Professional nurses' knowledge and clinical practice regarding patients with a traumatic brain injury in a tertiary hospital

By

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DECLARATION

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Date: December 2019

ABSTRACT

Background

Traumatic Brain Injury (TBI) is one of the main causes of disability and death worldwide. Even though the best chance of survival of patients with traumatic brain injuries will be in a neurocritical care unit, many patients with traumatic brain injuries are treated in non-specialised critical care units. To date, minimal studies are available that report on professional nurses' knowledge and clinical practices regarding caring of patients with traumatic brain injuries in South Africa.

Aim and objectives

The aim of the study was to determine the knowledge and clinical practice of professional nurses caring for patients with TBI in a critical care unit (CCU) within a tertiary hospital in the Western Cape of South Africa. The objectives for the study were to:

- Determine the knowledge of professional nurses caring for patients with TBI in a CCU.
- Investigate the clinical practice of professional nurses caring for patients with TBI in a CCU.

Research methodology

A quantitative descriptive study was conducted at a tertiary hospital in the Western Cape. The target population included all critical care nurses (N=98). Ethical approval was obtained from the Research Ethics Committee of Stellenbosch University (Reference: S17/07/120) and the tertiary hospital.

Data was collected through a self-administering questionnaire and a pilot testing was conducted involving nine participants. The results from the pilot testing were excluded from the main study. Analysis was done with the assistance of a statistician from Medicine and Health Faculty of Stellenbosch University using Software for Statistics and Data Science (STATA) program.

Results

A mean knowledge score percentage in CCU revealed 71% overall. Participants with a nursing degree were more knowledgeable than nurses with diploma and Masters/Honours degree. The knowledge score of nurses working in Neurocritical Care unit scored the highest percentage of 75% as total knowledge score and nurses within the Coronary Care unit had the lowest score of 66%. With regard to knowledge score of employment, it was evident that critical care nurses working for an agency have the highest knowledge score percentage of 75% compared to permanent staff of 71%.

Only 17% of critical care nurses monitored End Tidal Carbon Dioxide (ETCO2) at all times in their unit. Knowledge of nurses regarding ETCO2 monitoring is limited in clinical practice. Clinical guidelines improve quality of care to decrease variations in clinical practices and 59.6% of critical care nurses stated that they had never come across guidelines and protocols with regard to the management of raised intracranial pressure in the critical care unit.

Recommendations

Recommendations for this study include neurocritical care education, the amendments of protocols and guidelines, ETCO2 monitoring for all intubated patients, considering clinical competencies and rotation of critical care nurses.

Conclusion

A better understanding of TBI may result from the study and assist mentors, educational and administration staff to promote quality care for TBI in critical care units. The focus should be on becoming better nurses, experts in caring for patients with TBI and the ability to make countless decisions in order to solve problems in clinical areas.

Keywords

Knowledge, Clinical Practice, Brain, Trauma, Head Injury, Critical Care, Critical Care Nurse

OPSOMMING

Agtergrond

Traumatiese breinbesering (TBB) is wêreldwyd een van die hoofoorsake van gestremdheid en dood. Alhoewel die beste kans vir oorlewing van pasiënte met traumatiese breinbeserings in ’n neuro-intensiewe sorgeenheid is, word baie pasiënte met traumatiese breinbeserings in ongespesialiseerde intensiewe sorgeenhede behandel. Tot op datum is minimale studies beskikbaar wat verslag lewer oor professionele verpleegkennis en kliniese praktyke ten opsigte van die sorg van pasiënte met traumatiese breinbeserings in Suid-Afrika.

Doelstelling en doelwitte

Die doel van die studie is om die kennis en kliniese praktyke van professionele verpleegsters wat pasiënte met TBB in ‘n intensiewe sorgeenheid (ISE), binne ‘n tersiêre hospitaal in die Wes-Kaap van Suid-Afrika te bepaal. Die doelwitte van die studie is om:

- Die kennis van professionele verpleegsters wat pasiënte met TBB in ‘n ISE versorg, te bepaal
- Die kliniese praktyk van professionele verpleegsters wat pasiënte met TBB in ‘n ISE versorg, te ondersoek.

Navorsingsmetodologie

‘n Kwantitatiewe beskrywende studie is by ‘n tersiêre hospitaal in die Wes-Kaap gedoen. Die teikenbevolking het alle intensiewe sorgverpleegsters ingesluit (N=98). Etiese goedkeuring is verkry van die Gesondheid- en navorsingsetiekkomitee aan die Universiteit van Stellenbosch (Verwysing: S17/07/120) en die tersiêre hospitaal.

Data is gekollekteer deur n selfgeadministreerde vraelys en ‘n loodstudie wat deur die navorser versprei was is gedoen deur nege deelnemers te betrek. Die resultate van die loodstoets is nie by die hoofstudie ingesluit nie. Die data analise is met behulp van ‘n ervare statistikus gedoen wat gebruik gemaak het van die Sagteware vir Statistiek en Data Wetenskap (STATA) program.

Resultate

n Gemiddelde kennistelling in ISE het 71% in geheel getoon. Deelnemers met ‘n verpleegkundegraad is meer kundig as verpleegsters met ‘n Diploma in Verpleegkunde en Meesters/Honneursgraad. Die kennistelling van verpleegsters wat in ‘n Neuro-intensiewe eenheid werk, het ‘n telling van 75% as totale kennis en verpleegsters binne die Koronêre Sorgeenheid het die laagste telling van 66% behaal. Met betrekking tot die kennistelling van

indiensneming, was dit duidelik dat intensiewe sorgverpleegsters wat vir ‘n agentskap werk, die hoogste kennistellingpersentasie van 75% het, in vergelyking met 71% van die van permanente personeel.

Slegs 17% van intensiewe sorgverpleegsters het Ent Tidale Koolstofdioksied (ETKD2) ten alle tye in hulle departement gemonitor. Verpleegsters se kennis ten opsigte van die monitering van ETKD2 is beperk in kliniese praktyke. Die toepassing van kliniese riglyne verbeter die kwaliteit van sorg om die variasies in kliniese praktyke te verminder en 59.6% van intensiewe sorgverpleegsters het gemeld dat hulle nog nooit op riglyne en protokol afgekom het, met betrekking tot die behandeling van intraskedeldrukking in die intensiewe sorgdepartement nie.

Aanbevelings

Aanbevelings vir hierdie studie sluit in neuro-intensiewe sorgopleiding, die wysigings van protokol en riglyne, ETKO2 monitering van alle intubasie-pasiënte, met inagneming van kliniese vaardighede en rotering van intensiewe sorgverpleegsters.

Gevolgtrekking

Hierdie ondersoek mag aanleiding gee tot ‘n beter begrip van TBB om sodoende mentors, opvoeders en administratiewe personeel te help om beter kwaliteitsorg te bied aan pasiënte met TBB in intensiewe sorgeenhede. Die fokus behoort te wees om beter verpleegsters te word en deskundiges te wees wat sorg vir pasiënte met TBB, asook om oor die vermoë te beskik om vele besluite te neem in die oplossing van probleme in kliniese areas.

Sleutelwoorde

Kennis, Kliniese praktyk, Brein, Trauma, Brein besering, Intensiewe sorg, Intensiewe sorgverpleegster

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CHAPTER 1: FOUNDATION OF THE STUDY

1.1 INTRODUCTION

This researcher investigated the knowledge and clinical practice of professional nurses caring for patients with Traumatic Brain Injury (TBI) in a Critical Care Unit (CCU) within a tertiary hospital in the Western Cape of South Africa. This chapter introduces the foundation of the study and the significant contribution of the study. Furthermore, the justification for the study and a brief account of the research methodology are outlined.

Traumatic Brain Injury (TBI) is one of the main causes of disability and death worldwide (Hallman & Joffe, 2013:89). These head injuries are treated at healthcare centres in the private and public sector. Due to the high influx of patients with head injuries, hospitals began to organise separate units, which include neuro-critical care to make efficient use of equipment and highly specialised trained nursing staff to care for these patients (Urden, Stacy & Lough, 2018:2). The neurocritical care community stresses that nurses caring for patients with TBI should be qualified in clinical haemodynamic assessment, monitoring and stabilisation of these patients. Subtle changes should be detected and addressed immediately, as an imbalance of cerebral hemodynamic with pressure on critical brain structures, occurs immediately with potential irreversible damages. Furthermore, patients admitted with primary TBI is subjected to secondary injury which is more complexed to treat and subsequently boosts the morbidity and mortality of TBI (Tsaousi & Bilotta, 2016:1). Sanfilippo, Santonocito, Veenith, Astuto and Maybauer (2015:326) argued that the management of the intracranial pressure is key in the treatment of TBI. In the neurocritical care community it is a priority that expert nurses who are dedicated, competent and specifically trained, care for patients with TBI (Tsaousi & Bilotta, 2016:2).

However, the researcher, a trained critical care nurse, who previously worked in the CCU unit for less than 2 years, resigned to work for an agency in an emergency department and relocated to Saudi Arabia. He observed that patients with TBI at a tertiary hospital in the Western Cape, are admitted to different critical care units. In practice, the tertiary hospital only has one CCU with (6 beds), thus patients are sent to non-neuro CCUs if beds are unavailable. This health facility (tertiary hospital) also admit patients from other provinces and don’t always have space for TBI patients in the neuro CCU. Even though the best chance of survival of patients with traumatic brain injuries will be in a neuro-critical care unit, many patients with traumatic head injuries are treated in non-specialised critical care units. Furthermore, the neurological prognosis of such patients admitted in a non-neurocritical care unit is poor, due to seemingly unqualified and inexperienced professional nurses taking care of patients with TBI (Suadoni, 2009:35).

It is important for all professional nurses working in all the different critical care units of the public sector to understand the physiological effects of raised intracranial pressure of brain injuries, the significance of vital observations and how to care for these patients (Tsaousi & Bilotta, 2016:1). Futhermore, Benner (1982:403), indicated that beginner (novice) nurses who have no experience caring for patients, such as traumatic brain injuries in a critical care setting, presenting with intracranial and brain oxygenation monitors, will experience difficulties in executing tasks that are lifesaving, because of their inability to use discretionary judgement to care for TBIs. Therefore, it is important to investigate the knowledge and clinical practice of professional nurses caring for patients with TBI in the critical care units, in the tertiary hospital of the Western Cape, in order to improve the care of patients with TBI.

1.2 RATIONALE

Neurological patients have lower mortality and better outcomes when cared for in a specialised neuro-critical care unit than in general critical care units (CCUs) (Kurtz, Fitts, Sumer, Jalon, Cooke, Kvetan & Mayer, 2011:477). As a result, this will have an impact on their clinical judgement, caring practices, system thinking and clinical inquiry (Gentile, 2012:101). Monitoring of neuro-critical patients can be complex and challenging, due to the variances in parameters of the vital signs and specific knowledge of monitoring devices. Therefore, the more knowledge the critical care nurse accumulates, the better the outcomes for the critically ill patient, in order to prevent further impediments to the already critical patient.

According to Urden, Stacy & Lough (2018:2), nurses work technically with theoretical knowledge and are considered knowledgeable workers, attributed to their high vigilance, intelligence and cognition to swiftly draw together multiple data and make precise decisions regarding subtle and or deterioration of a patient’s condition. However, the primary aim of immediate care is to detect and avert neurological deterioration, while supporting the systemic as stated by Pritchard and Radcliffe (2011:233).

Mattar, Ying and Chan (2013:272) mentioned that, while devoting time in neuroscience disciplines, assessment of the Glasgow coma scale (GCS) between nurses were always incongruous, contradictory and occasionally led to the inaccurate assessment of patients. A proper and accurate assessment should be done on each shift, in order to monitor the progress of the critically ill patient and see if there is a slight improvement on the Glasgow coma score. Clinical knowledge, decision making and competence play an important role in caring for these patients (Gentile, 2012:103).

1.3 PROBLEM STATEMENT

Patients with TBI admitted at a tertiary hospital in the Western Cape are being nursed by non-specialised neurocritical nurses which hold a risk and devastating projection for these patients. The nursing care of patients with a TBI in CCUs other than a neurospecialised CCU, poses serious problems to the quality care of such patients which subsequently contribute to an increased morbidity and mortality rate. With the high influx of neurosurgical patients and limited bed occupancies in neurocritical care units, many patients require admission to additional CCUs. Therefore, specific nuances that are significant to neurocritical care patients become unrecognised (Kramer & Zygun, 2011:329) and lack of standardisation and dissimilarity of care across different CCUs occur (Lott, Iwashyna, Christie, Asch, Kramer & Khan, 2009:681; Taran, Trivedi, Singh, English & McCredie, 2018:53).

In these additional units, the knowledge and skills differ from unit to unit, since critical care is focused on unit-specific care only and this may initiate a dissimilar attitude towards the process of caring for the patient with a TBI (Tweedie, 2016:62). Professional nurses caring for patients with TBIs should have the adequate knowledge and clinical practices, in order to mitigate TBIs morbidity and mortality. Therefore, it is necessary to investigate the knowledge and clinical practice of professional nurses caring for patients with TBIs in a CCU within a tertiary hospital in the Western Cape of South Africa, as no previous studies were done.

1.4 RESEARCH QUESTION

What is the knowledge and clinical practices of professional nurses regarding patients with a traumatic brain injury in a tertiary hospital?

1.5 RESEARCH AIM

The aim of the study was to determine the knowledge and clinical practice of professional nurses caring for patients with TBI in a tertiary hospital.

1.6 RESEARCH OBJECTIVES

The objectives of this study were to:

- Determine the knowledge of professional nurses caring for patients with TBI in a CCU within a tertiary hospital within the Western Cape
- Investigate the clinical practice of professional nurses caring for patients with TBI in a CCU within a tertiary hospital within the Western Cape.

1.7 THEORETICAL FRAMEWORK

The theoretical framework for this study is guided by Patricia Benner's model (Figure1.1) of clinical competence. This model is still applicable and utilised by scholars in the 21st century to acknowledge levels of proficiency, allowing neophyte professional nurses to be mentored to reach the highest level of proficiency in the nursing profession, thus improving patient care and patient safety. Nursing in acute-care settings has grown so complex that it is no longer possible to standardise, routinise and delegate much of what the nurse does (Benner, 1982:402). Complex healthcare technology and specialisation increased, acuity levels of patients escalated and the need for highly experienced nurses arisen (Benner, 1982:402). Knowledge and clinical practice of caring for patients with TBI run parallel and therefore knowledge and clinical practice cannot be separated in nursing practice (Ajani & Moez, 2011:3929).

Benner's model who applied the Dreyfus Model of Skill Acquisition to nursing practice, entails five levels of proficiency namely, novice, advanced beginner, competent, proficient and expert (Benner, 1982:402). The model provides a basis for clinical knowledge development and progression in clinical nursing practice.

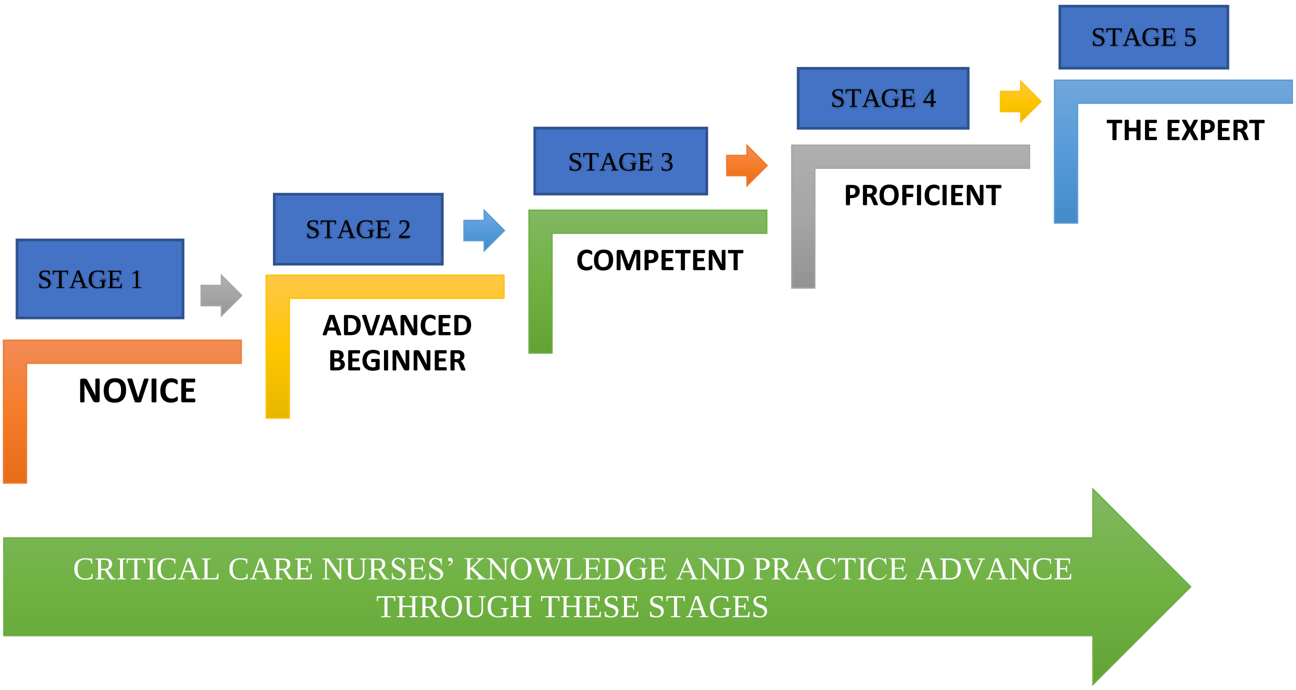

Figure 1.1: Patricia Benner (1982). From novice to expert: Excellence in clinical nursing practice.

1.7.1 Novice

The beginner has no experience and therefor adheres to rules rigidly with no use of discretionary judgement that relies on rational decision making (Gentile, 2012:101). No rule can tell a novice which task is most relevant in real life situations (Benner, 1982:403). The novice practitioner relies heavily on policy and procedures and has difficulty with ill-defined problems and limited experience with a variety of clinical situations on which to base decisions (Gentile, 2012:106). The novice learns the numerical value of raised intracranial pressure and is given specific rules when the pressure exceeds the normal value.

1.7.2 Advanced beginner

The advanced beginner demonstrates acceptable performances and persists with prior experience in actual situations. Guidelines can be initiated because the practitioner requires occasional supportive cues (Benner, 1982:404). The advanced beginner is unsure of her assessment and needs assistance with coordination, therefore, she has to rely on policy and protocols to guide her patient care (Gentile, 2012:106). During this stage, knowledge is developing. The advanced beginner will administer mannitol (osmotic diuretic) or hypertonic saline (saline solution with a concentration of sodium chloride higher than physiological 0.9%), according to the protocol for persistent raised intracranial pressure (Hickey, 2014:286).

1.7.3 Competent

The nurse is able to demonstrate efficiency and has confidence in her actions. This stage is characterized by a feeling of mastery and the ability to cope with and manage the many contingencies of clinical nursing (Benner, 1982:405). According to Gentile (2012:104), the practitioner provides routine and complex care using clinical information and nursing skills/technology based on conscious and deliberate planning. The competent nurse takes the cerebral perfusion pressure in consideration when a larger dose of sedation is needed. The competent nurse will realise when the patient's blood pressure becomes too low; it may have adverse effects on the patient's cerebral perfusion pressure and requires immediate intervention.

1.7.4 Proficient

Proficient nurses understand a situation as a whole, because they perceive its meaning in terms of long-term goals. Furthermore, experience teaches the proficient nurse what events to expect in a given situation and how to modify plans in response to these incidents (Benner, 1982:405). The proficient nurses initiate appropriate interventions in an attempt to prevent deterioration (Gentile, 2012:104). The proficient nurse assesses the current situation and will decide if a patient needs inotropic support in conjunction with continuous sedation, to maintain cerebral perfusion and a therapeutic intracranial pressure for the TBI patient.

1.7.5 Expert

According to Benner (1982:405), the expert operates from a deep understanding of the total situation. Gentile (2012:104) stated that the expert prevents future complications or adverse situations by thinking ahead and using preventative action. The expert applies innovative interventions and nursing skills/technology to carefully correlate to the patient's response and the integration of research-based knowledge into nursing practice (Gentile, 2012:104). The expert assesses the patient's pupil response in conjunction with the GCS, in the event of abnormality and deterioration. She or he alerts the medical practitioner immediately about a possible bleed on the affected side of the brain and starts to prepare for an urgent Computerised Tomography (CT) scan, as well as preparation for possible surgical intervention.

According to Gentile (2012:107), some nurses stagnate at a level and their practice does not advance beyond that point, and this is known as a perpetual novice status. Along with skills and knowledge, the critical care nurse progresses through the levels of expertise to overcome stagnation and convert to skilful critical care nurses caring for patients with TBI.

1.8 RESEARCH METHODOLOGY

1.8.1 Research design

A quantitative descriptive research design was used to conduct the study. The design was chosen to acquire knowledge and clinical practice of professional nurses caring for patients with TBI in a CCU within a tertiary hospital in the Western Cape in South Africa.

1.8.2 Study setting

The study includes professional nurses working in critical care units, in a public tertiary hospital in the Western Cape in South Africa.

