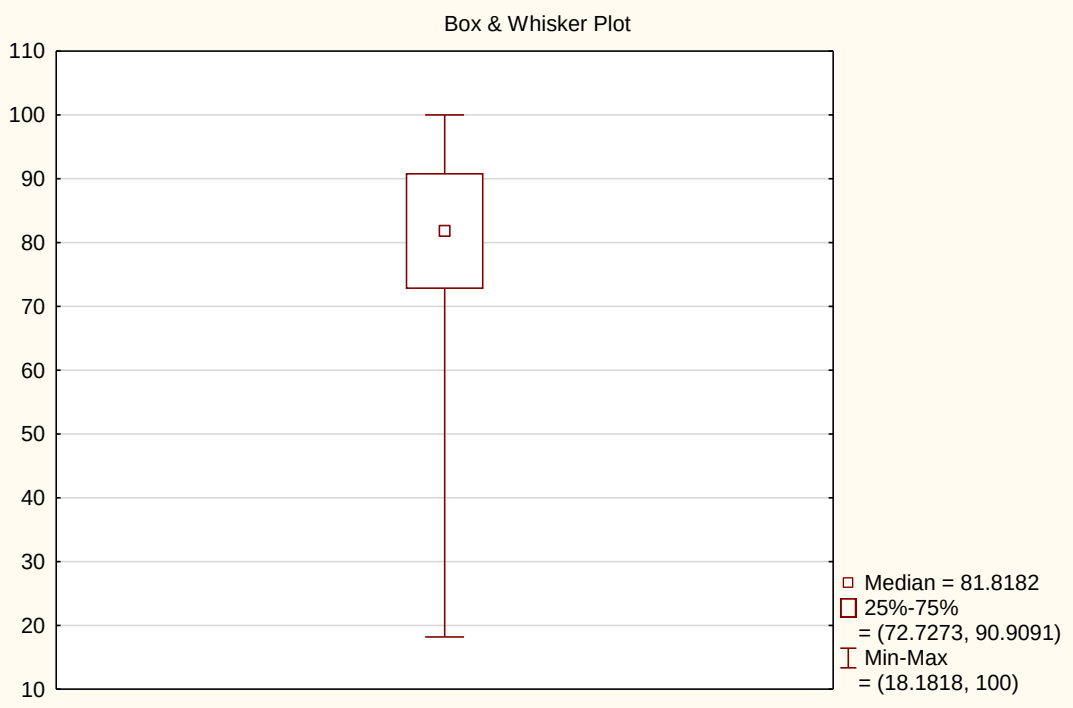


Figure 4.16 Median value of the total scores on critical care nurses' knowledge

Three categories for knowledge level were described by Ntlhokoe (2014) being poor (0-50%), average (51-70%) and good (71-100%). To set the knowledge level for this study, 70% was set as the pass mark for this study. Most participants 76.25% (n=61) scored above 70% and only 23.75% (n=19) scored below 70%. Overall, the critical care nurses displayed a satisfactory level of knowledge for the evidence-based management of central venous catheters.

4.1.2 COMPARATIVE RESULTS

Data was further explored to describe the relations between critical care nurses' knowledge score and selected demographic data of the participants. Significance was set at a value of p-value<0.05. Results were interpreted as having statistically significant difference if the p-value is less than 0.05 (p-value<0.05) and no statistically significant difference if the p-value is more than 0.05 (p-value>0.05). Spearman's rank correlation coefficient was used to assess for the correlation or the relationship between the variables. When assessing the strength of a relationship, the correlation coefficient, r is between -1 and +1. According to Polit, Beck and Hungler (2001), if r is less than 0.3 (r<0.3) the relationship is very weak or non-existent, if r is between 0.3 and 0.7 (>0.3 r<0.7) the relationship is moderate and if r is above 0.7 (r>0.7) the relationship is strong.

4.1.2.1 Comparison of total scores by qualifications

The statistical test used was Mann-Whitney U test. Statistical testing was done at p<0.05. Critical care nurses with diplomas scored the same as those with masters 'degree in nursing. Since the other group (master's degree in nursing) had small sample size as compared to the other group (diploma in critical care nursing), the value of an exact p-value was used to draw the conclusion. The exact p-value was 0.232183, which indicated that there are no statistically significant differences in the knowledge scores of those who had diploma and those who had masters' degree in nursing.

4.1.2.2 Comparison of total scores by age groups

Kruskal-Wallis Anova Test was used to compare total scores and age groups. The p-value was 0.0007 (p= 0.0007), which was lower than 0.05 (p<0.05). The results indicated a statistically significant difference between the scores obtained by the age groups, with age group 50-59 years and age group above 60 years scoring higher than other age group with median scores of 90%. This is depicted in the below figure.