1.8.3 Population and sampling

The study was conducted in a critical care unit of a tertiary hospital in the Western Cape in South Africa. The target population was professional professional nurses (N=98) working in the critical care units. A sample size calculation was done and the result was close to the target population of 98. Therefore, the statistician supported no sampling and that all participants should be included in the study. The population consisted of critical care professional nurses either neophyte, experienced or critical care trained operational in a CCU. Professional nurses on short, annual or sick leave were excluded from the study.

1.8.4 Data collection tool

The researcher used a paper-based questionnaire containing four sections marked as Appendix 4. A self-administered survey pertaining to the knowledge and clinical practice of professional nurses regarding the care of patients with traumatic brain injuries in critical care was used. This entails dichotomous questions, multiple-response statements with Likert-scales pertaining to the knowledge and clinical practices. Pre-testing of the instrument

The pre-test was conducted in March 2018 to check reliability, validity, the wording of the survey; statistical and analytical processes to determine the efficacy of the tool and modifications were made accordingly.

1.8.5 Pre-testing of the instrument

The pre-test was conducted in March 2018 to check reliability, validity, the wording of the survey; statistical and analytical processes to determine the efficacy of the tool and modifications were made accordingly.

1.8.6 Validity and reliability

Validity and reliability of the instrument were ensured by developing questions supported by existing literature. Validity was ensured by content and face validity. The instrument was reviewed by two experts in the neurosurgical field for evaluation, modification and to improve its content-related validity. Reliability was ensured by the accuracy and consistency of the information obtained in the study, as well as the interpretation of statistical results.

1.8.7 Data collection

A self-administered questionnaire was utilised to collect the data for the study. The researcher distributed the questionnaires at the tertiary institution and collected them after completion, over a period of two weeks.

1.8.8 Data analysis and interpretation

Statistical analysis was done by using the Software for Statistics and Data Science (STATA) program. Since the objectives were descriptive, analysis was done by the statistician, Dr Moleen Zunza using descriptive and inferential statistics. Frequency tables and relative frequencies were used to report data and illustration was done graphically by using bar charts.

1.9 ETHICAL CONSIDERATIONS

The approval of the Health Research Ethics Committee (HREC) at Stellenbosch University is the reference number: S17/07/120 (Appendix 1), for approved the research study. The research study was conducted according to the ethical guidelines and principles of the international Declaration of Helsinki, October 2013**.** After obtaining permission for the study, the researcher obtained permission from the respective hospital manager (Appendix 2), to conduct the study in their hospital. Thereafter, permission from the nurse manager and head of critical care medicine were obtained in order to conduct and access the participants.

The following ethical principles were supported during the research study:

1.10 INFORMED CONSENT

Informing refers to the transmission of essential ideas and content from the investigator to the prospective subject, whereby consent is the prospective subject's agreement to participate in a study as a subject (Grove *et al*., 2013:176). A full explanation was given to the participants regarding the nature and objectives of the study prior to the completion of the consent form for the study. Participation was completely voluntary and it clearly stated that the participant could withdraw at any stage if they wished. The participants were instructed to sign a consent form with a witness. One copy of the consent form was given to the researcher and one copy was returned to the participant after completion. After completion, participants placed the completed questionnaires and consent in a sealed envelope, and posted the envelopes in the boxes provided. The researcher was not able to identify participants by name, because they were completely anonymous.

1.11 RIGHT OF PRIVACY, ANONYMITY AND CONFIDENTIALITY

Privacy was maintained which is an individual's right to determine the general circumstances and extent under which personal information will be shared with or withheld from others (Grove *et al.,* 2013:169). Furthermore, the participants had the right to anonymity and the right to assume that data collected were kept confidential and that their identities could not be linked to them (Grove *et al*., 2013:171). The questionnaires will remain anonymous. A written consent form will be signed first, placed in an envelope and sealed off, where after the questionnaire will follow. All signed consent forms and questionnaires will be kept in a locked file cabinet in a secure room by the researcher for five years after the study has been completed. Only the researcher will have access to the documentation.

1.12 RIGHT TO PROTECTION FROM DISCOMFORT AND HARM

According to Grove *et al*. (2013:174) protection from discomfort and harm is based on the ethical principle of beneficence which holds that one should do good and inflict no harm. No harm was anticipated and no harm was observed during the duration of the study. Furthermore, no participant reported any discomfort or harm. Data generated from the study will benefit both nursing staff and patients towards improving quality of care towards traumatic brain injury patients.

1.13 RIGHT TO SELF-DETERMINATION

Participants have the right to decide voluntarily whether to participate in the study, without risking prejudicial treatment and have the right to ask questions, refuse to answer questions and drop out of the study (Polit & Beck, 2018:81). The questions the participants asked about the study were addressed and no participant asked to drop out of the research study.

1.14 CONCEPTUAL DEFINITIONS

1.14.1 Adult critical care nurse

This is a professional nurse who focuses on patients that are critically ill or unstable in the collaboration of a healthcare team. The nurse functions within a complex technological environment and displays a high level of knowledge, skill and competence in caring for the patient and family support system to be discharged in a safe place (SANC, 2014:2).

1.14.2 Critical care

It refers to an organized system for the provision of care to critically ill patients that provides intensive and specialized medical and nursing care, enhanced capacity for monitoring and multiple modalities of physiological organ support to sustain life during the period of life-threatening organ insufficiency (Marshall, Bosco, Adhikari, Connoly, Diaz, Dorman, Fowler, Meyfroidt, Nakagwawa, Pelosi, Vincent, Vollman, Zimmerman, 2017:270).

1.14.3 Critical care unit

A specially staffed and equipped, separate and self-contained are of a hospital dedicated to the management and monitoring of patients with life-threatening conditions which encompasses all areas that provides level 2 (high dependency) and Level 3 (critical care) (Adam, Osborne, Welch, 2017:24)

1.14.4 Neurocritical care knowledge

Nursing care knowledge is based on specific needs of neurocritical care patients, such as an intracranial pressure management. This includes the understanding of the effect on critical illness on the nervous system as well as knowledge of the disorder with regards to methods of diagnosis, assessment, treatment, management and prevention of further injury (Teitelbaum & Badawy, 2018:1).

1.14.5 Neurocritical care practice

Critical care is based on the most current scientific information, expert opinion and patient preference regarding neurological and neurosurgical activities (Hickey, 2009:6), which builds on the knowledge of basic nursing science and adds the in-depth knowledge and competencies required to provide specialised care to neuroscience patient population (Hickey, 2014:8).

1.14.6 Registered professional nurse

A person who is registered with the SANC in terms of section 31 of the Nursing Act, 33 of 2005. Practising comprehensive nursing independently and assumes responsibility and accountability for such practice (SANC, 2013). Professional nurses in South Africa take the responsibilty of caring for patients in intensive care units, assisted by enrolled and auxiliary nurses.

1.14.7 Traumatic brain injury

Is a head insult to the brain from an external force leading to fatal pathological development in the brain. Traumatic brain injury which is primary injury refers to the initial direct impact of trauma, whereas secondary injury is due to hypoxia during hospitalisation, leading to ischaemia (Oropello, Kvetan, Pastores, 2017:659).

1.14.8 Tertiary hospital

Tertiary hospitals are level three institutions which accept referred patients who require specialised critical care management (Hinds & Watson, 2008:3).

1.15 DURATION OF THE STUDY

Ethical approval had been obtained December 2017 and it was valid from December 2017 to December 2018. Data was collected over a period of two weeks during May 2018. Data was analysed during July 2018. The final thesis was submitted for examination in August 2018.

1.16 TIME FRAME

Literature Review	Continuously
Ethical Approval	December 2017
Pre-Testing of questionnaire	March 2018
Data Collection	May 2018
Analysis and interpretation of data	July, August 2018
Research Thesis	October, November 2018
Technical and grammar editing	July, August 2019
Thesis Submission	August 2019

1.17 CHAPTER OUTLINE

Chapter 1: Foundation of the study

describes the background and rationale for the research study, the problem statement and the research objective, and it also offers a brief overview of the research methodology. The ethical considerations are also discussed in this chapter.

Chapter 2: Literature review

This chapter comprises of an in-depth review of the relevant literature regarding the topic of care of patients with traumatic brain injury.

Chapter 3: Research methodology

Chapter 3 describes and discusses the research design and research methodology that were employed during this study.

Chapter 4: Results

Chapter 4 describes and discusses the analysis and interpretation of the collected research data.

Chapter 5:

Discussion, conclusion and recommendations.

1.18 SUMMARY

The research aim, question and objectives were discussed to clarify the justification for the study. A conceptual framework was included in briefing the reader of the proposed study and how the theory incorporates with the clinical practice. The research methodology was discussed and clearly outlined the steps that would be taken when the research commenced, during the research process, as well as how the findings would be used to draw conclusions from the study.

1.19 CONCLUSION

In chapter 1, an introduction and rationale of the pursued study were provided. The aim, problem statement, objectives, conceptual framework and research methodology were highlighted for the study. An in-depth discussion of ethical considerations pertaining to the study was discussed. In the next chapter, literature relating to knowledge and clinical practice of critical care nurses in critical care units regarding caring for patients with TBI, will be discussed.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

In this chapter, an overview focusses on existing literature based on knowledge and clinical practices of Traumatic Brain Injuries (TBI) in critical care. The chapter includes past research conducted with emphasis on Traumatic Brain Injury (TBI) and what is currently known, and how knowledge and clinical practices have an impact on caring for these critically ill patients. An overview of TBI and Neurocritical Care, knowledge of caring for patients with TBI, as well as clinical practices of TBI will be covered in the chapter.

2.2 LITERATURE REVIEW

Relevant literature related to knowledge and clinical practices of patients with traumatic brain injuries were reviewed throughout the study and continually evaluated recent practices in managing these patients in the critical care environment. The researcher made use of various search engines and textbooks to get a broader view regarding existing literature. Google Scholar database, Science Direct, Cumulative Index of Nursing and Allied Health Literature (Cinahl) and Public/Publisher Medline (PubMed) were used to conduct searches and search terms used were "critical care nurse", "neurocritical care nurse", "knowledge nurse", "knowledge critical care nurse", "clinical practice neurocritical care", "clinical practice critical care", "Traumatic Brain Injury", and "Traumatic Brain injury care."

The literature findings are presented in the following order:

- Overview of Traumatic Brain Injury
- Neurocritical care
- Knowledge of caring for patients with Traumatic brain injury (TBI)
- Clinical practice of Traumatic brain injury (TBI)
- Specific knowledge and practices about caring for patients with traumatic brain injury (TBI).
- Theoretical Framework

2.3 OVERVIEW OF TRAUMATIC BRAIN INJURY

In many parts of the world, patients with neurological injury requiring critical care are managed in one of three models of critical care, namely General Critical Care without direct neurosurgical/neurological input, CCUs co-located with a neuroscience unit, which may be a mixed speciality with direct input from neuroscience specialists or a stand-alone Neuro-Critical Care Unit (Tweedie, 2016:62). Neurological patients have lower mortality and better outcomes when cared for in specialised neurocritical care units than in general CCUs (Kurtz, Fitts, Sumer, Jalon, Cooke, Kvetan & Mayer, 2011, 477; Kramer & Zygun, 2011:332).

Knowledge about critical parameters is important and the recognition of abnormalities to provide the bedside nurse with guidance when to provide therapeutic interventions and when to summons the physician for further management instructions. A neurological assessment forms the foundation database to identify patients' needs for care, interdisciplinary and collaborative problems, plan of care and implement interventions and evaluate the outcomes (Hickey, 2014:180).

Competence in conducting neurological assessments properly by nurses, as well as understanding the meaning of each finding of the broad picture of neurological functioning, interpreting the trends and distinguishes whether to consult the physician to prevent negative, irreversible neurological deterioration are important (Hickey, 2014:180).

Intensive bedside neuromonitoring is critical in preventing secondary ischemia and hypoxic injury common to patients with traumatic brain injury in the days following trauma (Cecil, Chen, Callaway, Rowland, Adler & Chen, 2011:25). Tweedie (2016:62) stressed that optimal care of such patients also demands meticulous attention to maintenance of systemic and cerebral physiological targets, while ensuring appropriate protection of extra-cranial organs.

Traumatic Brain Injury remains the leading cause of death after trauma and the ability to predict outcome accurately has an important role in early clinical decision making (Hoffman, Lefering, Rueger, Kolb, Izbicki, Ruecker, Rupprecht & Lehmann, 2012:122).

2.3.1 Neurocritical care

For many years patients with neurological illnesses were admitted to critical care units where patients with general medical and surgical conditions were managed. Neurocritical care has developed into a subspecialty with expert knowledge and expertise to manage patients with acute neurological injuries (Wijdicks, 2017:3; Bithal, 2016:1). Currently, neurocritical care offers specific care which includes, monitoring of intracranial pressure, cerebral hemodynamic improvement, therapeutic hypothermia and advanced monitoring (brain oximetry, cerebral micro dialysis and continuous electroencephalography) (Bithal, 2016:1).

All critical care units should integrate neurocritical care with a primary goal to preserve the brain and specific expertise on central nervous pathophysiology should be evident (Meyfroidt, Menon & Turgeon, 2018;2222). According to Bithal (2016:1), a multidisciplinary approach to neurocritical care is advocated, due to the increased complexity of the neurodiseases.

2.3.2 Knowledge about caring for patients with traumatic brain Injury (TBI)

Although prior studies have assessed nursing care and management of TBI, a limited number of studies have been publishing the focus on knowledge of critical care nurses' caring for the TBI patient. A study conducted by Shehab, Ibrahim and Abd-Elkader (2018:1112), addressed the use of aesthetic knowledge in managing brain injury patients, incorporating the art and science of nursing with the focus on allowing the nurse to truly know and empathise with the civilian and military patients, with no focus and a lack of knowledge pertaining to critical care nurses caring for a traumatic brain injury patient. Shehab et al. (2018:1112) conducted a study with regards to caring for patients with TBI and the study revealed lack of knowledge and emphasized the importance for trained nurses to be equipped with appropriate knowledge and the unique needs of the patient competently.

Traumatic brain injury (TBI) patients have poor prognosis and require quality of care to maximise patients survival, and only with thorough knowledge and judgement of care of these patients, nurses can improve their neurological outcome (Varghese, Chakrabarthy & Menon, 2017:684). It remains evident that a lack of knowledge and skill still exist, caring for patients with TBI (Varghese *et al*., 2017:695).

Research has revealed the gap in nurses' knowledge according to Watts, Gibbons and Kurzweil (2011:128), and the study conducted in the United States has found that there was self-identify knowledge deficits in all aspects of care of the TBI patient and recommended a concise curriculum needed for bedside nurses in order to meet the requirements and provide them with knowledge, skill and abilities to care for the TBI patient.

Varghese *et al*., (2017:695) emphasised that management of TBI requires efforts of bedside nurses to manage the condition with different approaches, because it can be challenging and requires nurses to have enough knowledge and skill to provide quality care and be competent in the healthcare sector.

2.3.3 Clinical practice about caring for patients with traumatic brain injury (TBI)

Although the limited available research has revealed gaps in nurses' knowledge and inconsistencies in clinical practice, limited literature was available on nurses' clinical practice, caring for patients with traumatic brain injury in adults. Current literature focuses on management of mild TBI, with limited to no clinical practice guidelines focusing on severe or acute management of TBI in the adult patient.

American Association of Neuroscience Nurses (AANN) (2014), drafted a clinical practice guideline for the care of a patient with a mild brain injury and the nursing management of adults with severe traumatic brain injury's publication are still under supervision.

Van Wyck, Loos, Friedline, Stephens, Smedick, McCafferty, Rush, Keenan, Powel and Shackelford (2017:130) developed a prolonged field guideline preferably for tactical combat casualty care, when evacuation to a higher level of care is not available and this guideline is limited, because it only focusses on the initial treatment in the emergency unit and not on acute critical care.

The researcher is of the opinion that the BTF guidelines (2016) remain the gold standard, because it synthesizes literature by the available evidence and translate it into recommendations. Recommendations are only made where there is strong evidence, in order to support the management, as well as to observe and clarify what practices currently can and cannot be supported. A study conducted by Patel, Vieira, Abraham, Reid, Tran, Tomecsek, Vissoci, Euker, Gerado and Staton (2016:2) revealed that in Saudi Arabia, patients with severe TBI were managed with individual provider knowledge and experiences initially, but after the Critical Care protocol has been derived and implemented according to the BTF guidelines, Saudi Arabian providers were able to significantly reduce hospital and Critical Care mortality.

2.4 SPECIFIC KNOWLEDGE AND PRACTICES ABOUT CARING FOR PATIENTS WITH TRAUMATIC BRAIN INJURY (TBI) FROM LITERATURE

2.4.1 Glasgow coma scale

The Glasgow Coma Scale (GCS) is used as a surrogate marker for the presence of Traumatic Brain Injury (TBI) and to score the severity of TBI (Hoffman *et al.,* 2012:122). It was introduced in 1974 and has become the most common method of describing the patient's level of consciousness (Barlow, 2012:114; Namiki, Yamazaki, Funabiki & Hori, 2011:397). Mattar *et al.* (2013:272) define it as a neurological instrument, which measures the depth and duration of impaired consciousness. The GCS score is calculated by three components comprising of (eye opening, best verbal response, best motor response) and it is even used by medical personnel with no specialized training (Hoffman *et al.,* 2012:122). In addition, Gulanick and Meyers (2017:573) justified that a decreased level of consciousness is the first sign of raised intracranial pressure and patients usually present with increasing restlessness, irritability, or agitation.

It is vital to understand that the Glasgow Coma Scale (description in words) is used to define individual patients in a clinical situation, whereas the Glasgow Coma Score (a number) was invented for research and audit purposes (Barlow, 2012:115). Today, the total (sum) score from all three components, ranging from 3 which refers to a deep coma to 15 (referring to been fully alert and orientated) is widely practised and recorded in clinical practice (Braine

& Cook, 2017:281). TBI is graded into three severity categories namely: mild (GCS 13-15), moderate (GCS 9-12) and severe (GCS 3-8) categories (Hickey, 2014:356).

There is growing evidence that alludes to problems that have been encountered when completing some aspects of the GCS and the potential to perform an incorrect assessment (Mattar *et al*., 2013:272). Practices of executing GCS between nurses were found incongruous and contradicting, leading to an inaccurate assessment of patients and misunderstanding, with confusion still persisting (Braine & Cook, 2017:280; Mattar *et al.,* 2013:272).

Namiki *et al*. (2011:393) mentioned that the reliability of the GCS is insufficient in clinical practice, although fairly reliable by trained medical personnel. The misinterpretation of patients' true clinical status will adversely affect their management according to Reith, Brennan, Maas and Teasdale (2016:89). In addition, different stimulation techniques are used to assess mental status and it was highlighted that different stimulation methods produce different responses (Reith *et al.,* 2016:93, Barlow, 2012:118). Reith *et al.* (2016:89), and Braine & Cook (2017:288), revealed that a stimulus should first be applied to the fingernail and if there is a flexion response, the head, neck and trunk should be tested afterwards for localisation purposes. The poor distinction between abnormal and normal flexion, assessing confused conversation and the assessment of withdrawal in the best motor response are specific errors made by practitioners (Namiki, 2011:397).

Caution should be taken when assessing lower extremities, because the stimulus of the feet can provoke a triple flexion response, which is a sign of upper neuron impairment and can represent a withdrawal response in reaction to a stimulus, therefore it is not recommended to assess GCS from legs (Reith *et al*., 2016:93; Hickey, 2014:174). Furthermore, Braine and Cook (2017:284) argued that GCS may be misleading in patients presenting with hypoxic, haemodynamically unstable, postictal state of seizure patients. Assessment should be executed at least 10 minutes post ultra-short-acting drugs, such as Propofol should be discontinued, in order not to prevent an inaccurate assessment of the level of consciousness (Hickey, 2014:161). Terms in variations of GCS are common and lead to confusion, particularly when the terms are not defined, for example decerebrate and decorticate are not in the GCS and are best avoided, because they do a specific physio anatomically correlation for which there is no evidence (Barlow, 2012:118).

It is critical to follow a sequence of assessing the TBI patients and a good effort should be made to start at the top and work down to distinguish if the patient obeys commands, prior to the application of pain to assess a localising response (Barlow, 2012:115).

The application of pressure to the supra-orbital ridge is not the best way to test for eye-opening, as this can cause a reflex screwing up of the eyelids, resulting in eye closure (Barlow, 2012:115; Braine & Cook, 2017:288).

Damage to the speech centres, namely the Broca and Wernicke areas in the inferior frontal lobe and posterior temporal lobe, connected together via the nerve fibres called the arcuate fasciculus are the main cause of aphasia or dysphasia and should be taken in consideration when performing the assessment (Braine & Cook, 2017:284). Furthermore, this observation is common to occur when patients have right-sided weakness or evidence of left hemispheric damage (Barlow, 2012:115).

The motor response in neurological assessment is the most important of the three responses. Therefore, it carries the greatest prognostic significance, as well as the response causing most difficulties in assessment (Barlow, 2012:115). Barlow (2012:115-117) refers to motor response as an assessment of both upper limbs (in the best limb) and experience has shown that the best way to learn and teach the motor response is to follow a sequence.

Barlow (2012:117) refers to pinching the upper inner border of the trapezius muscle (the Mr. Spock death grip) or supraorbital pressure (which clinicians prefer not to apply), will cause the patient to raise one hand to the site of stimulation and if lifted above the clavicle, it is classed as localisation.

Pressure to be applied with pen or pencil to the side of the terminal interphalangeal joint rather than nail bed pressure (concern has been raised by some that this can damage the nail, causing it to fall off later) as well as resting the arm on the body approximately 30 to 40 degrees with elbow flexion refers to good flexion characterised when lifting the elbow clear of the body (Barlow, 2012:117).

A new scale, the Full Outline of Unresponsiveness (FOUR) score, was designed in 2005 by the researchers at the Mayo Clinic as an alternative application to the GCS (Johnson & Whitcomb, 2013:181). The FOUR components integrate eye and motor responses, brainstem reflexes and respiration patterns to evaluate the extent of the brain injury (Wijdicks, Kramer, Rohs, Hanna, Sadaka, O'Brien, Bible, Dickess, 2015:440; Braine & Cook, 2017:285). Highlighted by Johnson and Whitcomb (2013:182) the FOUR score scale has great potential and respectable feedback was obtained from nurses stating that it improves their bedside practice in assisting with the explanation of the depth of a patient's brain injury.

According to Wijdicks *et al*. (2015:439) the FOUR score may be a better predictor of mortality in intubated critically ill patients. According to experts, the FOUR score will aid in the accurate assessment of verbal response in intubated patients, as well as patients with abnormal brainstem function, respiratory patterns and in recognising different stages of herniation (Johnson & Whitcomb, 2013:181, Hickey, 2014:16). There are those who argue that the FOUR score provides a reliable neurological assessment of intubated patients, the brainstem and the respiratory component for damage and injury severity, as well as failure to maintain adequate ventilation, where the GCS does not differentiate patient status once intubated (Johnson & Whitcomb, 2013:183, Wijdicks *et al*., 2015:442).

However, the FOUR score appears not to have gained widespread acceptance outside their origin and not being used on a wide scale in clinical practice according to Barlow (2012:114) and Braine and Cook (2017:285). The GCS scale remains the gold standard for assessing the change in patient's consciousness and neurological status (Kornbluth & Bhardwaj, 2011:135; Johnson & Whitcomb, 2013:181; Braine & Cook, 2017:281).

2.4.2 Pupil evaluation

Evaluation of pupil size and light reflexes are essential elements in the protocol for treatment and management of severely brain-injured patients in critical care units worldwide (Couret, Boumaza, Grisotto, Triglia, Pellegrini, Ocquidant, Bruder & Velly, 2016:2). Early detection of pupillary changes in patients with head injuries can alert the team of the possibility of increased intracranial pressure (Kerr, Bacon, Baker, Gehrke, Hahn, Lillegraven, Renner & Spilman, 2016:213). On the other hand, Adoni and McNett (2007:191) stated that confusion regarding the specific aspects of the examination and physiological basis of the pupillary response pertaining to a patient with TBI still exist amongst health professionals.

According to experts, critical care and neurosurgical nurses underestimated pupil sizes in clinical practice and were unable to detect anisocoria and incorrectly assessed pupil reactivity (Kerr *et al*., 2016:213; Couret *et al*., 2016:8; Hoffman *et al*., 2011:122). In the critically ill, measurements of pupil size and reactivity are of great prognostic importance (Couret *et al*., 2016:2). Variations in pupil size may signal neurological deterioration and require a change in clinical management (Kerr *et al*., 2016:214). Pupil sizes focus on four characteristics: diameter, reactivity to light, shape, and presence of anisocoria. Pupil sizes should be assessed on both, before and after viewing to direct light stimuli, and shining light into pupils should immediately cause constriction and on withdrawal it should produce an immediate and brisk dilation of the pupil which is known as direct light reflex (Hickey, 2014:165; Adoni & McNett, 2007:193).

Kerr *et al*. (2016:214) argue that anisocoria remains the most important observation of pupil response and serves as a reliable indicator of TBI. The oculomotor nerve plays an important role in pupil assessment and is located in the midbrain and the tentorial notch. Therefore, any increase in pressure exerts a force down through the tentorial notch, compresses the oculomotor nerve which then results in a dilated, nonreactive pupil (Urden, Stacey & Lough, 2014:334). Research has found that pupil sizes are underestimated by as much as 1.5 mm in diameter and affects clinical decision making due to enlarged pupils indicating cerebral ischemia or herniation (Kerr *et al*., 2016:21: 334). Another point worth noting is that the consensual light reflex is the weaker constriction of the none-stimulated pupil causing the fibres crossing from each side, then intersecting the optic chiasm and posterior commissure of the midbrain (Hickey, 2014:129).

In clinical practice, pupillary evaluation is often assessed with a penlight to test for reactivity and pupil size. However, it is performed in a subjective measure which leads to inaccuracies and inconsistencies (Couret *et al*., 2016:2). To date, the best way to limit misdiagnosis of pupillary abnormalities, is the introduction of infrared pupilometer which provides an objective measurement and records reliable and consistent measurements, regardless of the skill level and level of experience of the practitioner (Couret *et al*., 2016:8; Hickey, 2014:165).

2.4.3 Bedside monitoring

Assessment of the patients remains the most important and the nurse should never become dependent on monitors, because the way the patient presents can provide critical information to determine a diagnosis (Schimpf, 2012:166). Secondary brain injury increases with hypoxia, episodic hypotension, ICP leading to neuronal death and normally generated from acute inflammation, cerebral oedema and ischaemia (Noble, 2010:242). The pathophysiology of brain injury is complex and can involve several secondary pathological cascades causing aggravation of neuronal injury (Stocchetti *et al*., 2013:201).

The core treatment for severe TBI targets the decline in raised ICP and the safeguarding of adequate cerebral blood flow and oxygenation (Farahvar, Gerber, Chiu, Hartl, Froelich, Carney, Ghajar, 2011:1417). Haemodynamic manipulations are cardinal among interventions to regulate cerebral perfusion pressure and cerebral blood flow (Lazaridis, 2012:163). Close neurological monitoring is necessary to guide goal-directed therapy for increased ICP and cerebral perfusion, and is the foundation of such a management strategy (Schimpf, 2012:160). The brain remains contingent on uninterrupted cerebral blood flow to supply metabolic substrates, required for continued functioning and survival, emphasising the need for ICP monitoring (Schimpf, 2012:161).

The assessment of patients by the critical care nurse is to ensure that monitoring devices are accurate and calibrated in the correct way, in order to prevent misinterpretation of the patient’s vital signs which may result in inappropriate administration of treatment (Jones, 2009:303).

On account of deterioration and signs of the Cushing's triad (widening pulse pressures, bradycardia and apnea), a Computerized Tomography (CT) scan (detecting bone and internal injuries) must be done promptly to rule out herniations, mass lesions, as well as life-threatening haemorrhages (Schimpf, 2012:166).

Despite the fact that certain conditions are not favoured for invasive monitoring, new Level II B evidence, according to the 4th edition guidelines of the Brain Trauma Foundation (BTF) recommends that monitoring is a necessity in severe TBI patients and the utilisation of information with regard to ICP values reduce in-hospital and 2-week post-injury mortality (Carney, N., Totten, A.M., O'Reilly, C., Ullman, J.S., Hawryluk, G.W.J., Bell, M.J., Bratton, S.L., Ghestnut, R., Harris, O.A., Kissoon, N., Rubiano, A.M., Shutter, L., Tasker, R.C., Vavilala, M.S., Wilberger, J., Wright, D.W., 2016:133).

2.4.4 Intracranial pressure and cerebral perfusion

ICP monitoring surfaced in the 1960s and aside from its prognostic value, it also guided early diagnostic and management of intracranial hypertension (Farahvar, Berber, Chiu, Hartl, Froelich, Carney, Ghajar, 2011:1474; Dias, Maia, Cerejo, Varsos, Smielewski, Paiva, Czosnyka, 2014:124). According to Farahvar *et al*. (2011:210) there is no difference in in-hospital mortality with using the ICP monitoring device which is also associated with an increased length of stay in monitored patients versus empirically treatment without monitoring. However, Talving, Karamanos, Teixeira, Skiada, Lam, Belzberg, Inaba and Demetriades (2013:1252), found that in-hospital mortality was significantly lower for monitored patients.

The Brain Trauma Foundation substantiates the evidence of lower mortality in in-hospital and 2-week post-injury mortality as Level II B moderate evidence recommendation (Carney *et al*., 2016:133). Cerebral blood flow is a complex and essential variable to determine the brain experiences post-traumatic secondary damage and is affected by metabolic regulation, a Partial pressure of arterial Carbon Dioxide (PaCO2), a Partial pressure of Oxygen (PaO2) and autoregulation (Cecil *et al*., 2011:30).

Cerebral perfusion pressure (CPP) requires assessments of cerebral autoregulation and monitoring of ICP response to MAP augmentation (Carandang, 2015:125). CPP plays an important role in TBI, because it represents the driving pressure required for transport of oxygen and nutrients to neuronal cells (Noble, 2010:244). The only reliable manner to monitor CPP is through continuously blood pressure and ICP monitoring, as for obtaining a CPP which is the difference between mean arterial pressure and ICP (Schimpf, 2012:161). The most detrimental situation in TBI is when the ICP exceeds the MAP, causing blood flow to diminish and facing the possibility of herniation (Noble, 2010:244). Different views and practices regarding the CPP threshold have been practised and Schimpf (2012:161; Cecil et al., 2011:33) supported the maintenance of CPP at more than 60 mmHg and pressures should be induced when needed. Multiple studies validate that systolic blood pressures (SBP) less than 90 mm Hg in patients with TBI is associated with poor outcomes and the Traumatic Brain Foundation recommends a SBP more than 100 mm Hg for patients the age of 50 to 69 years and 110 mm Hg or above for patients 15 to 49 of age or over 70 years old to decrease mortality and improve outcomes (Griesdale, Ortenwall, Norena, Wong, Sekhon, Kolmodin, Henderson & Dodek, 2015:114; Carney *et al*., 2016:164).

Noble (2010:244) revealed that CPP should range between 70-100 mm Hg and if pressures appear less than 40mm Hg, ischaemia is common. A study conducted at the Vancouver General hospital found that a CPP less than 50 mm Hg was associated with higher hospital mortality, because systemic hypotension reduces cerebral blood flow and leads to cerebral ischaemia (Griesdale et al., 2015:114). The Brain Trauma Foundation supported a targeted CPP between 60-70 mm Hg and articulated that the CPP may depend upon the auto regulatory status of the patient. This is supported with Level IIB evidence (Carney *et al.,* 2016:182), that leads to the elevated ICP causing a decrease in perfusion pressure which leads to a risk of secondary brain injury (Damkliang, Considine & Kent, 2013:133).

ICP is regulated by volumes of intracranial blood, cerebrospinal fluid, and brain tissue. Expansion of any of these volumes will initiate compensatory changes in the other compartments, resulting in an initially limited alteration in ICP (Czosnyka, Pickard, Steiner, 2017:67). Due to the rigid skull, compensatory mechanism becomes exhausted, the ICP intensifies rapidly and intracranial hypertension is associated with the unfavourable outcome of brain injury patients (Czosnyka *et al.,* 2017:67). ICP after trauma hinders CBF and is concomitant with ischemia and hypoxia (Cecil *et al*., 2011:28). Minimizing secondary ischemic injury common in TBI may be possible by manipulation of ICP, CPP, cerebral blood flow (CBF), blood pressure and brain temperature, and partial pressure of oxygen in brain tissue (PBTO2), in brain parenchyma after acute brain injury (Cecil *et al*., 2011:26; Farahvar *et al*., 2011:211).

ICP waveforms add value to pathophysiology and cerebrovascular mechanism of raised ICP (Farahvar *et al*., 2011:211). ICP waveforms assist with identifying patients experiencing changes in brain compliance and changes in pulse component (P1, P2, P3) of the waveform are associated with alterations of arterial pulsation in the large cerebral vessels (Gulanick & Meyers, 2017:573). The waveforms consist of three major components, namely the heart rate pulse, respiratory waves and slow vasogenic waves, and became useful in both therapy and prognosis in TBI (Farahvar *et al*., 2011:211). As a result, when mean ICP rises, the P2 wave progressively elevates and a state of decreased compliance exist, showing the P2 wave to be equal or higher than P1 (Morton & Fontaine, 2018:667).

The origin of ICP develops from mass lesions such as subdural hematoma, epidural hematoma and intracerebral contusions, whereas cerebral oedema and communicating and non-communicating hydrocephalus are treatable causes of raised ICP (Cecil et *al*., 2011:28).

Cecil *et al*. (2011:28) define ICP as the target parameter for many treatment algorithms, used to calculate CPP, the pressure gradient of blood perfusion in the brain measured in millimetres of mercury and used to calculate CBF which can be derived from the formula of CPP divided by cerebral vascular resistance.

Cerebral perfusion pressures can be affected by ICP and precipitate or worsen cerebral hypoperfusion and ischaemia (Carandang, 2015:125). Normal ICP ranges between 0-15 mmHg and will cause an increase if one of the components according to the Monro-Kellie hypothesis increase (Noble, 2010:244). However, Gulanick and Meyers (2017:572) supported a ICP less than 10 mm Hg as optimal for stable neurological status. The Monro-Kellie hypothesis consists of three intracranial components, namely brain tissue (80%), blood volume 10% and 10% of cerebrospinal fluid (Noble, 2010:244). Normal ICP is less than 15 mm Hg and the BTF recommends treatment to be initiated for ICP more than 20 mm Hg (Hickey, 2014:362).

An increase in any of the components causes a rise in ICP and cerebrospinal fluid significant in acute hydrocephalus, increased blood volume due to haemorrhages and swelling derived from an increase in brain tissue volume (Noble, 2010:244). ICP value more than 20 mm Hg is associated with worse outcome (Carandang, 2015:125). Nursing interventions can cause an increase in ICP due to benign manoeuvres such as positioning, inadequate sedation, recent suctioning and any other environment influence that can be treated promptly (Schimpf, 2012:166).

Plateau waves are common in TBI causing an increase in ICP above 40 mm Hg and are not usually associated with worst outcome, unless it persists longer than 30 minutes which is associated with diminished CPP (Dias *et al*., 2014:13). A rapid escalation in ICP can trigger catecholamine surge and may result in developing neurogenic pulmonary oedema causing cardiac decompensation (Hickey, 2014:316).

It is important to use a stepwise approach in clinical practice by using a critical tool guiding nurses regarding the management of ICP (Zerfoss, 2016).

2.4.5 Advanced cerebral monitoring

Studies on micro dialysis, the insertion of a micro dialysis catheter in the brain tissue to allow assessment of neurochemical processes found that regional hypoxemia and ischemia can occur in the setting of normal ICP and CPP (Carandang, 2015:127). It is confirmed by Carandang (2015:127) that PbtO2 less than 10 for 15 minutes are associated with worse clinical outcomes. To monitor brain oxygenation, a catheter with an oxygen sensor is placed inside the white matter of the brain, preferably the penumbra of the injured area (Cecil *et al*., 2011:33). Additional monitoring devices include jugular bulb catheter recommended in the BTF as level III evidence (Carney *et al*., 2016:152). A correlation can be made by an elevated ICP and low CPP with low PBTO2 and poor neurological outcome (Cecil *et al*., 2011:33).

Critical values of PbtO2 are defined as those less than 15 mm Hg (1.9 kpa) as the initiation of tissue hypoxia, 10 mm Hg (1.3 kpa) as hypoxia and any value below 5 mm Hg (0.6 kpa) as dying tissue (Hickey, 2014:372). PbtO2 monitors should always be used in conjunction with other monitoring devices and never in isolation.

The use of micro dialysis catheters in order to measure lactate to pyruvate ratio (LPR) appears to be a good indicator of ischaemic and hypoxic conditions, as well as mitochondrial damage in conjunction with hypoxia; glucose converts primarily to lactate causing decreased levels of pyruvate (Cecil *et al.,* 2011:27; Hickey, 2014:372). Multimodal monitoring provides ample care and has great potential for improving the outcome of traumatic brain injury (Cecil *et al*., 2011:35). Jugular venous bulb oximetry (SjvO2) may also be used to measure jugular venous oxygen saturation and divulge information on cerebral oxygen supply versus the demand (Hickey, 2014:362). SjvO2 has shown to be a better method to assess global oxygenation of the brain which reflects the balance between oxygen supply and demand (Hallman & Joffe, 2013:92). The BTF stated that this particular method of monitoring is not common outside the research setting (Carney *et al*., 2016:151).

In nursing practice, the understanding of fluid pressure to an External Ventricular Drain (EVD) strengthens the knowledge and improves safe clinical practice (Sundtherland, Billanueva & Pazuchanics, 2016:274). EVD is a fluid-coupled system known to be the gold standard of measurement of ICP (Farahvar, Huang, Papadakos, 2011:209), but the review and updated 4^{th} edition guidelines of the Brain Trauma Foundation, rated EVD as Level III evidence and recommended to Lower ICP burden more effectively when zeroed at midbrain with continuous drainage of CSF (Carney *et al.,* 2016:57). Hourly assessment remains an important concept in monitoring of ICP and a recommendation was posed to clamp the EVD each hour in order to obtain an accurate ICP reading, waveform analysis and interpretation of intracranial compliance (Sundtherland *et al*., 2016:277). The BTF recommended that drainage of CSF to decrease ICP in patients with GCS of less than 6 for the first 12 hours after insult may be considered (Carney *et al*., 2016:57).

2.4.6 Mobility and safety

Early mobilization in CCU has an impact on the reduction of delirium, mechanical ventilation, the risk of a hospital-acquired infection length of stay in CCU and hospital, and improved functional status on hospital discharge (Thelandersson, Nellgard, Ricksten & Cider, 2016:434). Nursing interventions can affect ICP positively or negatively and management of patient care should pose to decrease elevated ICP and prevent secondary brain injuries (Bell & Cox, 2009:338; Ledwith, Bloom, Maloney-Wilensky, Coyle, Polomano & Le Roux, 2010:280). The act of repositioning the patient tends to increase the ICP values immediately, but numerous studies have found that ICP values tend to decrease after 5 minutes of the intervention and may not result in a constant elevation of ICP as expected (Olson *et al*., 2013:436; McNett & Olson, 2013:121). By turning patients lateral with repositioning results in adverse effects on ICP, CPP and brain oxygenation and it should be practised with caution and close monitoring is required (Ledwith *et al*., 2010:284).

Brain oxygen monitors are useful tools in examining body positioning in nursing practice even though decreased trends in ICP are noticed, it has no adverse effect on brain oxygenation (Ledwith *et al*., 2010:282).

Patients need to be turned, because inadequate repositioning may lead to ischaemia of skin and subcutaneous tissues that may instigate risk of pressure ulcers (Ledwith *et al*., 2010:285; McNett & Olson, 2013:121). Venous thromboembolism, deep-vein thrombosis, and pulmonary embolism remain a complication postoperatively with a high rate of case fatality. Mechanical prophylactic devices, such as intermittent pneumatic compressions are widely applied in practice and are monitored exclusively by nursing personnel. Intermittent pneumatic compressions are less effective than chemical stratagems in deep vein thrombosis prevention and the compression devices remain superior to no prophylaxis and are recommended for patients who are at high risk for bleeding (Elpern, Killeen, Patel & Senecal, 2013:30). A state of hypercoagulability and dehydration is commonly associated with immobility in neurosurgical patients, contributing to venous thrombosis and hemoconcentration (Hickey, 2014:336).

Chemoprophylaxis in neurosurgery poses serious complications and heparin tend to cause more intracranial haemorrhage in postoperative patients (Adeleye, & Ogun, 2016:262; Carney *et al*., 2016:111). An observational study was done at an urban academic medical centre in Chicago and found 51% application errors for proper placement of intermittent pneumatic compressions devices on patients' legs and not applied as ordered and intended (Elpern, Killeen, Patel & Senecal, 2013:33-35). A critical component in neurointensive nursing care identifies the most optimal body positioning to strengthen cerebral blood flow, while controlling ICP, CPP, and Pbt02, because the body and head positioning may influence intracranial hemodynamics after traumatic brain injury (Ledwith *et al*., 2010:283).

Body positioning also alters oxygenation and careful monitoring is required. Pressure-care mattresses were designed to reduce the risk of pressure sores and close attention needs to be paid to pulmonary care and toileting in TBI patients (Ledwith *et al*., 2010:286).

No single position constantly improved ICP, CPP or PbtO2 and in absence of monitoring the best is to have the head of the bed elevated to 30º with slight knee elevation that may be the default position for ICP and CPP control (Ledwith *et al*., 2010:286; Damkliang *et al*.,2013:133). In absence of coagulation, TBI patients are classified as high risk to develop deep vein thrombosis due to immobility, recent surgery or trauma (Hickey, 2014:368). Venous thromboembolism (VTE), including deep vein thrombosis (DVT) and pulmonary embolism (PE), is common, though preventable in critical care.