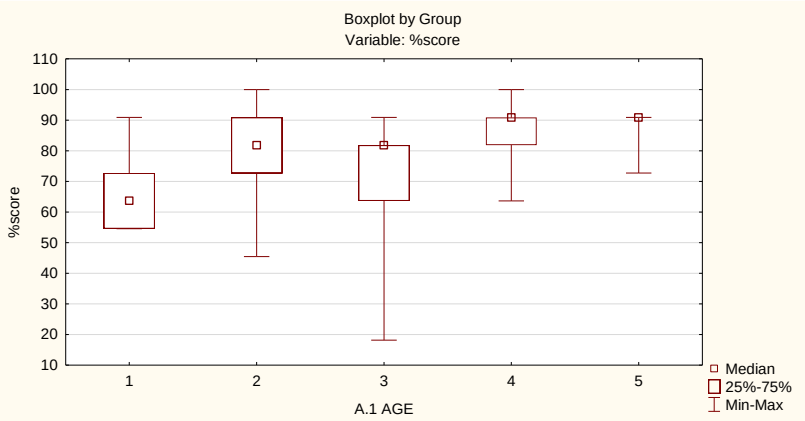


Figure 4.17 Box and whisker graph for differences in median scores by age groups

Further analysis was done to assess for the correlation. A spearman's rank correlation coefficient of 0.4074 (r=0.4074) was obtained which was between 0.3 and 0.7, indicating a positive moderate relationship between scores and age. Therefore, it can extrapolate that age has an influence on the scores. As age increases, scores were also increasing implying older nurses were scoring higher than younger nurses. It is expected for older nurses to be more experienced hence the higher knowledge in the field of practice.

Table 4.3 Spearman's rank Correlation coefficient of scores and age groups

	Spearman Rank Order Correlations (DATA2) MD pairwise deleted Marked correlations are significant at p <.05000	
Variable	SCORE	A.1 AGE
SCORE	1.000000	0.407421
A.1 AGE	0.407421	1.000000

The scatterplot matrix in figure 4.18 below displays a positive, moderate correlation between scores and age groups.

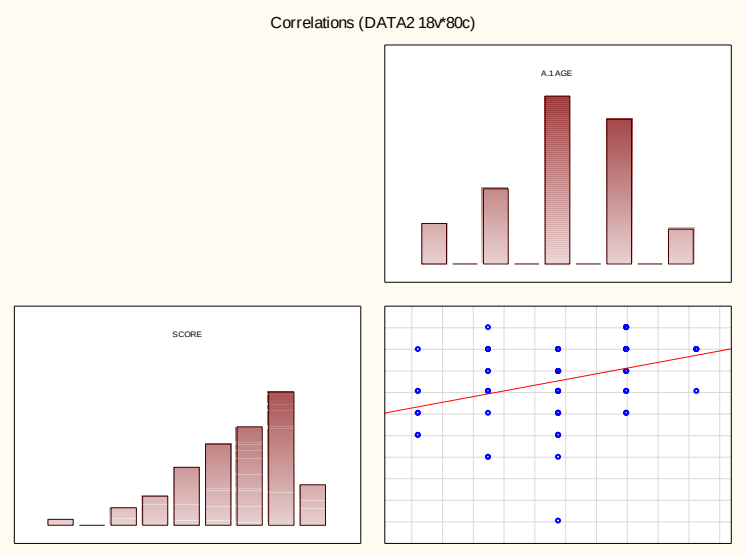


Figure 4.18 Scatterplot matrix for correlation of scores and age groups

4.1.2.3 Comparison of total scores by years of experience

The statistical test used for the analysis was Kruskal-Wallis test. The p-value was 0.0159 (p=0.0159) which was less than 0.05 (p<0.05), which indicated a statistically significant difference between scores and the years of experience groups. This implied that there was a difference between scores, with those having experience of more than ten years scoring higher scores (median 91%) followed by those having experience of 6-10 years (median 81%). The box and whisker graph below depicts the difference in median scores for different years of experience.

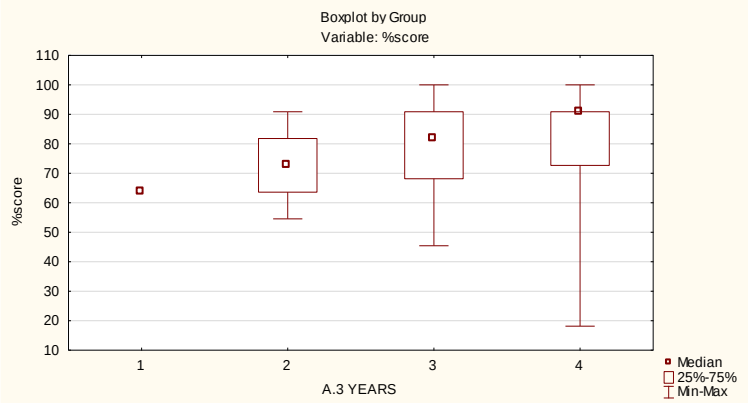


Figure 4.19 Box and whisker graph for differences in median scores by years of experience

Further testing was done to explore whether there is correlation between the scores and the years of experience. A spearman's rank correlation coefficient of 0.2941 (r=0.2941) was obtained which indicated a weak correlation because the correlation coefficient was less than 0.3. Based on the correlation coefficient (r=0.2941) which is less than 0.3, it can be concluded that years of experience have no influence on the performance scores as it implies there is no relationship between the two variables. Results are shown in the table below.