A descriptive study of postoperative venous thromboembolism was conducted in sub-Saharan Africa maintaining heightened vigilance and surveillance regarding VTE in their practice and monitored patients for any slight clinical suspicion of DVT or PE. Those with strong suspicions of DVT or PE received Doppler ultrasonographic evaluation of lower limbs and low-dose molecular weight heparins were commenced (Adeleye & Ogun, 2016:264). Predisposing influences to thrombus formation are called the Virchow triad which consists of blood hypercoagulability, endothelial injury and stasis of blood flow relating to deep vein thrombosis and possible pulmonary embolism (Hickey, 2014:335; Elpern *et al*., 2013:34).

In neurosurgery, practical problems arise and the prevention of deep-vein thrombosis, diagnosing and treating it. A concern was highlighted regarding a practical problem that is the effectiveness of TED with their fit-to-end users which are not infrequently too loose to be really effectual (Adeleye & Ogun, 2016:259-264). There is no TBI specific evidence for deep-vein thrombosis prophylaxis and compression stockings and mechanical treatments remain the general standard of care thus far (Carney *et al*., 2016:111).

2.4.7 Analgesia, sedation, and anxiolytics

Agitation and acute pain are common in patients post craniotomy and physiological changes may arise from intracranial haemorrhage and brain oedema (Zhao, Shi, Chen, Yin, Chen, Yuan, Cao, Xu, Hao & Zhou, 2017:132). Research has found that agitation can lead to tachycardia, hypertension, increased catecholamine production, increased oxygen consumption and immunosuppression (Zhao *et al*., 2017:137). Propofol remains the best choice to adequately sedate the injured patient with a short half-life, allowing nurses to assess the patient's neurological function frequently (Schimpf, 2012:160; Hickey, 2014:362). However, one of the complications of propofol is associated with cardiac toxicity and in extreme instances it may lead to propofol infusing syndrome showing early signs of cardiac instability, indicating a bundle branch block with an ST elevation in V1-3 (Hickey, 2014:363).

The use of dexmedetomidine after craniotomies have advantages, because patients become less agitated and with agitation, tachycardia, hypertension causing an increase in catecholamine levels occurs which contribute to increased oxygen consumption leading to myocardial ischaemia (Zhoa *et al*., 2017:137). With dexmedetomidine, patients remain easily arousable with no side-effect on respiratory function and actually mimicking natural sleep (Hickey, 2014 246). Side effects of dexmedetomidine were underlined as bradycardia and hypotension, though evidence confirmed that it as dose-dependent, with no detrimental effect on cardiac function (Zhao *et al*., 2017:138). Knowledge deficits, staff attitudes and misconceptions about the need for effective pain management may be barriers caring for the TBI patient (Damkliang *et al*., 2013:133).

Pain should be managed promptly in neurocritical care patients derived and pain associated with TBI derives from noxious stimuli causing increased ICP (Damkliang *et al*., 2013:133). As a result, a decrease in ICP values, both on one-to-five minutes intervals was experienced after analgesia, sedatives and anxiolytics were administered effectively (Olson *et al*., 2013:436). A study was conducted in a hospital in Beijing and evidence revealed that dexmedetomidine alone cannot reduce pain and may be used as prophylactic sedation in delayed extubations post craniotomy and may be administered synergistically with opioids after craniotomies (Zhao *et al*., 2017:138).

Adequate analgesia in the prevention of elevated ICP in patients with TBI is critical and opioid therapy titration is recommended (Damkliang *et al*., 2013:133). Undertreated pain and agitation pose serious consequences postoperatively and may cause elevated oxygen consumption which disturb the balance of oxygen supply causing an increase demand for brain oxygen, resulting in ischaemia (Zhao *et al*., 2017:132). Inducing heavy sedation can further decrease the oxygen demand for the brain tissue and increase the PBTO2 as part of treatment (Cecil *et al*., 2011:34).

2.4.8 Thermoregulation

Being aware of vital signs and how they affect haemodynamic parameters, the relationship between the parameter and the appropriate nursing care, as well as multi-disciplinary follow-up are basic nursing skills (Asgar Pour & Yavuz, 2014:326). Fever is defined as an increase in core body temperature of 38.3ºC and above, and of the thermostatic set point, which is controlled by the hypothalamus (Asgar Pour & Yavus, 2014: 326; Hickey, 2014:180). Patients presenting with hyperthermia and fever have higher mortality rates, disability and longer CCU stay according to Rockett, Thompson and Blissitt (2015:66). Fever can also present as a result of infectious and non-infectious causes (Asgar Pour & Yavuz, 2014:326; Celik, 2011:560; Hickey, 2014:179). Therefore, the nurse should be able to distinguish between the origin of hyperthermia caused by raised ICP and infection (Suadoni, 2009:35).

The origins of fever may be associated with Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa and this will mainly occur due to shunts, open wounds, urosepsis (infection in the urinary tract), ventriculostomies and much more (Hickey, 2014:179). Evidence-based practices are introduced in CCU to target the prevention of hospital-acquired infections, such as central line bundle, catheter-associated urinary tract infections (CAUTI) and ventilator-associated pneumonia (VAP) which are associated with high mortality (Hickey, 2014:179).

Temperature is a basic observation measured in CCU patients to evaluate the severity of fever, because when body temperature rises, important physiological changes occur in heart rate, skeletal muscle contractions which causing rigors, an effect on depth and rate of respiration, oxygen consumption and carbon dioxide production (Celik, Yildirim, Arslan, Yildirim, Erdal, Yandi, 2011:557; Hickey, 2014:180).

The most common fever in neuroscience patients is central fever caused by central neurogenic etiology experienced with space-occupying lesions, trauma or lesions involving the hypothalamus, the base of the brain, traction of the hypothalamus or brainstem (Hickey, 2014:180; Olson *et al*., 2015:67). Pyrexia of up to 41.5ºC is cardinal and in the absence of perspiration this diagnosis is made only after all other causes of fever have been ruled out (Hickey, 2014:180).

Temperature is controlled in the body by the hypothalamus, which is located between the brainstem and cerebrum (Suadoni, 2009:38). Emphasis on monitoring core body temperatures are important, because temperatures tend to be unstable as an increase of ICP exerts pressure on the hypothalamus (Gulanick & Meyers, 2017:573). On the other hand, tympanic membrane temperatures are an extracranial estimation of intracranial temperature and reflect the temperature of the hypothalamus which is easier, faster and less invasive than other temperatures (Asgar Pour & Yavuz, 2014:328). Olson *et al*. (2015:69) mentioned that core temperatures are normally measured by pulmonary artery thermistor, bladder thermistor, esophageal and rectal probe, oral and tympanic temperatures are allowed. They also revealed that undertreatment of fever occurs due to less accurate core temperatures which include temporal and axillary temperatures and are the least favourable if accuracy is measured (Olson *et al*., 2015:69). Core body temperatures are strongly recommended and need to avoid increasing metabolic demands which cause the increase of ICP rapidly (Schimpf, 2012:161).

A study conducted by Asgar Pour and Yavuz (2014:330) revealed that a 1º C degree increase in body temperature is associated with a decline of 4.43 mmHg in systolic blood pressure, 0.166 mmHg in mean arterial blood pressure and 0.64% arterial oxygen saturation. An association with an increase of 1.16 mmHg in diastolic arterial blood pressure and 7.64 beats per minute pulse rate was made (Asgar Pour & Yavuz, 2014:330). Consequently, fever causes an increase in heart rate, decreased systolic arterial pressure, mean arterial pressure, oxygen saturation and hourly urine output (Asgar Pour & Yavuz, 2014:330; Celik, 2011:560). A study conducted in Turkey showed a significant decrease in hourly urine output with fever and literature stated that 1º C increase in body temperature will result in the loss of 250 ml fluid from the body in 24 hours (Celik *et al*., 2011:560). Fever is a serious concern in caring for the TBI patient and one of the goals should be to maintain normothermia to prevent unfavoured outcomes.

Two cooling methods described by Cook (2017:6) for induced hypothermia are by inserting an endovascular catheter into the femoral artery and advancing it to the vena cava inferior and external pads are placed along patient's trunk and thighs by circulating cooled water via a machine. Prophylactic hypothermia is commonly practiced in pediatrics and one of the most important management protocols postresuscitation as per Advanced Cardiac Life Support pathways. It is believed that therapeutic hypothermia decreases damage to the brain and improves neurological outcome. Nonetheless, the BTF classified prophylactic hypothermia as Level IIB (low quality of evidence) and are not indicated for early or short-term management in diffuse injuries (Carney *et al*., 2016:36). Conversely, prophylactic hypothermia may cause shivering, a complication reducing core body temperature below 34º C which causes detrimental life-threatening consequences including arrhythmias, increase of oxygen consumption, skin breakdown and impaired wound healing (Cook, 2017:9; Cecil *et al*., 2011:34).

2.4.9 Intracranial pressure lowering agents

Patients with pupillary changes may benefit from early or continued maneuvers to lower ICP and patients presenting with low GCS scores (GCS 3 with or without anisocoria) follow good outcome, despite CT finding and presence of hypotension (Faravhar *et al*., 2011:1476). According to experts, practices of doing CT scans according to the parameters prior to initiate ICP lowering therapy, are not an indicator of patients who may benefit from ICP lowering therapy (Faravhar *et al*., 2011:1476). Fluid management is important in traumatic brain injuries and it is of utmost importance to keep patients euvolemic and in a normal-hyperosmolar state and this practice is best achieved through administration of isotonic solutions (Schimpf, 2012:161).

Studies have shown that mannitol and hypertonic saline cause a decrease in intracranial pressure. Furthermore, brain swelling remains a common result of TBI and the use of Mannitol to draw free water out of the tissue, into the circulation in order to reduce ICP is common practice (Schimpf, 2012:161; Mangat, Chiu, Gerber, Alimi, Ghajar, Hartl, 2015:203).

There is a significant difference between mannitol and hypertonic saline, because hypertonic saline causes volume expansion, whereas mannitol triggers to reduce body perfusion and blood pressure due to its diuretic effect (Mangat *et al*., 2015:208; Li, Li, Li, Yang, Wang Gao, Zhang, Cheng, Fang, Zhao, Wang, Gao & Li, 2015: 1753). In a retrospective study, Mangat *et al*. (2015:208) found that hypertonic saline reduces the number of CCU days and is the preferable agent in reducing CCU costs. Li *et al*. (2015: 1753) suggest that hypertonic saline should be considered the gold standard medical therapy for intracranial hypertension.

Mannitol showed good outcomes and the recommended dose for raised ICP control is 0.25-1g/kg body weight in emergency situations (Damkliang *et al*., 2013:13). The administration of mannitol (osmotic diuretic) is used to manage intracranial hypertension, but may lead to diminished circulatory blood volume and blood pressure and specific nuances need to be applied to intake and output monitoring, as well as administration of crystalloids and blood products to maintain adequate MAP and to ensure adequate CPP intake and output monitoring (Noble, 2010:247). The Fourth Military Medical University Tangdu Hospital in China conducted a retrospective study treating patients with a continuous micro-pump infusion of 3% Hypertonic Saline combined with furosemide to control raised intracranial pressure found to be safe and feasible with a promising ICP-lowering therapy (Li *et al*., 2015:1753).

Mangat *et al*. (2015:205) argue that hypertonic saline has a longer-lasting effect on raised intracranial pressure and a tendency not to cause rebound increase on ICP other than mannitol. Cognisance should be taken when administering hypertonic saline, because the adverse effects include myelinolysis, acute heart or renal failure, acute pulmonary edema and serum electrolytes imbalance (Li *et al*., 2015:1753). Numerous studies found hypertonic saline superior to mannitol, but the BTF does not support the evidence of hyperosmolarity recommendation for lowering of ICP for traumatic brain injury due to insufficient evidence (Carney *et al*., 2016:49). In situations of refractory elevated ICP, a decompressive craniectomy is an option and a large frontotemporoparietal craniectomy is supported by Level

IIA evidence to improve neurological outcomes (Hallman & Joffe, 2013:94; Carney *et al*., 2016:27). Decompressive craniotomies are effective and provide rapid and sustained control in ICP as supported by its efficacy in the literature (Schimpf, 2012,160).

2.4.10 Oxygenation and ventilation

In the United States, neurosurgeons routinely use prophylactic hyperventilation in patients with severe TBI (Curley, Kavangagh & Laffey, 2010:1349). Hyperventilation in TBI for short periods should be avoided in practices, even though the efficacy in emergently decreasing ICP in acute settings, because the consequences of diminished cerebral perfusion and worsening of injury may occur due to vasoconstriction seen in hyperventilation (Schimpf, 2012:16; Naidoo, 2013:613). It is clearly recommended that all intubated patients have End-Tidal Carbon Dioxide (ETCO2) monitoring to ensure correct placement of endotracheal tubes and to monitor ETCO2 whilst intubated (Damkliang, Considine & Kent, 2013:133).

According to Wright (2017:10), ETCO2 would not disregard the need for arterial blood gases, but will assist Partial pressure of arterial Carbon Dioxide (PaCO2) to remain within targeted parameters. Damkliang *et al*. (2013:133) specified that the knowledge of nursing might be limited regarding the importance of ETCO2 monitoring and the utilization of ETCO2 values to guide management of patients with severe TBI if limited exposure exists.

It is important to use capnography to detect hypercapnia, which causes cerebral vasodilation, increases ICP and a decrease in cerebral perfusion pressure which places the patient at risk of a secondary brain injury (Damkliang *et al*., 2013:133;). If ETCO2 is not available, keeping track of exhaled minute ventilation and correlation with the PaCO2 of the patient is important, because a change in exhaled minute ventilation will mimic a change in PaCO2 and sedation, respiratory rate or tidal volumes will need to be adjusted to keep PaCO2 in therapeutic value (Wright, 2017:10). Hyperventilation should be considered carefully because a PaCo2 less than 2.6 kpa (20 mm Hg) may decrease cerebral blood flow due to vasoconstriction that produces hypoxia and on the other hand, PaCo2 greater than 45 mmHg (5.9 kpa) induces vasodilation, increasing cerebral blood flow and may trigger an increase in ICP (Gulanick & Meyers, 2017:574).

When patients are mechanically ventilated, positive end-expiratory pressure (PEEP) in conjunction with pressure support mode may be used within limitations and it is believed that PEEP and positive airway pressure raise ICP (Hickey, 2014:290). Research has found that PEEP has a less of an effect on ICP and few studies on traumatic brain injury and subarachnoid hemorrhage have shown PEEP ranging from zero to 15 cmH20 and has no increase in ICP or decrease in CPP (Hickey, 2014:290).

To ensure a patent airway, clearing secretions through suctioning may cause agitation and the maneuver may lead to an elevation of ICP therefore, suctioning should be determined by the presence of secretions in an upper respiratory pathway, the observation of abdominal and chest movement, chest auscultation and patients' colour (Hickey, 2014:290). It is important to be alert to signs of respiratory distress, including an increase of pulse rate, perspiration and restlessness, because they can cause partial obstruction of the respiratory tract (Hickey, 2014:290). According to an expert, suctioning causes agitation and an assessment should be made and an evaluation should be done to consider the need for additional sedation or administration of endotracheal lidocaine (up to 2mg/kg/hr) to blunt the rise of ICP on suctioning (Hickey, 2014).

2.4.11 Nutrition

The importance of initiating nutritional support in critically ill patients receiving mechanical ventilation is of high importance in clinical practice (Ellis, 2015:263; Carney *et al*., 2016:84). Early commencement of enteral feeding is a good strategy to reduce disease severity, lessen complications, decrease the length of stay in CCU and have a positive impact on patient's outcomes (McClave, Taylor, Martindale, Warren, Johnson, Brainschweig, McCarthy, Davanos, Rice, Cresci, Gervasio, Sacks, Roberts & Compher, 2016:161). The Brain Trauma foundation acknowledged that enteral feeding should commence at least at day five (Carney *et al*., 2016:85), whereas the American Society for Parental and Enteral Nutrition (Aspen) guidelines recommends that initiating enteral feeding within 24-48 hours once the patient is hemodynamically stable following the onset of critical illness on admission to CCU enhances the goals over the first week of stay in CCU (McClave *et al*., 2016:163). The ordering status of nil per mouth should be minimized for diagnostic test and procedures to reduce propagation of the ileus and prevent inadequate nutrient delivery (McClave *et al*., 2016:169).

The benefit of early initiation of enteral feeding supports the functional integrity of the gut by maintaining tight junctions between intraepithelial cells, invigorating blood flow, inducing trophic endogenous agents and maintaining the structural activity of villous height (McClave *et al*., 2016:165). The risks of stress ulcers are possible (may occur) within 96 hours of initial injury and in TBI patients, stress ulcers are related to hypothalamic dysfunction and hyperactivity secondary to vagal hyperactivity requiring a buffer to a pH greater than 7 using H2 receptor antagonist, such as ranitidine to prevent ulcer formation (Hickey, 2014:370).

Interruptions of enteral feeding pose negative effects, such as poor wound healing, susceptibility to infection, neuromuscular and impaired immune response (Ellis, 2015:263). Inadequate caloric intake, excessive protein breakdown, and gluconeogenesis lead to a systemic inflammatory response in the critically ill, organ dysfunction and increase mobility and mortality (Ellis, 2015:263; McClave *et al*., 2016:161).

Underfeeding and progressive malnutrition are serious risk factors in mechanically ventilated patients and deprive the patients with less energy and proteins, therefore enteral feeding remains superior to parental feeding, due to less dysfunction of the hepatobiliary system and electrolyte imbalances (Ellis, 2015:263-264; Hickey, 2014:187; McClave *et al*., 2016:166). On insertion of the feeding tube, the norm in nursing practice is usually to allow gravity drainage for 24 hours and on returning of bowel sounds feeding will be initiated and advanced as tolerated (Hickey, 2014:189). As a result, the Aspen guidelines stated that bowel sounds and bowel function (passing of flatus and stools) are not required for initiation of enteral feeding, because bowel sounds only indicate contractility and not necessary relates to mucosal integrity, barrier function or absorptive capacity (McClave *et al*., 2016:167; Hickey, 2014:189).

The earlier commencement of feeding promotes tissue healing, decrease physiological stress and decrease the rate of nosocomial infections and pressure ulcers (Ellis, 2015:263). Close monitoring is required for patients on vasopressors and any sign of intolerance such as abdominal distension, hypoactive bowel sounds, escalation of metabolic acidosis or base deficit should be scrutinized due to the possibility of gut ischemia and enteral feeding should be withheld until symptoms and interventions stabilize (McClave *et al*., 2016:168).

2.5 THEORETICAL FRAMEWORK

Knowledge and competency are necessary in nursing practices and is parallel to the progressive movement of the critical care nurse from the novice level to the expert. Benner carried out research on methods of achieving, assessment, professional evaluation and practical application to expand knowledge and clinical practice. The aim of the study was to address the application of Benner's novice to expert theory (1982) in the nursing career. Benner describes five stages of skill acquisition in nursing knowledge: novice, advance beginner, competent, proficient and expert. Knowledge and clinical practice are used by critical care nurses on an everyday basis and attention given to the neurocritical ill patient is too little. The novice according to Benner's theory refers to the beginner stage and are normally taught what to do in order to perform a task. The advanced beginners based their principles on experience, whereas the competent nurse apply analytical thinking with greater efficiency. The proficient nurse perceives and understands situation holistically in order to improve decision making skills whereas the expert nurse no longer relies on principles, rules and guidance according to Benner's theory. These five stages reflect changed in three aspect of skill performance and decision-making: (a) a move from reliance on abstract principles to the use of past concrete experiences, (b) a change from viewing a situation in multiple fragments to see a more holistic picture, and (c) a movement from detached observer to an active performer (Stinson, 2017:53). Research questions evaluate how much the critical nurses know (novice to expert) and what are the clinical practices caring for the TBI patient. The researcher made use of the framework to achieve critical care nurses in becoming experts in providing care to the TBI patients.

2.6 SUMMARY

Critical Care nurses should have a strong foundation of knowledge in order to care for TBI patients in a critical care environment. It is evident that some vital aspects, for example Glasgow Coma Scale needs accuracy, which is still a concern pertaining to nursing knowledge, because deterioration needs to be identified promptly in order to prevent further deterioration of the already critically ill patient. Clinical practice keeps on transforming in order to ensure safe practices and evaluating current research findings to improve current management. Knowledge deficits were identified and limited literature on clinical practices, specifically with regard to caring for the TBI patient was highlighted. Specialised training and education with regard to caring for these patients will provide the critical care nurse with knowledge of the pathophysiology of TBI, link current evidence-based practice guidelines for better care and improved outcome of the TBI patient cared for in a Critical Care Unit.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter outlines the research methodology that was applied during the study to investigate the knowledge and clinical practices of professional nurses in the critical care unit within a tertiary hospital in the Western Cape, South Africa. The research design, population, sampling, data collection and analysis will be discussed in this chapter.

3.2 RESEARCH AIM AND OBJECTIVES

The aim of the study was to determine the knowledge and clinical practice of professional nurses caring for patients with Traumatic Brain Injury in a Critical Care Unit within a tertiary hospital in the Western Cape of South Africa.

The objective of this study was to:

- determine the knowledge of professional nurses caring for patients with TBI in a CCU within a tertiary hospital within the Western Cape
- investigate the clinical practice of professional nurses caring for patients with TBI in a CCU within a tertiary hospital within the Western Cape.

3.3 STUDY SETTING

The study setting refers to the location where the study is conducted. The study was conducted in a natural setting, which is an uncontrolled, real-life situation or environment (Grove *et al*., 2013:373).

The research setting for this study is the CCUs of a public, academic tertiary hospital, in the Western Cape of South Africa. There are two tertiary academic hospitals in the Western Cape, the researcher chose one only. The CCUs consist of a Respiratory, Coronary Care, Acute Spinal Cord Injury, Cardiothoracic, Renal transplant unit, Isolation, Oncology, Neurosurgical CCU and Neurosurgical High Care Unit. There are 98 practising professional nurses, with a bed capacity of 55, caring for patients with life-threatening conditions. The Surgical CCU, Cardiothoracic CCU and Respiratory CCU receive the overflow of traumatic brain injury patients. Despite the overflow of traumatic brain injury patients at another tertiary hospital in the Western Cape, the patients remained in the trauma unit until a bed becomes available in the Neurosurgical CCU.

3.4 RESEARCH DESIGN

A research design is defined as a blueprint for conducting a study which will guide the researcher in planning and implementing the study in a way to achieve accurate results

(Grove, Burns & Gray, 2013:195). This design is a quantitative descriptive research design, with a self-administered questionnaire. Knowledge was acquired in an area which little research has been conducted (Grove *et al*., 2013:216). No similar studies pertaining to knowledge of professional nurses caring for critical TBI patients were found during the review. Hence, the research design for conducting the studies pertaining to knowledge was mainly descriptive design quantitative methods. A quantitative descriptive design was pursued to determine professional nurses' knowledge and to investigate the clinical practice caring for patients with TBI in a CCU within a tertiary hospital in the Western Cape. A quantitative approach emphasizes objective measurements in numerical form and the statistics were used to manipulate computational techniques. Objective methods were used in order to control the research situation with the goal of minimizing bias and maximising validity (Polit & Beck, 2018:9).

3.5 POPULATION AND SAMPLING

Sampling involves selecting a group of people to conduct a study, therefore when referring to nurses, a particular group of professional nurses in a critical care unit was the focus of the research.

3.5.1 Population

Grove *et al*. (2013:351), describe a population as a particular group of people that is the focus of the research and targeted the entire set of individuals or elements who meet the sample criteria.

Table 3.1: Total number of participants responded in main study (n=57)

Critical care unit	Total population (n)	Number of participants in pre-test (n)	Number of participants to be sampled in main study (n)	Number of participants responded in main study (n)
Surgical	16	3	13	6 (46.1%)
Respiratory	16	2	14	13 (93%)
Cardiothoracic	12	0	12	10 (83,3%)
Coronary Care	8	0	8	3 (37,5%)
Neurosurgical/ High Care	24	4	20	16 (80%)
Other	22	0	22	9 (40,9%)
Total	98	9	89	57 (58,1%)

The study included professional nurses only, working in CCUs, at a public academic tertiary hospital in the Western Cape. As indicated in table 3.1, a summary was made of critical care nurses working in the critical care discipline.

The target population was professional nurses, who work in the critical care units at a public academic tertiary hospital in the Western Cape. In this case, the population consisted of critical care professional nurses either neophyte, experienced or critical care trained operational in a CCU. The researcher had a discussion with the assistant nurse manager regarding the population. A total of N=98 nurses were currently working in the critical care unit (including night and day staff). A total of n=9 participants formed part of a pre-test and was not included in the main study which concludes to a total of n=89 participants in the main study. In order to recruit participants, self-designed questionnaire were distributed to each participant in the CCU and an envelope for the answered questionnaire and consent form was handed out, to be sealed and posted in the two boxes provided (questionnaires and consent forms).

3.5.2 Sampling

De Vos, Strydom, Fouche and Delport (2011:223), define sampling as an element or subject of the population considered for actual inclusion in the study or measurement drawn from a population in which we are interested. A statistician was consulted regarding the sample size for the proposed study. A precision test was used to calculate the sample size. Statistical precision refers to the closeness with which it can be expected to approximate the relevant population value which is necessarily an estimated value in practice, since the population value is generally unknown (Brown, 2007:22). A precision of plus-minus 0.017 (1.9%) with 82 participants was calculated on a confidence set of 95% and precision of plus-minus 0.019 (1.9%) with 22 participants calculated on a confidence set of 95%.

A sample size calculation was done and the participants were close to the target population N=98, that is why no sampling method was used. The total population of professional nurses working in the critical care unit was included in the study due to the small population size, however only n=57 (64%) participants were included in the study. The population included individuals with a variety of knowledge levels, from neophytes to experts.

3.5.2.1 Sampling error

Sampling error refers to the difference between sample value and the population values (Polit & Beck, 2017:258). In this study, the small population affected the representativeness of the sample due to a low response rate of participants. In spite of high rate of non-response increasing the potential for biased estimates, it does not necessarily bias an estimate (Fosnacht, Sarraf, Howe & Peck, 2017:247). It has been noted that a decline in responded co-operation has been widely reported in survey research literature, including government - conducted surveys (Rindfus, Choe, Tsuya, Bumpass & Tamaki, 2015:799). Fosnacht *et al*. (2017:246) reported that low response rate may or may not lead to non-response bias, because answers to survey items may not differ substantially between responders and non-responders. Furthermore, the impact of non-response on an estimate depends upon the relationship between the outcomes of interest and the decision to participate in the survey. Nevertheless, if survey participation is not correlated with its content, the answers of responders and non-responders to a survey will not substantially differ (Fosnacht *et al*., 2017:246).

3.5.2.2 Inclusion criteria

Grove *et al*. (2013:353), explained it as the inclusion criteria or characteristics that the subject must possess to be considered part of the target population.

Professional nurses from zero to more than twenty years' experience, who are working in the critical care unit of the tertiary hospital in the Western Cape were used in order to conduct the study.

3.5.2.3 Exclusion criteria

Exclusion sampling criteria are characteristics that can cause a person or element to be excluded from the target population (Grove *et al*., 2013:353).

Professional nurses in training, short, annual or sick leave were excluded from the study.

3.6 DATA COLLECTION TOOL

Instrumentation is defined as the application of specific rules to the development of a measurement device or instrument (Grove *et al*., 2013:44).

The researcher used a paper-based questionnaire which was the most appropriate method to answer the research question. The questionnaire was in English, because all teaching and instruction are conducted in English at the selected teaching hospital and it contains four sections to obtain biographical information, determine the knowledge about nursing patients with a traumatic brain injury consisting of dichotomous questions, investigate the practices using the Likert scale, guidelines and in-service training questions were assessed by the Likert scale, for it was not feasible to include the two questions in the practices section.

3.6.1 Section A (Questions 1-9)

Biographical/Demographical information

- Gender
- Age group
- Nursing Qualification
- Intensive care qualification
- Total number of years of experience in nursing

- Employment
- Clinical discipline
- Length of time in current discipline
- Length of time worked in neurocritical care

3.6.2 Section B (Questions 10-28)

Close-ended questionnaires were used to assess the knowledge about nursing patients with a traumatic brain injury. These are questions in which response options are pre-specified to ensure comparability of responses and facilitate analysis (Polit & Beck, 2017:168). The dichotomous questions were '(1) agree' or '(2) disagree'.

Table 3.2: Questions related to Benner's theoretical framework:

Knowledge level	Question
1.Novice	10, 11, 12, 26
2. Advanced beginner	16, 27, 28
3. Competent	13,15,18,19,20,25
4. Proficient	14,17,22,23
5. Expert	21,24

3.6.3 Section C (Questions 29 – 36)

This section focused on the practices of professional nurses caring for patients with a traumatic brain injury. The questions were presented in a five multiple-response with statements: (1) never, (2) rare, (3) sometimes, (4) frequent and (5) always.

Table 3.3: Questions related to Benner's theoretical framework:

Knowledge level	Question
1. Novice	29,36
2. Advanced beginner	32,35
3. Competent	30
4. Proficient	34
5. Expert	31,33

3.6.4 Section D (Questions 37- 38)

This section focused on the guidelines and in-service training of professional nurses caring for patients with a traumatic brain injury. Five multi-response statements namely (1) never, (2) rare, (3) sometimes, (4) frequent and (5) always were used in order to answer the questions

Table 3.4: Questions according to Benner's theoretical framework:

Knowledge level	Question
Advanced beginner	37,38

3.7 PRE-TESTING OF INSTRUMENT

A pilot study is a smaller version of a proposed study in order to refine the research (Grove, Burns & Gray, 2013:46), whereas a pre-test refers to a trial run of a measure and data-collection method that are undertaken to provide information regarding the validity and reliability to reveal problems relating to the scoring, administration and its content (Waltz, Strickland, Lenz, 2017:183). Pilot studies are often used to pre-test or try out a research instrument to resolve factors prior to the main study (Simon, 2011:1). The reason is to identify problems with the research design, clarify sampling techniques and representation of the population, check the reliability, as well as validity of the instrument and to strengthen the major study design (Burns & Grove, 2011:49). Misleading, inappropriate or redundant questions can be avoided with the use of pretesting the tool. The pre-test was conducted in a public, academic tertiary hospital, in the Western Cape of South Africa. Data was collected via pre-testing in March 2018, as a trial in which validity and reliability were measured. The pre-test was conducted prior to the main study in the tertiary hospital on professional nurses (n=9/10%) of the target population. The participants were all professional nurses working in the critical care unit. The research was conducted under similar circumstances as the main study. The participants and the questionnaires used in the pre-test were excluded in the main study.

A pre-test was conducted to check reliability, validity, the wording of the survey, statistical and analytical processes to determine the efficacy of the tool. An interim analysis was performed in order to assess and improve the instrument, modify and restructuring the research instrument, as well as the time frame needed for completion. The instrument was amended accordingly after the interim analysis. Therefore, the pre-test questionnaire was excluded from the data analysis in the main study.

On commencement of the pre-test, the purpose of the research was explained to the participants, convincing them that they are the experts in the field of critical care and can be assured that their opinions would be valued. The researcher was present whilst the participants were completing the questionnaire. The questionnaire was administered in the same way as planned for the main study. The participants were not told if they were wrong and the researcher did not argue or contradict with opinions of respondents. No teaching was done and no advice given to any respondent.

Time was recorded and all questionnaires were answered in less than 20 minutes. The time allocated was reasonable as indicated in the questionnaire that it should approximately take 20-30 minutes. All questions were answered and participants were asked for feedback afterwards.

Feedback as follow:

- Question 18 was highlighted as confusing because the participants noted that the measurement of carbon dioxide was in mmHg and not in kPa. The conversion was done on the spot and participants were able to answer the question.
- Question 36: According to participants the question led to confusion because feeding has always been initiated as soon as possible and will never wait until day 5.
- According to the participants, the rest of the questions were making sense and no question was reported as difficult to complete.

Highlighted questions were reworded and corrected according to the feedback from the participants. Data from the pre-test was excluded from the main study.

3.8 VALIDITY

Burns and Grove (2011:334) describe validity as a determination of how well the instrument reflects the abstract concept being examined.

3.8.1 Content validity

Content validity will be examined to ensure adequacy of the content of the instrument. This was ensured by the pilot study and the input of nursing experts. The questionnaire was reviewed by two experts (a certified specialist neurosurgeon and professional nurse with a neurological/neurosurgical nursing qualification) in the critical care field to determine clarity and relevance of content. De Vos *et al*. (2011:173) describe face validity as the simplest and the least scientific definition of validity, which concerns the superficial appearance or face value of a measurement procedure.

3.8.2 Face validity

Face validity also gives the appearance of measuring the construct supposed to be measured. A subjective assessment was made by the researcher regarding the questionnaire and the instrument gave the appearance of measuring the construct it was supposed to measure. It is important for the usefulness of the instrument, to relate to the perception measured by the instrument. Face validity will be ensured by the pilot testing and nursing expertise. An assessment was made of the important aspects focusing on caring for the patient with a TBI and substantiated with evidence-based literature. The instrument was given to nursing and neurosurgery expert for evaluation, modification and to improve its content-related validity.

3.9 RELIABILITY

Reliability is defined by De Vos *et al*. (2011:177) in synonyms as dependable, consistent, stable, trustworthy, predictable and faithful. Burns and Grove (2011:332) described reliability, as a consistency of the measurement method. Internal consistency of the instrument will be calculated in conjunction with the Cronbach's alpha coefficient, which will occur during data analysis. The reliability coefficient of 0.70 or higher is considered acceptable (Supino & Borer, 2012:168).

3.10 PRE-TEST

Cronbach's alpha coefficient was calculated after the pilot study had been conducted. The Cronbach's alpha coefficient, calculated on 11 items of the Likert scale, revealed 0.119. A correlation matrix was run to identify items not correlating with the domain.

Questionnaire has been amended and following questions were excluded:

1. **Question 38 and 39** did not refer to nurses' practices, it therefore refers to another underlying construct and was deleted from the scale and included as separate questions referring to guidelines and in-service training.
2. **Question 30** was deleted because the item-total correlation is negative, meaning that it does not co-vary with the other variables.

3.11 MAIN STUDY

The final questionnaire revealed a Cronbach's alpha coefficient of 0.548 on an 8 item Likert scale. The tool was self-designed and questions were based on literature. The tool has not been adapted from an established instrument to this context with no validity and reliability measures that were published previously. Uncertainties and unclear questions have been clarified after conducting the pilot study and the instrument did not lend itself to calculating a Cronbach's alpha coefficient. The statistician was consulted and advised that question 31 (pertaining to the use of ETCO2 monitoring) should be treated separately from the Likert scale. A calculation was done without question 31 and the Cronbach's alpha coefficient improved to 0.60. The researcher aimed to investigate the clinical practice of critical care nurses with regard to ETCO2 monitoring, because it should be standard practice for all intubated patients to monitor carbon dioxide (CO_2) and endotracheal tube placement (Damkliang, Considine & Kent, 2013:133). It is standard in first world countries where sources are not problematic. As a result, this is not the case in practice due to scarce or unavailable resources, instead, an arterial blood gas will be done to monitor $PaCO_2$. Thus, the low value of the Cronbach's alpha might be due to the heterogeneous construct pertaining to clinical practices (Tavakol & Dennick, 2011:54). According to Mc`Neish (2018:422), Cronbach's alpha remains familiar, commonly reported in research, as well as easily obtainable in software, but the test is rarely an appropriate measure of reliability and stated that its assumptions are overly rigid and almost always violated. At this stage, the researcher was only interested in investigating clinical practices with the tool generated from the Brain Trauma Foundation and current literature.

3.12 DATA COLLECTION

Grove *et al*. (2013:45) refer to data collection as the detailed, organised gathering of information pertinent to the research purpose or the specific objective questions of a study. Each professional nurse had an equal opportunity to participate in the completion of the questionnaire rather than to be pre-selected.

Amendments were made and the amended tool was distributed as the main study amongst the critical care nurses at a public academic tertiary hospital for completion in the month of May 2018. Both day and night staff participated in the study. Permission was obtained from the chief executive officer, head of the critical care department, head of nursing in order to conduct the research project. The data was collected by the researcher himself. Participation was voluntary and no incentives were given to participants after completion.

3.13 DATA COLLECTION STRATEGY

The researcher approached the CCUs at 05:45 a.m. aimed at staff coming on duty, because hand-over time was 06:45 a.m. for staff who wished to participate in the study without any compensation, in order not to interfere with routine nursing care. The researcher also availed himself from 17:45 p.m. because hand-over time was 18:45 p.m. aimed at staff coming on duty to complete questionnaires. This ensured the researcher not to disrupt the nursing care routine, because it was aimed at the staff members who came on duty, preparing to start their shift and staff members ending their shifts. On completion, consent forms and questionnaires were sealed in an enclosed envelope provided and posted in a provided box for collection by the researcher. The questionnaire consisted of 38 questions, which took the participants less than 20 minutes to complete. Data was collected by the researcher himself.

The sealed envelopes were posted in the box marked "questionnaires" and collected by the researcher. On opening the envelopes, each questionnaire was assigned numbers and colour-coded according to the CCU. After the validation, data collection proceeded and recorded for data analysis. Data was collected over a maximum period of 2 weeks, entered in Excel and handed to the statistician for analysis.

Out of the 98-total population, 9 participants were used to perform the pre-test and were not reselected to take part in the main study. In the main study, only n=57 professional nurses participated voluntary and completed the questionnaire. The researcher approached all the CCUs and from those remaining participants who did not complete the questionnaire were on either sick leave or annual leave, participants who refused to participate and a few of the participants articulated that they have no time to complete questionnaires; they worked in neurosurgical CCU too long ago, as well as a few mentioned that they did not like neurosurgery.

3.14 DATA ANALYSIS

Burns and Grove (2011:535) describe data analysis as a technique used to reduce, organize and give meaning to data. An analysis technique category was used, namely descriptive (describes the distribution of the sample) with the aim to frequency. Data preparation occurred in conjunction with checking and editing of collected data and coding those (De Vos *et al*., 2011:252). A computer program with a spreadsheet (Microsoft Excel spreadsheet) was used by the researcher to enter the data and later submitted to the statistician for analysis. On data varification, some questions were not answered and were left blank on the Microsoft Excel sheet.

Two major classes of statistics will be performed in this study: a descriptive statistic which is computed to reveal the characteristics to describe study variables and inferential statistics, in order to draw conclusions and make inferences about the greater population based on sample data set (Grove *et al*., 2013:538).

Significance was evaluated by p-values and was less than 0.05 for the value to be considered statistically significant. All data will be kept in a safe for 5 years (SAMRC, 2018) and will be made available only to the supervisor, co-supervisor and Research Ethics Committee on request.

Out of 89 professional nurses, 32 professional nurses refused to participate because they were feeling tired due to the long shift, not been expose to neuro-critical care, worked in the Neurocritical Care Unit days beyond recall and task which kept them occupied with the critically ill patients.

The following test was used to analyse the collected data:

3.14.1 Descriptive statistics

Descriptive statistics are used to synthesize and describe data which can be presented in terms of three characteristics: the shape of the distribution of values, central tendencies and variability (Polit & Beck, 2018:229). The measurement of the data were summarized by the use of the mean, referring to the arithmetical average of all the scores (LoBiondo-Wood & Haber, 2014:316) and standard deviation measuring the average deviation of the scores from the mean and can be used to interpret individual scores (LoBiondo-Wood & Haber, 2014:318). Frequencies for nominal and ordinal level data were included in the data summary. The data will be presented with the use of bar graphs, tables, histograms and pie charts.

3.14.2 Inferential statistics

Inferential statistics are based on laws of probability and assist with drawing inferences about a population and given data from a sample (Pilot & Beck, 2018:238). Analysis of Variance (ANOVA) was used to test mean group differences between the critical care nurses' educational training level, qualifications, knowledge and associations with years of experience. Kruskal-Wallis test was used to test the number of groups greater than two and a one-way test for independent samples (Pilot & Beck, 2012:420). The use of the t-statistic test was used to test whether two group means are different (LoBiondo-Wood & Haber, 2014:325). Internal consistency was estimated by an index called Cronbach's alpha, indicating consistency to which the various components of multicomponent measures (Pilot & Beck, 2018:250).

3.15 SUMMARY

Research methodology including population and sampling, data collection, data analysis were discussed in this chapter. In the following chapter, comparisons of the results of knowledge will be done, as well as the outcome of the study will be discussed with regard to the interpretation of collected data and the result of data analysis.

CHAPTER 4: DATA ANALYSIS, INTERPRETATION AND RESULTS

4.1 INTRODUCTION

The previous chapter discussed the research methodology process; however this chapter will focus on the results obtained from the questionnaires and will provide a brief overview of statistical procedures. Data analysis involves organising and giving meaning to data which uses descriptive analysis techniques, describing demographic and study variables, and statistical techniques to test proposed relationships amongst variables (Grove *et al*., 2013:46). The statistical analyses are linked to the research question, design and level of data collected. The discussions consist of data preparation, data analysis, research results and statistical tests results.

4.2 CONTEXT OF RESEARCH STUDY

The nursing care of patients with TBI in CCUs poses serious problems to the quality of care. Patients with TBI admitted at a tertiary hospital in the Western Cape are being nursed by professional nurses in CCUs. The researcher investigated the clinical practice, as well as determining the knowledge of professional nurses caring for patients with TBI in a CCU, within a tertiary hospital in the Western Cape.

A quantitative descriptive research design was used to conduct the study and the researcher used a paper-based questionnaire containing four sections, in order to acquire the knowledge and clinical practice of these professional nurses.