Table 4.4 Spearman's rank correlation coefficient for scores and years of experience

	Spearman Rank Order Correlations (DATA2) MD pairwise deleted Marked correlations are significant at p <.05000	
Variable	SCORE	A.3 YEARS
SCORE	1.000000	0.294183
A.3 YEARS	0.294183	1.000000

The scatterplot matrix in figure 4.20 below shows a very weak positive correlation.

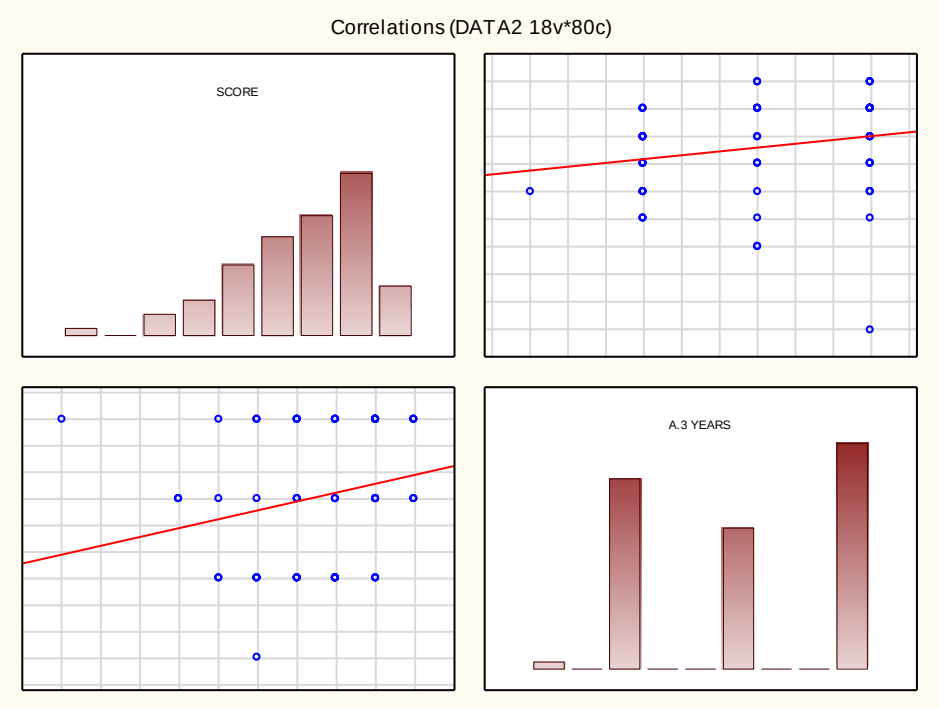


Figure 4.20 Scatterplot matrix for Correlations of scores and years of experience

4.2 SUMMARY

This chapter presented data analyses and results. The descriptive and inferential statistics were used to describe the data. Non-parametric statistical tests were used to compare the data. Data was reported as frequencies and percentages. The findings were presented in tables and graphs and interpreted. Eighty (80) critical care nurses participated in the study. The largest age group was 40-49 years. Majority of them had diploma in critical care nursing. Majority of the critical care nurses had more than 10 years working experience in an ICU. Overall, the knowledge level depicted in this study was good with only nineteen (19) participants scoring below 70% and sixty-one (61) scoring above 70%.

The next chapter will discuss the main findings of the study, limitations, conclusions.

and recommendations.

CHAPTER 5: DISCUSSION OF THE FINDINGS, LIMITATIONS, RECOMMENDATIONS AND CONCLUSION

5.0 INTRODUCTION

This chapter reports on the discussion of the findings of the study and limitations of the study. Recommendations for nursing practice as well as nursing research are presented in this chapter. Conclusion for the study is also discussed in this chapter.

5.1 DISCUSSION OF FINDINGS OF THE STUDY

5.1.1 Biographical data & workplace data

The results for demographic data showed that most critical care nurses were aged 40-49 years, accounting to 36.3% followed by the age group 50-59 years (31.25%) which reflects an aging and mature population. This is in line with the South African trend for age distribution for Registered Nurses/midwives. According to SANC annual report (2020), most registered nurses/midwives were aged 50-59 years (27%) followed by the age category of 40-49 years (26%). Critical care nurses fall in the category of registered nurses/midwives in the nursing council.

Majority of the critical care nurses (91.3%) had diploma in critical care nursing and the minority (8.8%) had Master of science in critical care nursing. Looking at the statistics for registrations and listed qualifications from SANC for the year 2019, there were 327 critical care nurses registered altogether and 225 nurses were from colleges of nursing as compared to 102 from universities. The same trend is also seen for the 2020 statistics where most nurses were registered from nursing colleges (161) as compared to universities (56), (SANC 2020). This may explain the high number of critical care nurses having diploma in critical care nursing.

Regarding ICU experience, majority of critical care nurses (40%) had served for more than 10 years in ICU, which indicates a higher level of experience and expertise. These higher years of experience may explain the high level of knowledge depicted in the current study. Schmollgruber 2015 reported that experience does not necessarily mean the duration acquired on the job but the

integration of learned concepts and practical skills, therefore knowledge is acquired through transformation of experience.

5.1.2 Individual questions result on Evidenced-based knowledge assessment.

5.1.2.1 Flush the lumen with saline after administration of medication/fluid

Regarding care of the central venous catheter, 92.5% of the participants knew the correct evidence-based practice that lumen should be flushed after administration of medication/fluid. With this knowledge score, it implies CCNs have evidence-based knowledge on the current management of CVCs, and as such application of this knowledge is anticipated to lower the CLABSI rates. These results are similar to the results obtained by Esposito, Guillari and Angelillo (2017) who recorded a 90.1% score for CVC care, and Barbosa *et al.* (2017) also reported a 75% score which was also regarded as good. The nurses in these studies depicted good evidence-based knowledge of CVC care. They are competent in evidence-based practices of CVC care updates as per CDC guidance. Flushing the lumen of a central venous catheter after administration of medication/fluid is a good practice measure and with majority of critical care nurses knowing it, it is expected to lower the incidence rates for CLABSI.

5.1.2.2 Catheter site dressing regimens

95% of the participants are aware of the type of dressing regimen to be used on central venous catheter sites. These results reflect the highest level of knowledge among critical care nurses, and it is comparable to other studies internationally. Esposito, Guillari and Angelillo (2017) recorded the results of 85.9% as the baseline score for the dressing types to be used on the CVC insertion site. Contrary to this current study, Chen *et al.* (2015) reported a low score regarding the type of dressing regimen to be used. Only 22.9% of critical care nurses knew that both sterile and transparent, semi-permeable dressings are used on the catheter site dressing and this lack of knowledge was attributed to unfamiliarity with guidelines (Chen *et al*. 2015). Transparent dressings on the CVCs allow for visual inspection of the catheter site which helps in early

identification of signs of infection and the use of sterile gauze dressing is recommended for oozing and bleeding sites to absorb the fluids, (CDC 2017). Dressing is primarily a nurse's role; therefore, with this evidence-based knowledge depicted in this study, infections may be reduced as they may be identified early and prompt management ensued.

5.1.2.3 Needleless intravascular catheter system

Regarding the disinfection of the needleless connectors before administration of medication/fluid, most participants (85%), knew the recommended evidence-based practice, that needleless connectors should be disinfected prior to medication/fluid administration. The nurses in the current study depicted evidence-based knowledge on disinfection of needleless connectors. Similarly, Barbosa *et al*. (2017), Esposito, Guillari & Angelillo (2017) and Bianco *et al.* (2013) reported 90%, 77.5% and 71% respectively as the knowledge score the participants had about disinfection of the needleless connectors. Improper care of needleless connectors has been identified as the route for microbial entry thereby possessing a risk for CLABSI occurrence, (Lutwick 2019; Best Care Always 2017). Nurses' evidence-based knowledge on the proper care of needleless connectors can serve as a reducing measure for CLABSI occurrence.

5.1.2.4 Frequency of catheter dressing changes

Related to the frequency of catheter site dressing changes, 83.75% of participants in this current study were knowledgeable of how often a dressing should be changed. Compared to other studies, the results in the current study are higher than results by Alkubati *et al*. (2015), Chen *et al.* (2015), Dedunska and Dyk (2015) and Bianco *et al.* (2013), who reported 10%, 15%, 62% and 63.9% respectively. CDC (2017) recommends that dressings for the CVC insertion site should be replaced on weekly basis for sterile semi-permeable dressing or immediately if the dressing is wet, loose, or dirty. A wet, loose, and dirty dressing may cause catheter colonization. With nurses depicting good knowledge score on the frequency of catheter site dressing changes, lower rates of catheter colonization can be ensued thereby decreasing CLABSI incidence rates.