4.3 DATA PREPARATION

On the opening of closed envelopes, each questionnaire was assigned a number and was colour coded according to a CCU. The data was captured on an Excel spreadsheet and was rechecked twice for errors to ensure accuracy. An overall response rate of 67% (n=66 included 9 participants of pre-test) was achieved for the study. According to Polit and Beck (2012:305), a response rate for questionnaires of more than 50% is an acceptable validity level. It appears that the group "other" was responding poorly to the study. The group included nurses working in renal, acute spinal cord injury, renal transplant, isolation and oncology CCUs. A rationale behind this response might be that very seldom, almost never, a TBI patient will be admitted to these units. The majority of professional nurses working in these areas declined to participate in the study, either they were never exposed to the neurosurgical CCU before, it had been too long that they were rotated to this area or they had no interest in neurosurgical CCU. Corner and Lemonde (2019:59) confirmed that the more applicable the study is to the respondents in the nursing population, the more likely they will respond. The nine (9) questionnaires that were used for pre-testing the instrument were not included in the final study. The final total of the questionnaires that was valid, amounts to n=57 (which n=54 was completed and n=3 had missing data). The researcher noted that three (3) participants did not answer three questions and were left blank in the questionnaire. Data that was missing at the item level was left blank in the cell of the excel spreadsheet. The three participants did not answer Question 15, 19 and 24, and the incomplete questionnaires were included in the study, because data was sufficient for analysis.

4.4 DATA ANALYSIS

Each questionnaire was assigned a number and the capturing of raw data was entered on an Excel spreadsheet. Following the capturing, data were verified and the spreadsheet was then submitted to a qualified statistician of Stellenbosch University who used the STATA, version 15 program to analyse the data.

Two major classes of statistics were performed in the data analysis which include descriptive and inferential statistics. Significance was evaluated by *p*-value (0.05) to obtain statistical significance to all statistical tests. Measurement of the data was summarized by the use of the mean, referring to the arithmetical average of all the scores, standard deviation (SD) measured the average deviation of the scores from the mean and frequencies for nominal and ordinal level data. Inference was drawn with the use of Analysis of Variance (ANOVA), Kruskal-Wallis and *t*-test. The data will be presented with the use of bar graphs, tables, histograms and pie charts.

4.5 RESEARCH RESULTS

The results are presented according to the chronological order of the questionnaire:

4.5.1 Section A: Demographical data

This section consists of data collected regarding demographical information formulated into nine questions presented in tables and figures. Questions were based on gender, age, nursing qualification, critical care qualification, years' experience, employment history, clinical discipline and length of stay in the unit.

4.5.1.1 Gender (n=57)

The majority of participants were female 87.7% (n=50) and only seven (12.3%) were male as illustrated in Figure 4.1.

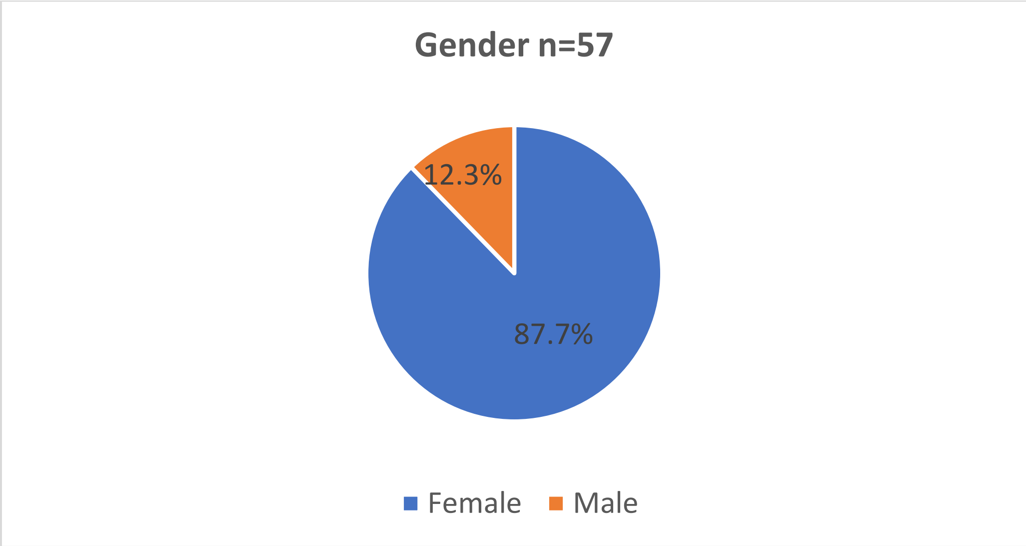

Figure 4.1: Gender

On account of gender, males only represent a small population within the total nursing workforce (McKenna, Van der Heide & Brooks, 2016:74).

4.5.1.2 Age group (n=57)

Figure 4.2 refers to the age distribution of participants. The age group (31-40 and 41-50) share equal percentages 29.8% (n= 17), in addition participants in the category of 51-60 years have 17.5% (n=10) of the total population.

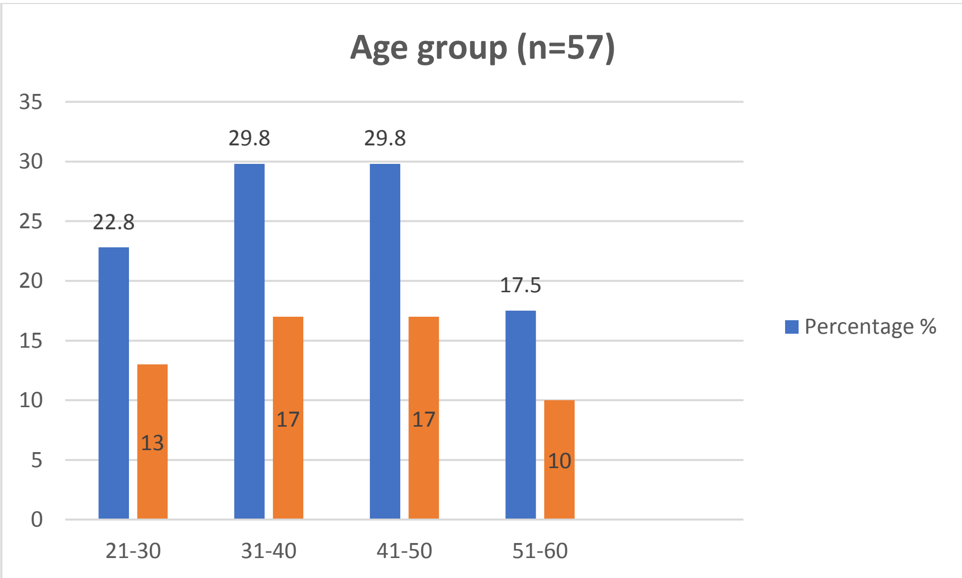

Figure 4.2: Age group of participants

4.5.1.3 Academic qualification (n=57)

Figure 4.3 shows that the majority of respondents had a diploma in nursing 66.7 % (n=38) compared to 17.5% (n=10) with a nursing degree and Honours/Master's degree in Nursing 15.8% (n=9).

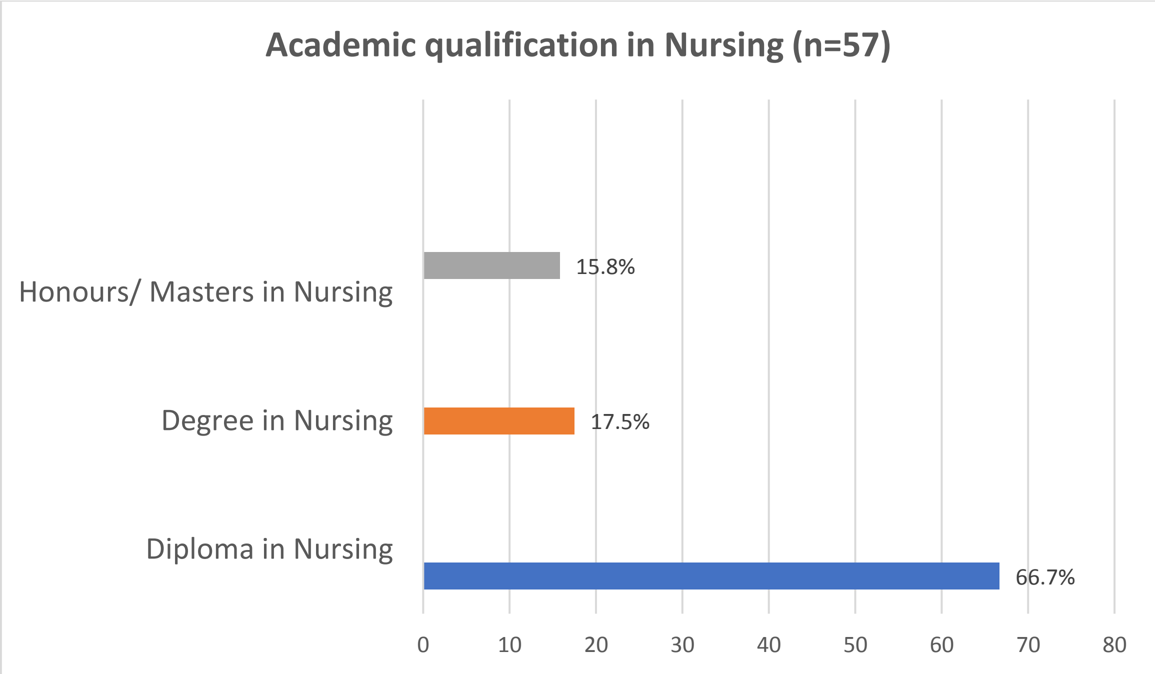

Figure 4.3: Academic qualification in nursing

4.5.1.4 Intensive care qualification (n=57)

As reflected in Figure 4.4, half of the respondents (n=29, 50.9%) have no postgraduate qualification in critical care and only 33.3 % (n=19) are in the position of a postgraduate qualification.

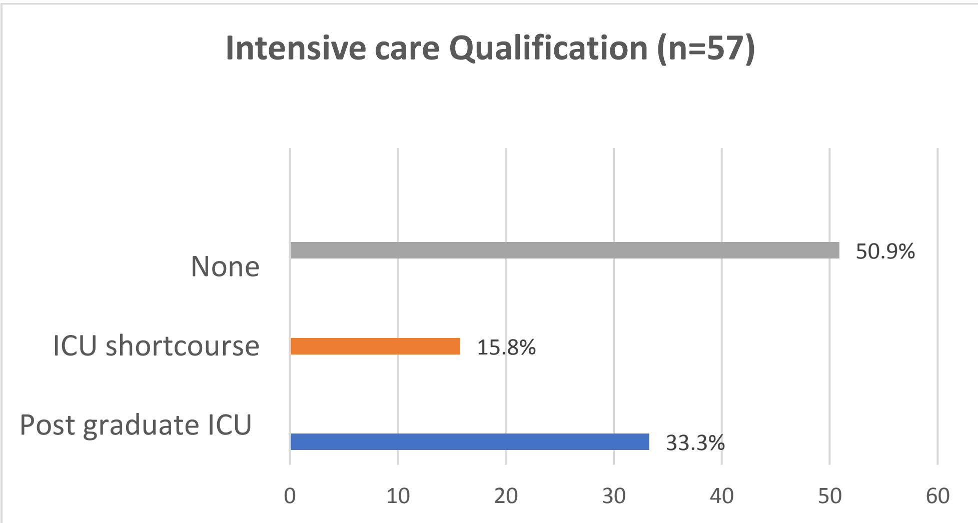

Figure 4.4: Intensive care qualification

In a 2007 National Audit of Critical Care resources done by Scribante and Bhagwanjee (2007:1315), an acute shortage of trained nurses was depicted already.

4.5.1.5 Total number of years of experience in nursing (n=57)

Figure 4.5 illustrated the total number of years' experience of respondents in the age group of 20 and more years as 35.1% (n=20) which is the majority and 15 to 19 years' experience in nursing 7% (n=4) was the group with the least responses. As a result, the group of 20 and more years can be categorised as experts in general critical care, due to their deep understanding of the total situation and enormous background of experience according to Benner (1982:405). Therefore, it would be expected that experts apply innovative interventions and general critical care nursing skills to correlate with the patient's responses.

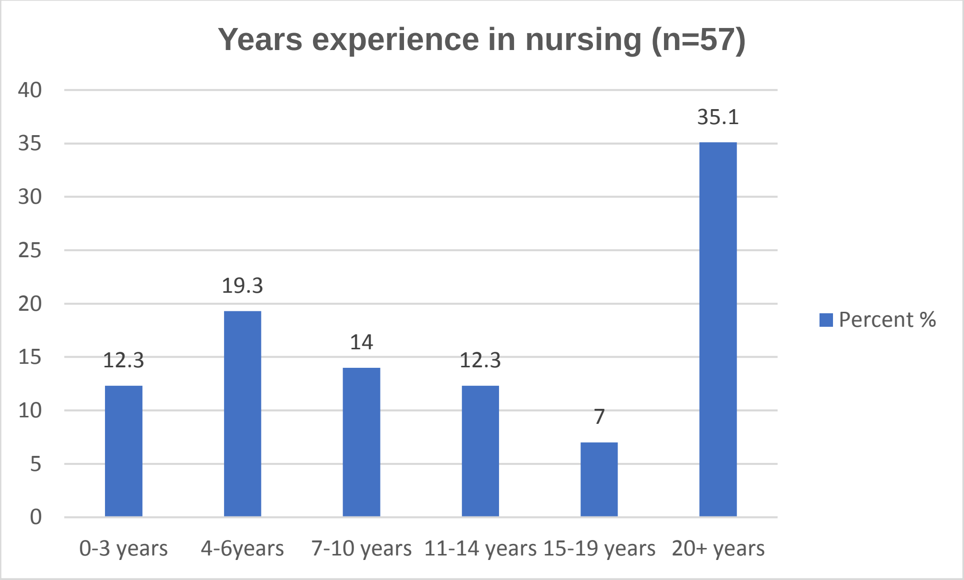

Figure 4.5: Total number of years' experience in nursing

4.5.1.6 Employment (n=57)

In table 4.6, it is evident that the majority of respondents are permanently employed at the hospital and indicate a dependable workforce 82.5% (n=47). The staff at the permanent hospital should be familiarised with the policies and care of the patients with traumatic brain injuries.

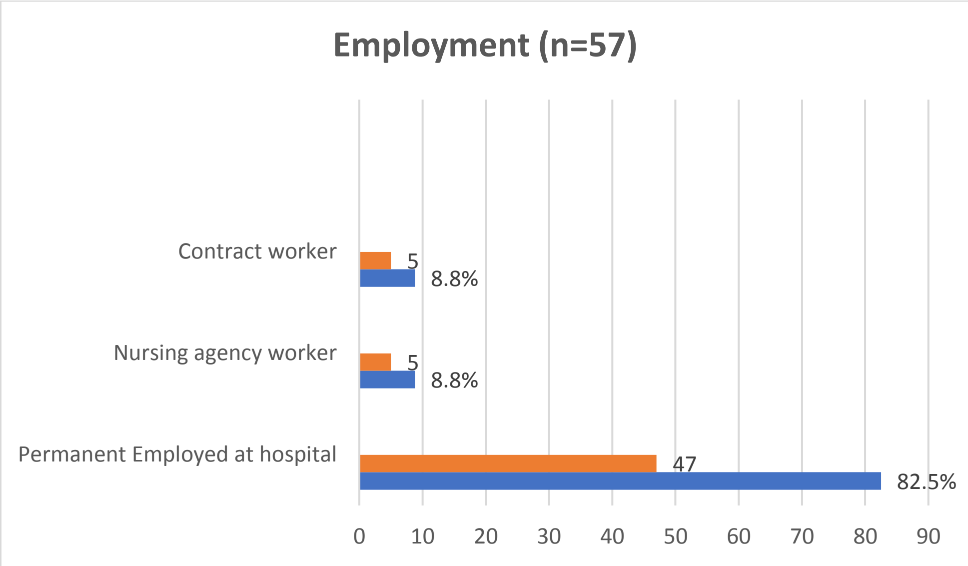

Figure 4.6: Employment

4.5.1.7 Clinical discipline (n=57)

Figure 4.7 highlights the distribution of the clinical discipline in which the participants practise. The greater number of participants were in neurosurgical critical care, n=16 (28.1%) and only n=3 (5.3%) who participated were in coronary care.

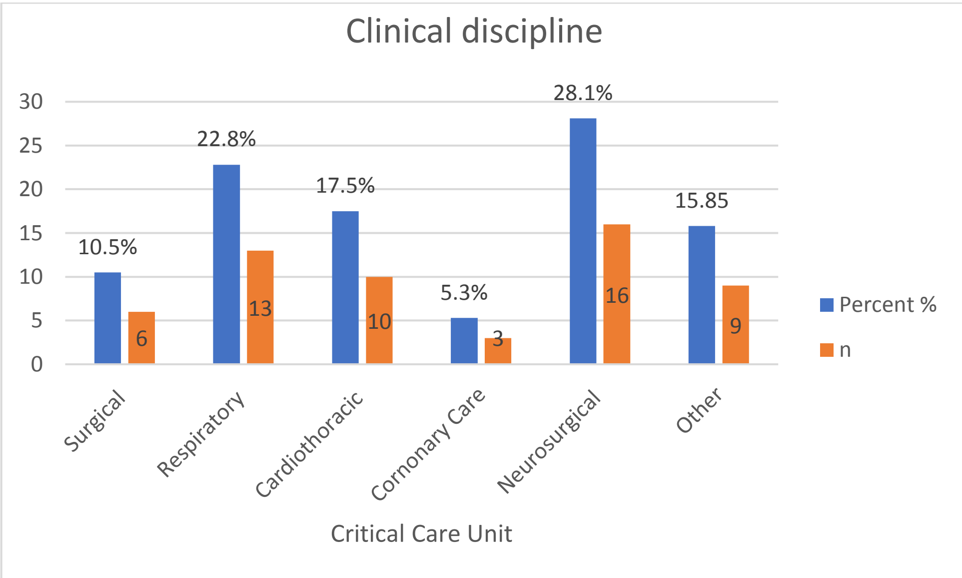

Figure 4.7: Clinical discipline (n=57)

4.5.1.8 Length of time in the current discipline (n=57)

Table 4.5 revealed participants working 1-5 years in a discipline, showed the higher response rate n=20 (35.1%) and more than 10 years were the minority n=7 (12.3%).

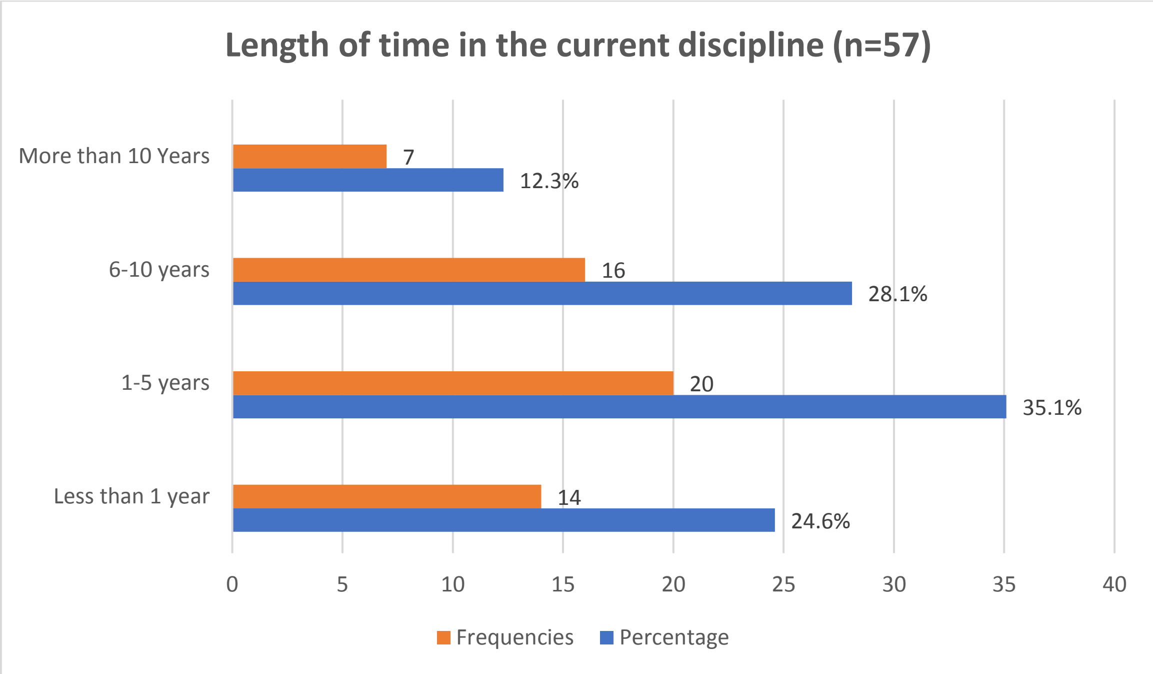

Figure 4.8: Length of time in the current discipline (n=57)

4.5.1.9 Length of time worked in neurocritical care (n=57)

In Figure 4.4, it is more evident that 26.3% (n=15) of nurses never worked in neurocritical care and less than the half of the nurses 43.9% (n=25) were exposed to neurocritical care for less than 1 year. Most of the participants have novice clinical experience according to Benner's 1982 theory; to be an expert in clinical nursing the nurse requires five years to be able to look at a given patient with traumatic brain injury and act without conscious thought to the need of the patient without informed guidance (Stinson, 2017:55).