5.1.2.5 Antibiotic/antiseptic ointments

Regarding the use of antibiotic/antiseptic ointment on catheter insertion site, 73.75% of the participants were aware that topical antibiotic/antiseptic ointment are not recommended to be used on central venous catheter insertion site. These results are similar to results observed in studies by Dedunska and Dyk (2015) and Esposito, Guillari & Angelillo (2017), whereby findings of 75.4% and 75.5% were reported, respectively. However, low levels of knowledge were reported in other studies regarding the use of topical antibiotics/antiseptics on the CVC site. Muslim *et al.* (2017) and Alkubati *et al.* (2013) reported knowledge levels of 40% and 9.16% respectively. The use of topical antibiotics is recommended on the hemodialysis catheter insertion site as it has been found to decrease colonization, whereas the use of antibiotic/antiseptic ointments on CVCs may increase colonization and infection (CDC 2017). With majority of nurses being knowledgeable on catheter insertion site care, infections can be prevented. This calls for nurses to transform this knowledge into practice.

5.1.2.6 Replacements of administration sets

Related to the replacement of IV administration sets, 85% of the participants knew that IV administration sets are changed every 72 hours, compared to 70.7% by Esposito, Guillari & Angelillo (2017), 25% by Barbosa *et al.* (2017) and 25.6% by Dedunska and Dyk (2015) in previous studies. The current study reflects a higher level of knowledge, which is expected since it is nurses' role to change administration sets. Changing administration sets every 72-96 hours have been found to be safe, cost effective and decreases microbial growth which can be caused by the fluids administered (CDC 2017). Nurses' knowledge on the frequency of changing IV administration sets may enhance safe practice by preventing the development of CLABSI as the microbial growth will be minimized on the IV administration sets.

5.1.2.7 Disinfection of catheter insertion sites

CDC (2017) recommends the use of chlorhexidine solution to disinfect the catheter site. The results for the current study indicated that 63.75% of participants were aware of the correct solution to

use. Compared to previous studies, these results are low as they are below the competency mark of 70%. Muslim *et al.* (2017) and Esposito, Guillari & Angelillo (2017) reported 86% and 70% knowledge levels on the type of solution to use on the CVC insertion sites. The use of chlorhexidine solution has been associated with a reduction of CLABSI (CDC 2017). Catheter site care involves disinfection as well as dressing the site, which is usually done by the nurses, therefore nurses need to be aware of the correct disinfectant to use. With a knowledge score below the set competency mark of 70%, this may compromise the care offered to patients and subsequently contribute to emergence of CLABSI.

5.1.2.8 Anticoagulants

Regarding the routine use of anticoagulants on the CVC, 51.25% of the participants are aware of the evidence-based practice. Compared to previous studies, the findings are slightly lower than 64.4% reported by Esposito, Guillari and Angelillo (2017) and 55% reported by Barbosa *et al.* (2017). For this current study it can be depicted that the knowledge regarding the routine use of anticoagulants on CVCs is moderate. CDC (2017) does not recommend the routine use of anticoagulants on CVCs.

5.1.2.9 Monitoring catheter insertion sites

The insertion catheter sites should be observed for any infection signs after removal of the dressing and in the presence of a dressing, palpation of the insertion sites should be done to assess for presence of infection signs regularly (CDC 2017). 87.5% of the participants were knowledgeable about this practice. This finding is consistent to studies done by Bianco *et al.* (2013) and Muslim *et al.* (2017), who reported 83.9% and 98% respectively as the knowledge level for this practice. Monitoring of CVC sites helps for early detection of the infections and prompt management and with majority of nurses being knowledgeable, infections arising from the dressings can be prevented.

5.1.2.10 Skin preparation during CVC insertion

During skin preparation for CVC insertion, the skin is cleansed with antiseptic solution and it is recommended that the skin should be allowed to dry before the catheter can be inserted (CDC 2017). The knowledge level depicted in the current study for this question stand at 85%, which is comparatively higher than in previous studies. Alkubati *et al.* (2015) reported the results of 31.3% and Bianco *et al.* (2013) reported results of 72.9%. The results for the current study indicate that nurses are well knowledgeable in this practice, as such they are in a better position to advise doctors accordingly during CVC insertion.

5.1.2.11 Hand hygiene

Regarding hand hygiene, 58.8% of the participants knew the need for handwashing. Hand washing should be done regardless of using gloves. This finding depicts a lower level of knowledge as compared to 92% reported by Muslim et al. (2017) and 68.1% reported by Bianco et al. (2013). The results for the current study for hand hygiene is below the competency mark of 70%, as such knowledge is lacking among critical care nurses. These results are surprising because hand hygiene practices are monitored and encouraged in all the ICUs that participated in the study. Hand hygiene remains the cornerstone for every infection control practices. It is vital to wash hand before any contact with a patient to prevent nosocomial infections.

5.1.3 Total Knowledge scores for the questionnaire

Guided by the objective of this study, overall critical care nurses had a good baseline knowledge of evidence-based guidelines for the management of central venous catheters with a median score of 81.8% (median: 81.8 % and IQR: 72.7-90.9%) (median=78.29). Individual scores were ranging from a low of 18.2% to a high of 100%. Majority of the participants, 76.25% (n=61) scored above 70% while 23.75% (n=19) scored below 70%, which indicates that most critical care nurses scored above the competency pass mark of 70%. This high knowledge score in the current study may mean that CCNs are aware and familiar with the CLABSI guidelines. The population for the current study composed of only CCNs with postgraduate training in Critical care nursing and this could have attributed to high scores as they have advanced knowledge. With this good knowledge of management of central venous catheters depicted by critical care nurses, safe practice may be

anticipated to ensure lower rates of CLABSI is expected in the ICUs. Muslim *et al.* (2017) reported similar results as this study, they reported a mean knowledge of 73.65% among ICU nurses regarding care of central venous catheters. Contrary to the latter, the results in the current study are comparatively higher than reports from studies by Ibrahim *et al.* (2019); Chen *et al.* (2015) and Gnanarani, Venkatesan & Manikandan (2018) in which the overall knowledge scores were 46%, 40.85% and 23.34% respectively and this was attributed to lack of familiarity with guidelines as well as lack of training on the guidelines.

Nurses in the current study are knowledgeable in the management of central venous catheters, however their competency is questionable as there is still existence of CLABSI infections in their ICUs. Schmollgruber (2015) describes competency as the application of knowledge and skills consistently in clinical practice to achieve high quality outcomes. Therefore, without the application of the evidence-based knowledge to prevent CLABSI, these infections may continue to exist. Knowledge coupled commitment of staff is a strategy that can contribute to successful implementation of protocols (Schmollgruber 2015). Therefore, since the knowledge level is good, it calls for assessment of staff commitment to ensure proper implementation of CLABSI guidelines. An effective attitude may assist in successful performance.

5.1.4 Comparison of knowledge scores and selected demographic data

Regarding knowledge scores and qualifications, nurses with diploma in critical care nursing scored similarly to nurses with MSc nursing (critical). This finding was similar to the report by Muslim *et al.* (2017), in which there was no difference between marks obtained by nurses with different qualifications.

Regarding knowledge scores and age groups, there was difference between scores obtained by different age groups with age group 50-59 years and age group above 60 years scoring higher than other age group with median scores of 90%. Based on correlation coefficient, a positive moderate correlation ($r = 0.4074$) was observed. This implies that, as age increases, scores were also increasing. Older nurses were scoring higher than younger nurses, which is an expected results because it is expected for older nurses to be more experienced hence the higher knowledge in the field of practice.

Data of knowledge scores and years of experience showed a statistically significant difference between the scores (p-value=0.0159), with those having experience of more than ten years scoring higher scores (median 91%) followed by those having experience of 6-10 years (median 81%) and those having experiences of 6-11 months achieving less scores (median score 62). However, a weak correlation was marked between the two variables, a correlation coefficient of 0.2941 (r=0.2941) was observed which is less than 0.3, which indicated no relationship between the two variables. Although there was difference between scores obtained, based on the correlation coefficient (r=0.2941) which is less than 0.3, it can be concluded that years of experience have no influence on the performance scores. Therefore, it can be indicated that years of experience have no influence on the performance. This was an unexpected result because it is usually said that experience is the best teacher, meaning experience can increase knowledge. This weak correlation between scores and years of experience cannot be underestimated as it may indicate lack of continuous development by the nurses and the possibility of not applying the knowledge they have in clinical practice. In comparison to other studies, Bianco *et al.* (2013) and Chen *et al.* (2015) found out that knowledge was increasing as the number of years in practice increases. Experience can increase knowledge of the best practices (Chen *et al.* 2015)

5.2 SUMMARY OF THE STUDY

The purpose of this study was to determine critical care nurses' evidence-based knowledge of management of central venous catheters in four intensive care units in a central hospital in Gauteng.

The objective of the study was to describe critical care nurses' evidence-based knowledge of central venous catheters in four intensive care units in a public hospital in Gauteng. This objective was met as the critical care nurses' knowledge was established as good regarding evidence-based guidelines for the management of central venous catheters.

The study was conducted in four adult ICUs of a central hospital in Gauteng, with a population of 80 trained critical nurses. Pilot study was done prior to main study to examine practicability and comprehension of the questionnaire and four critical care nurses participated. A questionnaire developed by Esposito, Guillari and Angelillo (2017) was modified and used as a data collecting

instrument. Data collection ran for a period of three months, from November 2020 to January 2021. A quantitative, non-experimental, and descriptive research design was used to achieve the objective of the study. Data analysis was done with the assistance of a biostatistician. Descriptive and inferential statistics were used to describe the data and reported in frequencies and percentages. Statistical testing was done at p-value<0.05. The methodology for this study was appropriate. The research question was answered, and the study objective was met.