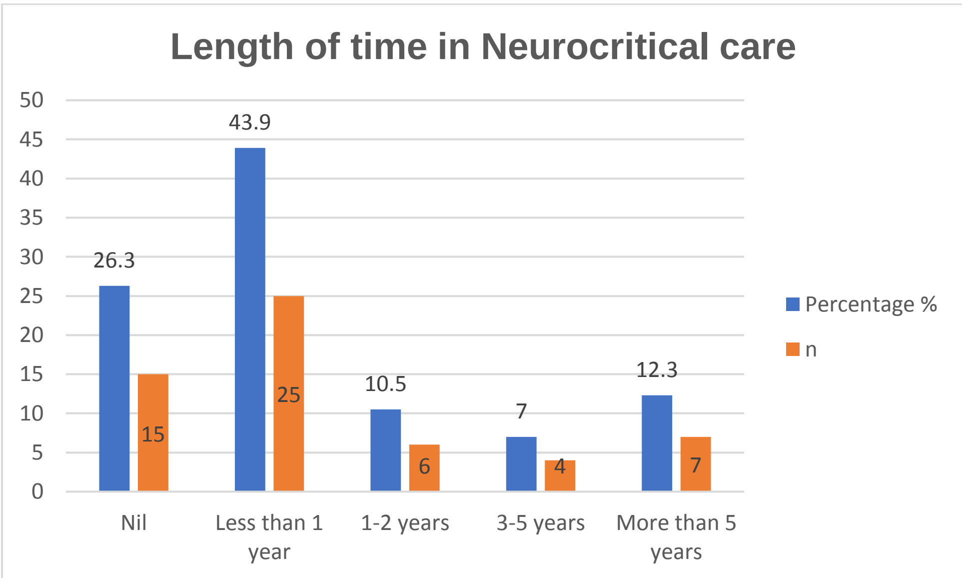

Figure 4.9: Length of time working in Neurocritical Care

4.5.2 Section B: Knowledge level on nursing patients with traumatic brain injury

This section aimed at collecting data with regard to knowledge of the Glasgow Coma Scale (GCS), fever, intracranial pressure monitoring, brain oxygenation, extra-ventricular drain and positioning of traumatic brain injuries.

This section consists of (Agree/disagree) statements and presents 18 questions (10-28). In order to answer these questions, participants had to tick the correct statement. The outcome of this section has been presented in table 4.1.

4.5.2.1 Variable: Glasgow Coma Scale (n=57):

Question 10 (n=57): A severe head injury is classified as a Glasgow Coma Score of 8 and below?

The classification of severe head injury was unknown to 12, 2% (n=7) of the participants and 87.7% (n=50) of participants knew how severe head injury is classified. This question was aimed to examine the knowledge from the novice to the expert regarding elements of the GCS.

Question 11 (n=57): Localising refers to: Patient will move hand above the clavicle after applying supra orbital pressure or pinching trapezius muscle?

A localising response refers to when the patient moves the hand above the clavicle after applying supraorbital pressure or pinching trapezius muscle (Barlow, 2012:114); 77.1% (n=44) agreed to have the knowledge, from the novice to the expert, according to Benner's theory.

Question 12 (n=57): A good flexion response on pain stimuli is characterised by flexing of the elbow, often accompanied by lifting the elbow clear of the body?

More than half of the participants from novice to experts answered correctly regarding a flexion response 84.2% (n=48). In abnormal flexion there is adduction of the shoulders with internal rotation known as decorticate posture, these patients do better overall than those with extensor posturing (Bhaskar, 2017:3)

Question 13 (n=57): A dilated pupil represents cerebral oedema or herniation on the same side of the dilated pupil?

Bilateral and unresponsive pupils are usually considered an indication of irreversible brainstem damage (Anthanasiou, Balogiannis & Magras, 2017:229). The nurses in the critical care unit caring for patients with TBI should know that a dilated pupil does not represent cerebral oedema or herniation on the same side of the dilated pupil. Of n=57, 61.4% (n=35) answered the question incorrectly, indicating the competence of the critical care nurse assessing pupil responses.

Question 14 (n=57): Bradycardia, widening pulse pressure, irregular respiration and rise in blood pressure are signs of Cushing's response?

The presence of Cushing's sign is an indication for immediate neurosurgical intervention (Sukesh, Sai Satyanarayana, Reddy, Ravi, & Vojjini, 2018:1); 78.95% (n=45) knew the signs of Cushing's response and showed proficient knowledge.

4.5.2.2 Variable: Fever

Question 15 (n=56): Central fever is a concept defined as a fever caused by trauma or lesion that involves the medulla oblongata and the base of the brain?

Only 66% (n=37) participants were competent and aware that central fever does not involve the medulla oblongata and disagreed. Central hyperthermia is associated with the worst outcomes in traumatic brain-injured patients (Natteru, George, Bell, Nattanmai & Newey, 2017:1).

Question 16 (n=57): Rectal temperature are one of the most acurrate routes of monitoring core temperatures?

Rectal membrane temperature via a rectal probe is one of the greatest validities in measuring body temperature (Huggins, Glaviano, Negishi, Casa & Hertel, 2012:337); 96.49% (n=55) agreed and critical care nurses should consist of the knowledge from the advanced beginner phase of Benner's theory that rectal temperature is to be more accurate.

Question 17 (n=57): Hyperthermia can increase ICP (intracranial pressure)?

Periods of hyperthermia initiate worsening of functional outcomes in patients with TBI (Atkins, Bramlett & Dietrich, 2017:4). The majority of participants have proficient knowledge and are aware that hyperthermia increases ICP with the result of 87.2% (n=50).

4.5.2.3 Variable: Brain oxygenation

Question 18 (n=57): During intracranial hypertension, the target level of Partial Pressure of Carbon Dioxide (PCO2) is 4 to 4.6 kpa?

Therapeutic hyperventilation is to reduce increased ICP by manipulating the autoregulatory functions connected to cerebrovascular CO_2 reactivity (Godoy, Seifi, Garza, Lubillo-Montenegro & Murillo-Cabezas, 2017:1). Participants are competent and are aware of the target levels of PCO_2 where 85.48% (n=47) answered correctly.

Question 20 (n=57): Cerebral perfusion pressure (CPP) is calculated as, (Systolic Pressure – ICP)?

The correct calculation for Cerebral perfusion pressure is CPP=Mean arterial pressure (MAP) minus ICP (Kawoos, McCarron, Auker & Chavko, 2015: 28980). The majority of participants

61.4% (n=35) agreed to the incorrect statement regarding calculating the cerebral perfusion pressure at the competent phase of Benner's theory.

Question 22 (n=57): Brain tissue monitoring (Licox) is used to monitor brain oxygenation. A value less than 20 mmHg is associated with poor outcome of patients with traumatic brain injury?

The normal brain oxygenation is 23-35mmHg with Licox (Tasneem, Samaniego, Pieper, Leira, Adams, Hasan & Ortega-Gutierrez, 2017:3); 80.7% (n=46) participants were competent on answering the question pertaining to brain perfusion parameter on Licox monitoring.

4.5.2.4 Variable: Intracranial pressure monitoring

Question 19 (n=55): On intracranial pressure monitoring, 3 waveforms are reflected on the monitor?

ICP waveforms are helpful in identifying changes in patients' neurological condition and three distinct pressure waves have been identified by Lundberg (Hickey, 2014:293); 85.5% (n=47) agreed and were competent on answering the question regarding intracranial waveforms correctly.

Question 21 (n=57): Intracranial pressure (ICP) compliance can be described as - P1 curve is smaller than P2 and P3 curve?

Compliance refers to the amplitude of ICP waveforms in clinical practice (Howells, Lewen, Skold, Ronne Engstrom & Enblad, 2012: 1061)and 57.89% (n=33) of the participants were correct in answering the question pertaining the expert stage of Benner's theory.

Question 23 (n=57): Patient's positioning affects an intracranial pressure reading?

According to Mir, AlOtaibi, Albaradie and ElRazkey (2015:1559), the position of the patient has a profound effect on the intracranial pressure stability of head-injured patients; 94.7% (n=54) agreed and were proficient in answering the question correctly regarding positioning affecting intracranial pressure.

Question 24 (n=55): Reverse Trendelenburg position is one fastest, least invasive way to acutely lower intracranial pressure?

Reverse Trendelenburg position with an angle of 20-30 degrees will lower the ICP. Furthermore, hypoxia develops due to an increase in ICP if positioned in traditional Trendelenburg position (Ozgun, Sargin, Karaman, Gunusen, Alper & Askar, 2017:1797); 62.2% (n=37) have the same opinion regarding reverse Trendelenburg position for the faster-lowering effect of intracranial pressure and showed expertise knowledge.

Question 26 (n=57): Normal ICP parameter is (15mmHg)?

The normal ICP in adults is 5-15 mmHg (Tasneem *et al*., 2017:3); 87.7% (n=50) knew the correct ICP parameter.

4.5.2.5 Variable: Extra-ventricular drain

Question 25 (n=57): Extra-ventricular drain (EVD) should always be lower than the patient in order to facilitate draining of cerebrospinal fluid?

Under-drainage of cerebrospinal fluid will occur when the extra-ventricular drain is too high above the patient (Humphrey, 2018); 61.4 % (n=35) answered correctly and showed competent knowledge.

Question 27 (n=57): Extra-ventricular drain (EVD) should be kept open at all times?

The EVD should be closed to drainage during positioning if clinically feasible. Furthermore, the EVD should be closed for accurate measurement at least hourly (Lele, Hoefnagel, Schloemerkemper, Wyler, Chaikittisilpa, Vavilala, Naik, Williams, Raghavan & Koerner, 2017: 199); 59.6% (n=24) agreed that an EVD should be kept open at all times and showed knowledge at the stage of the advanced beginner.

4.5.2.6 Variable: Need for training

Question 28 (n=57): I need more training/information regarding nursing a patient with raised intracranial pressure?

Intracranial pressure is complex and require understanding of the nursing care management for patients' safety (El Hussein, Zettell & Suykens, 2016:6). When it comes to further teaching, all participants (n=57,100%) agreed that they needed more training/knowledge for nursing patients regarding raised intracranial pressure.

Table 4.1: Knowledge of professional nurses caring for patients with traumatic brain injury (n=57)

Question	Variable	Correct response	Agree n	Agree %	Disagree n	Disagree %	Not Answered #
Q10	A severe head injury is classified as a Glasgow Coma Score of 8 and below	Agree	50	87.72	7	12.28	
Q11	Localising refers to: Patient will move the hand above the clavicle after applying supraorbital pressure or pinching the trapezius muscle	Agree	44	77.19	13	22.81	
Q12	A good flexion response on pain stimuli is characterized by flexing of the elbow, often accompanied by lifting the elbow clear of the body	Agree	48	84.21	9	15.79	
Q13	A dilated pupil represents cerebral oedema or herniation on the same side of the dilated pupil	Disagree	22	35.60	35	61.40	
Q14	Bradycardia, widening pulse pressure, irregular respiration and rise in blood pressure are signs of Cushing's response	Agree	45	78.95	12	21.05	
Q15	Central fever is a concept defined as fever caused by trauma or lesion that involves the medulla oblongata	Disagree	19	33.93	37	66.07	1
Q16	Rectal temperature is one of the most accurate routes of monitoring core temperature	Agree	55	96.49	2	3.51	
Q17	Hyperthermia can increase ICP	Agree	50	87.72	7	12.28	
Q18	During intracranial hypertension, the target level of PCO2 is 4 to 4.6 kpa	Agree	47	85.45	10	17.54	
Q19	On ICP monitoring, 3 waveforms are reflected on the monitor	Agree	47	85.45	8	14.55	2
Q20	CPP is calculated as: Systolic Pressure – ICP	Disagree	35	61.40	22	38.60	
Q21	ICP compliance can be described as P1 Curve smaller than P2 and P3 Curve	Disagree	24	42.11	33	57.89	
Q22	Brain tissue monitoring (Licox) is used to monitor brain oxygenation. A value less than 20 mmHg is associated with poor outcome of patients with TBI	Agree	46	80.70	11	19.30	
Q23	Patient's position affects an ICP reading	Agree	54	94.74	3	5.26	
Q24	Reverse Trendelenburg position is one of the fastest ways to acutely lower intracranial pressure	Agree	37	62.27	18	32.73	2
Q25	EVD should always be lower than the patient in order to facilitate draining of cerebrospinal fluid	Disagree	22	38.60	35	61.40	
Q26	Normal ICP parameter is less than 15 mmHg	Agree	50	87.70	7	12.28	
Q27	EVD should be kept open at all times	Disagree	23	40.35	34	59.65	
Q28	I need more training/information regarding nursing a patient with raised ICP		57	100.00	0	0.00	

Not answered

4.5.3 Section C: Practices of professional nurses caring for patients with traumatic brain injury

This section aimed at collecting data with regard to practices of professional nurses caring for patients with traumatic brain injury.

This section consists of (never, rare sometimes, frequent and always) statements and presents 8 questions (29-36). In order to answer these questions, participants had to tick the correct statement. The outcome of this section has been presented in Table 4.2, which follow.

Question 29 (n=57)

In Table 4.2 only 64.9% (n=37) are targeting a systolic pressure more than 90 mmHg always, but also 21, 0% (n=12) are targeting the systolic pressure sometimes. A systolic pressure above 90 mmHg should be maintained, a single episode of hypotension is associated with increase morbidity and doubling of the mortality rate (Boniface, Lugazia, Ntungi & Kiloloma, 2017:3). It is expected from the novice to the expert to know the values of the target systolic pressure in TBI.

Table 4.2: Question 29 - We aim for systolic blood pressure 90 mmHg and higher in traumatic brain injury patient (n=57)

	n	%
Never	3	5.26
Rare	0	0
Sometimes	12	21.05
Frequent	5	8.77
Always	37	64.91

Question 30 (n=57)

In Table 4.3, 68.4% (n=39) are competent targeting a CPP value more than 60 mmHg to perfuse the brain. Raising the CPP above 60 mmHg can avoid cerebral oxygen desaturation (Prabhakar, Sandhu, Bhagat, Durga & Chawla, 2014:318).

Table 4.3: Question 30 - We target CPP value, more than 60 mmHg for brain perfusion (n=57)

	n	%
Never	0	0
Rare	1	1.75
Sometimes	9	17.54
Frequent	8	14.04
Always	39	68.42

Question 31(n=57)

Only 17.5% (n=10) from the novice to the expert critical care nurse, in Table 4.4, make use of the end-tidal carbon dioxide device at all times in the critical care units. Continuous End-tidal capnography is highly recommended for TBI patients, as it measures arterial carbon dioxide levels to indicate hypoxemia and patients' response to treatment (Chowdhury, Kowalski, Arabi & Dash, 2014:114).

Table 4.4: Question 31 - We monitor End-tidal carbon dioxide (ETCO2) in my CCU (n=57)

	n	**%**
Never	12	21.05
Rare	12	21.05
Sometimes	13	22.81
Frequent	10	17.54
Always	10	17.54

Question 32 (n=57)

The majority of the participants 63.1% (n=36) have advanced beginner knowledge and agree to always use mannitol or hypertonic saline to alleviate raised intracranial pressure. Hyperosmolar therapy which reduce blood viscosity and cerebral oedema is an effective treatment for intracranial hypertension with monitoring of arterial pressure, serum sodium and osmolality (Llorente & de Mejia, 2014: 29-31).

Table 4.5: Question 32 - Hyperosmolar therapy (mannitol or hypertonic saline) are used to control raised ICP (n=57)

	n	**%**
Never	0	0
Rare	1	1.75
Sometimes	7	12.28
Frequent	13	22.81
Always	36	63.16

Question 33 (n=57)

According to Table 4.6, only 43.8% (n=25) showed expert knowledge stating that hyperventilation is used for reducing elevated ICP in the critical care unit at all times. Best practice indicates that hyperventilation therapy controls TBI intracranial hypertension (Godoy *et al*., 2017:1).

Table 4.6: Question 33 - Hyperventilation is used as a temporary measurement for reducing elevated ICP (n=57)

	n	%
Never	3	5.26
Rare	4	7.02
Sometimes	16	28.07
Frequent	9	15.79
Always	25	43.86

Question 34 (n=57)

The majority of participants 64.91% (n=37) are proficient in using Propofol infusion to control raised ICP "Always." Propofol is an anaesthetic agent and can reduce as much as 50% in the cerebral metabolic rate of oxygen which is an advantage for raised intracranial pressure (Tan, Cheng & Sim, 2015:161).

Table 4.7: Question 34 - Propofol infusion is used for control of raised ICP (n=57)

	n	%
Never	2	3.51
Rare	2	3.51
Sometimes	3	5.26
Frequent	13	35.09
Always	37	64.91

Question 35 (n=57)

As illustrated in Table 4.8, 47.37% (n=27) initiated feeding at least 24 hours post-injury at all times, whereas 21.05% (n=12) have done it sometimes. This should be known to the advanced beginner stage according to Benner's theory. Early feeds optimize recovery of patients with traumatic brain injury by decreasing the metabolic rate and protein catabolism, as well as hospitalization (Chapple, Chapman, Lange, Deane & Heyland, 2016:2).

Table 4.8: Question 35 - Feeding is initiated at least 24 hours post-injury(n=57)

	n	%
Never	0	0
Rare	7	12.28
Sometimes	12	21.05
Frequent	11	19.30
Always	27	47.37

Question 36 (n=57)

In question 36, (84.21% n=48) agreed and showed knowledge at the novice stage according Benner's theory that Intermittent pneumatic cuffs are available to all traumatic brain injury patients as prophylaxis. Patients with TBI are at risk for DVT due to hypercoagulability, intermittent pneumatic cuffs are effective at reducing DVT (Paydar, Sabetian, Khalili, Fallahi, Tahami, Ziaian, Abbasi, Bolandparvaz, Ghaffarpasand & Ghahramani, 2016:4).

Table 4.9: Question 36 - Intermittent pneumatic cuffs for DVT prophylaxis is available to all patients (n=57)

	n	%
Never	0	0
Rare	0	0
Sometimes	3	5.26
Frequent	6	15.76
Always	48	84.21

4.5.4 Section D: Guidelines and in-service training

4.5.4.1 Question 37 Guidelines and protocols are available in my unit with regard to management of raised intracranial pressure

Guidelines have a range of purposes to improve effectiveness and quality of care to decrease variations in clinical practice in order to decrease costly, preventable mistakes and adverse events (Kredo, Bernhardsson, Machingaidze, Young, Louw, Ochodo & Grimmer, 2016:123). As illustrated in Table 4.18, the majority of participants (n=34; 59.6%) stated that they have never come across guidelines and protocols with regard to the management of raised intracranial pressure in the critical care unit. The minority (n=7; 12.3%) agreed that there were always guidelines and protocols.

Table 4.10: Guidelines and protocols are available in my unit with regard to management of raised intracranial pressure (n=57)

	n	%
Never	34	59.6
Rare	14	0
Frequent	2	3.5
Sometimes	0	0
Always	7	12.3

4.5.4.2 Question 38 In-service training and informative sessions about monitoring equipment and nursing care of patients with raised intracranial pressure monitoring

In-service training, owing to its practical nature, improves the competency and professional skills of nurses (Chaghari, Saffari, Ebadi & Ameryoun, 2017:31). In addition, the majority of participants 35.1% (n=20) responded that in-service training and information sessions are held rarely in CCUs, whereas n=17 (29.8%) stated "FREQUENT" and n=16 (28%) never had the in-service training or information session.

Table 4.11: In-service training and informative sessions about monitoring equipment and nursing care of patients with raised intracranial pressure monitoring (n=57)

	n	%
Never	16	28.1
Rare	20	35.1
Frequent	17	29.8
Sometimes	2	3.5
Always	2	3.5

4.6 INFERENTIAL STATISTICAL RESULTS

4.6.1 Total knowledge scores of professional nurses caring for traumatic brain injury patients

Table 4.15 illustrates knowledge score (n=57), a standard deviation (SD) 0.09 with a mean (M) score of 0.71.

Table 4.12: Knowledge score (n=57)

Variable	n	Mean	Std. Dev.	Minimum	Maximum
Knowledge score	57	0.71	0.09	0.52	0.94

The minimum SD of 0.52 and the maximum SD 0.94, which a low SD indicating confidence in the statistical conclusion.