5.2 LIMITATIONS OF THE STUDY

The limitations for the study were:

- The study was carried out in one hospital.

In view of the above limitations, the findings for this study cannot be generalized to other populations.

5.3 RECOMMENDATIONS

The emergence of new conditions and use of high technology equipment makes ICUs to be complex and challenging environments. Therefore, patient safety should always be the number one priority in these setting. Based on the promotion of patient safety and delivery of quality care, recommendations are made for clinical nursing practice, and nursing research.

5.5.1 Recommendations for clinical nursing practice

- There is a need to increase awareness about Evidence-based practice in relation to CLABSI guidelines through regular in-service lectures and demonstration of CVC care in the areas such as hand hygiene, use of chlorhexidine solution to disinfect insertion sites as well as not routinely using anticoagulants on the insertion sites.

- Induction programs for the newly qualified nurses in ICUs should incorporate evidence-based guidelines for the prevention of CLABSI.

- Nurses should be encouraged to engage in research activities in their area of specialty to maintain the current level of EBP.

5.3.2 Recommendations for Nursing research

- The study should be carried out in other hospitals with a larger sample size.
- Further research study should be done to assess the implementation and compliance to guidelines for the prevention of CLABSI.

5.4 CONCLUSION

The purpose of the study was to determine critical care nurses' evidence-based knowledge for the management of central venous catheters. Knowing the knowledge level may assist in planning continuous development trainings in ICUs based on the identified level. Knowledge may contribute to compliance to practice which in turn may lead to quality nursing care.

The knowledge of the participants was found to be good in this study, however it should be noted that knowledge does not reflect the practices or compliance to guidelines. This is because our current study findings reflect good baseline knowledge, but we still have the emergence of CLABSI in the ICUs. There was a positive, moderate correlation between age groups and scores. Although it is expected that knowledge increases with experience, this study showed no correlation between scores and years of experiences. Nurses with Diploma in critical care nursing scored similarly to those with MSc nursing (critical).

This chapter concludes the research report. It provided discussion of the findings, summary of the study, main results, recommendations, and conclusions. Learning is an on-going process which does not have a limit, therefore improvement in knowledge can aid in decision making processes regarding patient care.

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APPENDINX A: DATA COLLECTING TOOL

CRITICAL CARE NURSES'KNOWLEDGE OF EVIDENCE-BASED GUIDELINES FOR THE MANAGEMENT OF CENTRAL VENOUS CATHETERS

SECTION A: DEMOGRAPHIC DATA AND PROFESSIONAL CHARACTERISTICS

1. What is your age?

20-29 years	
30-39 years	
40-49 years	
50-59 years	
60 years and above	

2. What is your highest nursing qualification?

Diploma in Critical Care Nursing	
MSc Nursing (Critical care nursing)	

3. How many years do you have of intensive care unit experience?

6-11 months	
1-5 years	
6-10 years	
>10 years	

4. How many beds do you have in the intensive care unit?

<8 beds	
8-15 beds	
>15 beds	

SECTION B: ASSESSMENT OF INDIVIDUAL KNOWLEDGE ON EVIDENCE-BASED INTERVENTIONS FOR THE MANAGEMENT OF CENTRAL VENOUS CATHETERS

Which is the recommended evidence-based practices for the management of central venous catheters to prevent Central Line-Associated Bloodstream Infections (CLABSI)?

	Yes	No	I do not know
1. Flush the lumen with saline after the administration of medication or fluid	☐	☐	☐
2. Use sterile gauze or sterile transparent semi-permeable dressing to cover the catheter site	☐	☐	☐
3. Disinfect the needless connectors before administering medication or fluid	☐	☐	☐
4. Replace the catheter site dressing every 7 days for sterile semipermeable dressing or if the dressing becomes visibly soiled or loosened	☐	☐	☐
5. Use topical antibiotic ointment on catheter insertion sites	☐	☐	☐
6. Replace the IV administration sets every 72 hours	☐	☐	☐
7. Disinfect the catheter insertion site with hydrogen peroxide	☐	☐	☐
8. Routine use of anticoagulants solutions	☐	☐	☐
9. Monitor the catheter sites visually or by palpation through an intact dressing on a regular basis	☐	☐	☐
10. Allow the skin antiseptic on the insertion site to dry before catheter insertion	☐	☐	☐
11. The use of gloves before infusion port access replaces the need for hand washing	☐	☐	☐

Thank you for completing this questionnaire.

APPENDINX B: INFORMATION SHEET

CRITICAL CARE NURSES' KNOWLEDGE OF EVIDENCE-BASED GUIDELINES FOR THE MANAGEMENT CENTRAL VENOUS CATHETERS

Study information sheet

Dear Sir/Madam

My name is Rebaeng Gaonyatsege-Thankane. I am a masters' student in the field of Critical care nursing at the University of Witwatersrand. As part of my qualification, I am bound to conduct a research study and would therefore like to invite you to participate in my research study. The purpose of the study is to describe critical care nurses' knowledge on the evidence-based guidelines for the management of Central venous catheters.

Your decision to participate in the study is voluntary and you cannot be penalized for refusal. Even if you consented to participate in the study, you may withdraw your consent anytime without any consequences. Completion of the questionnaire will take less than 15 minutes of your time. After completing the questionnaire, you will post it on the provided sealed box. By completion of the questionnaire, it implies that you have consented to participate in the study. The questionnaire is anonymous in that you will not write your name on it. Completed questionnaires will be stored in a secure place under lock and key only accessible to the researcher and the supervisor. The result of the study will be available to you should you wish.

This study has been approved by the Human Research Ethics Committee (Medical) of the University of the Witwatersrand, Johannesburg.

Thank you for taking time to read this information sheet. If you have any questions or concerns about the research, kindly contact me or my research supervisors on the following communication modes.

- Rebaeng Gaonyatsege-Thankane; 073 629 2926 or email; 1826321@students.wits.ac.za
- Ms Linette Engelbrecht (MSc). Telephone no. 011 488 4061; e-mail: linette.engelbrecht@wits.ac.za
- Ms. Vivian Herbert (MSc). Telephone no: 011 488 4273; e-mail: Viv.Herbert@wits.ac.za

APPENDIX C: ETHICS CLEARANCE CERTIFICATE

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

R14/49 Mrs Rebaeng Gaonyatsege-Thankane

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M200623 MED20-05-103

NAME: (Principal Investigator)	Mrs Rebaeng Gaonyatsege-Thankane
DEPARTMENT:	Nursing Education Charlotte Maxeke Johannesburg Academic Hospital
PROJECT TITLE:	Critical care nurses' knowledge of evidence-based guidelines for the management of central venous catheters
DATE CONSIDERED:	26/06/2020
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Mrs Linette Engelbrecht and Mrs Vivian Herbert
APPROVED BY:	Dr C Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	14/09/2020

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary in Room 301, Third floor, Faculty of Health Sciences, Phillip Tobias Building, 29 Princess of Wales Terrace, Parktown, 2193, University of the Witwatersrand. I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report**. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. In this case, the study was initially reviewed June and will therefore be due in the month of June each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature _____ Date _____

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

APPENDIX D: HOSPITAL APPROVAL LETTER



GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

MAXEKE JOHANNESBURG ACADEMIC HOSPITAL

Office of the Nursing Director
Enquiries: Mr. Moses Tshabuse
Tel: (011) 488-4558
Email: Moses.Tshabuse@gauteng.gov.za
12 August 2020

GP_202008 _006

Dear Rebaeng Gaonyatsege-Thankane

STUDY TITLE: Critical care nurses' knowledge of evidence-based guidelines for the management of central venous catheters

Permission is granted for you to conduct the above-mentioned study as described in your request provided:

1. Charlotte Maxeke Johannesburg Academic Hospital will not anyway incur or inherit costs as result of the said study.
2. Your study shall not disrupt services at the study sites.
3. Strict confidentiality shall be observed at all times.
4. Informed consent shall be solicited from patients participating in your study.

Please liaise with the HOD and Unit Manager or sister in charge to agree on the dates and time that would suit all parties.

Kindly forward this office with the results of your study on completion of the research.

Supported / ~~not supported~~

Ms. M Pule
Nursing Director
DATE: 12/08/2020

Approved/not approved

Ms. G.M Bogoshi
Chief Executive Officer
Date: 18.08.2020

APPENDIX E: POST GRADUATE COMMITTEE APPROVAL

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Private Bag 3 Wits, 2050

Tel: 02711 7172076

Reference: Mrs Sandra Benn
E-mail: sandra.benn@wits.ac.za

08 September 2020
Person No: 1826321
PAG

Mrs R Gaonyatsege-thankane
Private Bag 007
Bobonong
Bobonong
0000
Botswana

Dear Mrs Rebaeng Gaonyatsege-thankane

Master of Science in Nursing: Approval of Title

We have pleasure in advising that your proposal entitled *Critical care nurses' knowledge of evidence-based guidelines for the management of central venous catheters* has been approved. Please note that any amendments to this title have to be endorsed by the Faculty's higher degrees committee and formally approved.

Yours sincerely

Mrs Sandra Benn
Faculty Registrar
Faculty of Health Sciences