4.6.2 Comparisons of the results of the knowledge of professional nurses regarding nursing patients with traumatic brain injury in a CCU; with the demographic factors of the participants

The comparison of knowledge of professional nurses regarding nursing patients with traumatic brain injury in a CCU; with the demographic factors of the participants were facilitated by further inferential statistical test, such as the *t*-test, ANOVA and Kruskal-Wallis. The knowledge of the nurses are not associated with their demographical factors. The tests show (Table 4.13) that the results were not statistically significant ($p<0.05$) as further discussed:

Table 4.13: Comparison of knowledge of professional nurses regarding nursing patients with traumatic brain injury by demographic factors

Demographic	Knowledge mean ±SD	Test statistics
Gender		
Male	0.714±0.12	0.89∊
Female	0.719±0.09	
Age group		
21-30	0.73±0.08	0.42≠
31-40	0.71±0.10	
41-50	0.69±0.87	
51-60	0.75±0.10	
Nursing qualification		
Diploma	0.72±0.10	0.17∇
Degree	0.74±0.04	
Honours/Master	0.67±0.83	
Intensive care qualification		
Post graduate ICU	0.73±0.10	0.52≠
ICU short course	0.72±0.07	
None	0.07±0.09	
Employment		
Permanent	0.71±0.95	0.65≠
Nursing Agency	0.75±0.09	
Contract worker	0.69±0.10	
Clinical discipline (Critical Care units)		
Surgical	0.71±0.10	0.66∇
Respiratory	0.69±0.06	
Cardiothoracic	0.70±0.11	
Coronary Care	0.66±0.12	
Neurosurgical	0.75±0.11	
Other	0.73±0.05	
Years' experience in nursing		
0-3 years	0.67±0.09	0.71≠
4-6 years	0.74±0.61	
7-10 years	0.71±0.10	
11-14 years	0.71±0.12	
15-19 years	0.75±0.10	
20+ years	0.71±0.09	
Length of time in the current discipline		
Less than 1 year	0.71±0.09	0.29≠
1-5 year	0.68±0.09	
6-10 years	0.74±0.08	
More than 5 years	0.75±0.11	
Length of time worked in neurocritical care		
Nil	0.68±0.10	0.24≠
Less than 1 year	0.71±0.08	
1-2 years	0.77±0.11	

3-5 years	0.07±0.02
More than 5 years	0.75±0.12

∈ *t*-test
≠ Analysis of variance (ANOVA)
∇ Kruskal-Wallis

4.6.2.1 Gender

The knowledge score according to gender: Mean score for male participants 0.714 and females 0.719 with a standard deviation of 0.095 for females and 0.128 for male participants. There was a difference in the mean score and as illustrated, females consist of a slightly higher mean score than males. The *t*-test calculation was done for the difference in scores and revealed that it is not statistically significant (p=0.89).

4.6.2.2 Age group

A one-way between subject's ANOVA was conducted to compare the knowledge and age group in the CCU. The SD in the age group 51 to 60 is marginally higher for those between 21 and 30. ANOVA score (p=0.42) shows no significant differences of knowledge between age groups.

4.6.2.3 Nursing qualification

With regard to nursing qualifications, the participants with a degree in nursing have the highest mean score, as well as the lowest SD amongst the nursing qualification group. Participants with a honours/master degree have a mean of 0.67 and an SD of 0.83, which placed them in the lowest category. Even though the degree participants have the highest mean knowledge score, the Kruskal-Wallis test (p=0.17) shows no significant difference between the nursing qualification group.

4.6.2.4 Intensive care qualification

With regard to the ICU qualification knowledge scores, the participants holding a postgraduate qualification have a mean knowledge score (mean 0.73 and SD 0.10) and the participants with an ICU short course, have a mean score (mean 0.72 and SD 0.04). Even though the participants show a higher knowledge score, it is not statistically significant according to ANOVA (p=0.52).

4.6.2.5 Employment

Knowledge score for nurses working for the agency, is the highest (mean 0.75 and SD 0.09) in the employment knowledge score group. There is a small difference between the permanent nurses (mean 0.71 and SD 0.95) and contract workers (mean 0.69 and SD 0.10) in the lowest score range. In summary, nurses working for the agency seem to be more knowledgeable than the other two categories, but according to the statistical test ANOVA (*p*=0.65), it is not significant.

4.6.2.6 Clinical discipline (Critical Care Units)

Nurses in neurosurgical critical care have the highest knowledge score (mean 0.75 and SD 0.11) and nurses working in coronary care have the lowest knowledge score (mean 0.66 and SD 0.12). The difference in knowledge is not significant according to the Kruskal-Wallis test (*p*=0.66).

4.6.2.7 Years' experience in nursing

In terms of knowledge score according to total years of experience in nursing, the group of 15-19 years (mean 0.75 and SD 0.10) has the highest knowledge score and the group of 0-3 years (mean 0.67 and SD 0.09) has the lowest knowledge score, but no significance amongst the groups were reported with the ANOVA test (*p*=0.71).

4.6.2.8 Length of time in the current discipline

Nurses that remain in current disciplines for more than 10 years have the highest knowledge score (mean 0.75 and SD 0.11), whereas nurses in the clinical discipline for 1-5 years have the lowest knowledge score (mean 0.68 and SD 0.09). With regard to statistical significance, the ANOVA test shows no significant difference (*p*=0.29) amongst the groups.

4.6.2.9 Length of time worked in neurocritical care

On account of knowledge scores according to the length of time nurses working in the neurocritical care between 1-2 years, have the highest knowledge score (mean 0.77 and SD 0.11) and nurses working in neurocritical care for 3-5 years, have the lowest knowledge score (mean 0.07 and SD 0.02), as illustrated in Figure 4.13 and 4.14. The ANOVA test has found that the difference is not statistically significant (*p*=0.24).

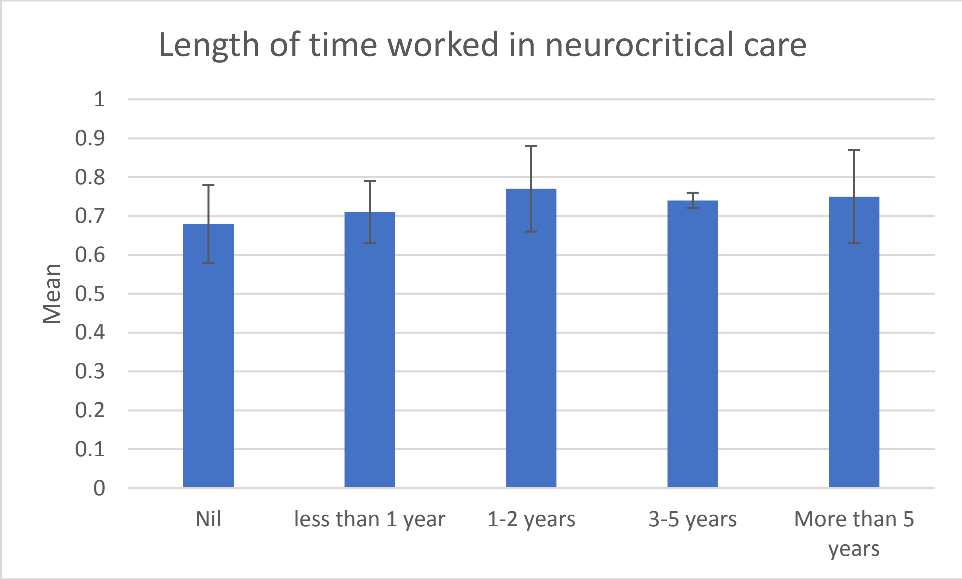

Figure 4.10: Length of time worked in neurocritical care

4.7 SUMMARY

In this chapter the data analysis was presented and interpreted in the form of tables, graphs and pie charts as visual presentation. The assistance of STATA version 15 was a statistical software that provided the data science needs, analysis and manipulation in order to examine and report data patterns. Protocols and guidelines play an important role in practice and more than half of the population agreed that no available protocols and guidelines were in place, caring for the TBI patient in critical care. It is prevalent that exposure to neurocritical care will allow you to have a better understanding with peers who did not. It is also evident that nurses in neurocritical care show a deep understanding of caring for TBI patients and are able to prevent future complications or adverse situations by thinking ahead and taking preventative action.

According to Benner's theoretical framework (1982:405), the expert, referring to the neurocritical care nurse, can integrate knowledge into practice, utilise her/his skills and show insight into a particular situation.

4.8 CONCLUSION

In conclusion of chapter 4, the researcher discusses the data analysis and results presented in table and graphic format to answer the research question. Literature was used to support the results and will be discussed in Chapter 5. The data collection and analysis of 57 questionnaires revealed an average knowledge score of 71% of professional nurses caring for a TBI patient in a CCU, although guidelines and protocols remain a concern in clinical practice. In chapter 5, the researcher discusses the limitations, recommendations and conclusions of the research study.

CHAPTER 5: DISCUSSION, RECOMMENDATION AND CONCLUSION

5.1 INTRODUCTION

The aim of the study was to determine the knowledge and clinical practice of professional nurses caring for patients with TBI in a CCU, within a tertiary hospital, in the Western Cape In this chapter, the discussion, conclusions and recommendations are discussed. Recommendations based on the research results are presented.

5.2 DISCUSSION

The discussion focused on the findings of the objectives of the study and derived from the statistical data analysis illustrated in chapter 4. The discussion that follows is focused on the objectives of the study.

5.2.1 Objective 1: Determine the knowledge of professional nurses caring for patients with TBI in a CCU within a tertiary hospital

A summarized mean knowledge score percentage in the CCU revealed 71% overall (n=57) participants responded. The outcome of the knowledge score according to qualifications, appears to be in a similar range. It was expected for participants with postgraduate qualifications to have a higher knowledge score, because at postgraduate level, the neurological and neurosurgical system were discussed in depth. Participants with a degree in nursing were more knowledgeable than nurses with a diploma and Masters/Honours degree (Table 4.13). This is an unexpected result and might be related to respective programmes and emphasis placed on neurological and neurosurgical nursing. Findings in a study done in the United States found that hospitals with a higher proportion of nurses with Baccalaureate degrees, have shown to have lower in-patient, lower 30-day mortality, as well as lower failure to rescue and cardiac deaths (Blegen, Goode & Park, 2018:93).

The knowledge score of critical care nurses working in the Neurocritical Care Unit CCU scored the highest percentage of 75%, as total knowledge score and critical care nurses within the Coronary Care Unit have the lowest score of 66% with regard to the clinical discipline (Table 4.8). This might be due to the frequent encounter with neurological patients and staff becomes familiar with the management of TBI patients. Another reason behind this might also be due to TBI cases that rarely go to the coronary care CCU, as well as CCUs other than neurocritical care, cardiothoracic, respiratory and surgical CCU for management. Surprisingly, critical care nurses working in other CCUs revealed a higher knowledge score than critical care nurses working in Cardiothoracic, Respiratory and Surgical Critical Care Units, and CCUs taking the overflow of TBI patients.

Amongst the three CCUs, the Surgical CCU has the highest knowledge score of 71%, higher than the Respiratory CCU (69%) and Cardiothoracic CCU (70%). The knowledge in these disciplines will possibly limit their capacity in clinical judgement and decision making in managing the TBI patient.

From the data, it can be concluded that the length of time working in Neurocritical Care is off significant value with regard to knowledge. Critical care nurses that were never exposed to neurocritical care have the lowest knowledge score, compared to critical care nurses who have been rotated through the Critical Care Unit. According to the data, critical care nurses exposed to neurocritical care between one and two years show the highest knowledge score of 77%, compared to critical care nurses exposed to neurocritical care for more than five years (Table 4.8). One reason behind this can be an interest in learning about another discipline, the studiousness of critical care nurses wanting to learn more about the new specialty, guidance from seniors and peers, as well as adopting new skills. It is expected of nurses exposed to neurocritical care for more than five years, to have the highest knowledge score amongst all, due to the amount of experience. Moreover, it is known that once you have been exposed to neurocritical care, you will have a better understanding as compared with peers who did not undertake such practices (Mattar, Liaw, Chan, 2013:279). It is expected of nurses who have more than five years exposure to neurocritical care, to have the highest knowledge score amongst all, due to the amount of experience.

With regard to knowledge score for employment, it is evident that critical care nurses, working for an agency have the highest knowledge score percentage of 75%, compared to the permanent staff of 71% (Table. 4.8). Contract workers seem to have the lowest knowledge score percentage of 69%. It can be concluded that the knowledge percentage of agency critical care nurses might be higher, due to the exposure to different hospitals and CCUs. Orientation programmes, unit policies and guidelines might be in place, as well as in-service training offered at additional hospitals' CCUs.

In terms of knowledge score according to total years of experience in nursing, the group of 15-19 years has the highest knowledge score and the group of 0-3 years has the lowest knowledge score, but no significance amongst the groups was reported with the ANOVA test ($p=0.71$). Nurses having more experience were able to apply the knowledge more accurately than inexperienced nurses. Furthermore, research has shown that nurses with lesser work experience gain guidance from nurses with substantial work experience (Mattar, Liaw, Chan, 2014:102-105). Cerebral perfusion pressure (CPP) is defined as the blood pressure gradient across the brain and is calculated as Mean Arterial Pressure (MAP) minus ICP. In table 4.6 (n=35), 61.4% answered the question incorrectly. CPP is of vital importance in neurocritical care, because events reducing CPP may lead to cerebral ischemia, which is an important and potentially avoidable cause of secondary brain injury (Griesdale *et al*, 2015:111; Livesay, McNett, Keller & Olson, 2017:374).

5.2.2 Objective 2: Investigate the practices of professional nurses caring for patients with traumatic brain injury

As a result, question 31 illustrated in Table 4.4 that only (n=10) 17% “ALWAYS” monitored ETCO2 in their unit. Capnography is an important element of care for patients with TBI and normocapnia should be maintained (ETCO2 <35-40 mmHg) in an attempt to control cerebral blood flow (Damkliang, Considine, Kent, 2013:133; Genzler, Johnson, Ghildayal, Pangarakis & Sendelbach, 2013:243). This question was also highlighted as low in the Cronbach’s alpha coefficient of reliability. This might be due to the unfamiliarity with the ETCO2 monitor, because the majority of participants (n=13,22.8%) answered “Sometimes” and some participants (n=12,21.5%) answered “Never” to question 31. Damkliang *et al*. (2013:133) confirmed that the knowledge of nurses regarding ETCO2 is limited regarding the numerical values and the importance of monitoring.

In general, current practices of professional nurses with regard to maintaining systolic pressures for adequate brain perfusion, hyperosmolar therapy, hyperventilation, sedation, feeding and deep vein thrombosis prophylaxis synchronised with the evidence-based recommendations of the BTF and literature, and nurses in neurocritical care are pioneers and supporters of evidence-based medicine and should continue in this endeavour.

5.2.3 Discussion: Guidelines and in-service training

Another point worth noting, is that (n=34), 59% of participants indicated that there are limited available guidelines and protocols with regard to management of raised intracranial pressure in the CCUs. Protocol or guidelines present in Neurosurgical CCU. All participants admitted that they required further training in neurocritical care. Protocols are very important and this will assist in avoiding secondary neurological insults in neurocritical care and can be beneficial as a checklist for "best practice" (Kramer & Zygun, 2014:177).

5.3 DISCUSSION OF FINDINGS RELATED TO KNOWLEDGE AND CLINICAL PRACTICE COMPETENCY LEVEL (BENNER THEORY) IN THE CCUS

5.3.1 Novice

The novice according to Benner’s theory refers to the beginner stage and are normally taught what to do in order to perform a task. Overall, the four questions were answered well and the novice critical care nurses who know how to classify traumatic brain injury, are aware of the differences between flexion and localization, as well as the numerical value of normal ICP.

5.3.2 Advanced beginner

The advanced beginners based their principles on experience as stated in Benner's theory. Through their experiences, the advanced beginners are aware that a rectal temperature is the most accurate measure to monitor temperature in the critically ill patient. They have prior knowledge and recognized meaningful components.

5.3.3 Competent

The competent critical care nurse consists of two- or three-years' experience as per Benner's theory. These critical care nurses apply analytical thinking with greater efficiency. The study revealed that more than half of the critical care nurses are aware that central fever does not involve the medulla oblongata, know the target PCO2 value, show knowledge of ICP waveforms and competence in EVD, but the majority calculated CPP incorrectly. Cerebral perfusion pressure plays an important role in caring for the traumatic brain injury patient.

5.3.4 Proficient

Benner describes the proficient nurse as someone who perceives and understands situations holistically in order to improve decision making skills. The proficient critical care nurse knew the signs of Cushing's response, the effect fever has on ICP; they were vigilant regarding brain oxygenation and knew the importance of positioning the TBI patient.

5.3.5 Expert

The expert no longer relies on principles, rules and guidance and remains highly proficient according to Benner's theory. Critical care nurses with expert knowledge were the majority, functional in neurocritical care. Less than 60% of the critical care nurses could recognize compliance of ICP monitoring and were aware of reducing ICP with a non-pharmacology measure, by positioning the bed in reverse Trendelenburg position.

5.3.6 Summary of participants not completing questions in questionnaire:

Two participants, identified as novice according to Benner's theory failed to answer question 19. Both participants have a total number of 0-3 years' experience as professional nurses and have less than one year's experience in neuro-critical care.

One participant, identified as an advanced beginner according to Benner's theory, did not answer question 24 and has been a professional nurse for 15-19 years, indicating the experience in neuro-critical care was limited to less than one year.

One participant, with a total of 21 years' experience in nursing and limited to only been exposed to a neuro-critical care unit for less than one year, failed to answer question 15. According to Benner's theory, the participant has been labelled as an expert for the amount of nursing experience.

Another participant, identified as proficient according to Benner's theory, did not answer question 24. The participant has a total of 7-10 years' experience as a professional nurse, critical care trained and have 3-5 years' experience in neuro-critical care. A reason to justify this might be stagnation and no interest in evidence-based care.

As a result, the participants that did not answer the question with regard to intracranial pressure and waveforms are both novice with limited experience in neuro-critical care. The proficient nurse was unable to complete the question related to reverse Trendelenburg position to lower ICP and this might be as a result of limited neuro-critical exposure. The participant labelled as an expert was unable to complete the question referring to the cause of central fever in TBI patients and this might also be due to stagnation.

5.4 RECOMMENDATIONS

5.4.1 Neurocritical care education

Management of TBI should form a larger component of the induction programme and should be taught in depth by expert neurocritical care nurses, and update/refresher training to be conducted regularly. Variation in training also leads to inconsistencies in quality of care (Oyesanya *et al*., 2017:11). Nurses are trained in critical care, but it would be useful to train more nurses in neurosurgical care, because subtle neurological cues may be missed and lead to poor management of TBI.

There is a growing demand for nurses who are trained to increase their awareness of neurological findings at bedsides, recognize early warning signs of subtle neurological conditions, and to communicate effectively within the multidisciplinary team (Shields, Perkins, Clark & Shields, 2018:301). Therefore, cursory knowledge regarding neurological disorders can be improved if a Neurological and Neurosurgical course can be implemented. The course will be beneficial to increase the need for skilled nurses, in order to treat our escalating hospital population with TBI. The focus on workload should refocus on theory and clinical practices, instead of skills and technology, and nurse leaders must engage and adapt education for nurses, in order to instil confidence to deliver competent and safe patient care. A valid and reliable test of the actual knowledge of critical care nurses should be conducted, in order to better identify the gaps in knowledge, as well as the areas where additional training and education are needed (Oyesanya, 2017:13).

Practice-based studies should be incorporated in practices, for example, simulations of caring for ICP, EVD and Glasgow Coma Score assessments etcetera, in order for critical care nurses advancing to become experts, caring for the TBI patients in CCUs. Symposiums are offered on a regular basis at Tygerberg Hospital for nursing staff with regard to neurology/neurosurgery. The focus should be on becoming better nurses, experts in caring for the TBI and the ability to make countless decisions in order to solve problems in clinical areas.

5.4.2 Protocols and guidelines

Knowledge and adherence to protocols are a prerequisite for improving clinical excellence and ensuring better patients' results (Oliveira, Pereira, & Freitas, 2016:283). A multimodal monitoring protocol must be formulated to address and optimize the multiple physiological parameters that affect brain function, to deal with complicated disorders and most complex system of the body in the brain and the nervous system (Carandang, 2015:130). Nursing-specific clinical guidelines for post-acute TBI will aid in the care of the critically ill patient.

This guideline-driven nurse assessment protocol will have a positive impact on mortality or functional outcomes of patients with TBI. As a result, increased use of ICP monitoring used with detailed management protocol has been associated with more favourable outcomes (Kramer & Zygun, 2014:177). A good starting point is reviewing the Brain Trauma Foundation guidelines and initiate protocols/guidelines from the literature in order to be incorporated with excellence in clinical practice.

5.4.3 End-tidal carbon dioxide monitoring

All intubated patients should have ETCO2 monitors to ensure correct tube placement and to place an important element to maintain normocapnia in TBI, because hyperventilation should be avoided due to the end result of vasoconstriction leading to cerebral ischemia (Damkliang *et al*., 2013:133). ETCO2 is a non-invasive and inexpensive way to help nurses gather information and proactively plan on when and how many interventions to provide at a time, for example, the need to decide when to pre-treat the patients with medication to decrease pain and anxiety (Genzler *et al*., 2013:243).

5.4.4 Competencies for critical care nurses

Another factor to consider is clinical competencies. The competency topics should focus on clinical knowledge of disease processes, as well as procedural areas of critical care, because clinical knowledge and understanding of complex disease management, diagnostics and treatment are of vital importance. Some can be done on a regular basis or yearly or on entry-level which may result in an improvement of self-confidence, as well as job satisfaction. The adoption of these evidence-based competencies for clinical practices aid to guide training and lead to higher quality health care at lower cost (Kopf, Watts, Meyer & Moss, 2018:399). Training based on formal assessment of knowledge might be more effective than relying on nurses' knowledge, particularly in an area in which knowledge is rapidly evolving and could substantially alter care plans. (Oyesanya *et al*., 2017:11).

5.4.5 Rotation

The research found that job rotation improves organisational performance and is necessary to meet organisational policies and procedures, improve special skills, to solve problems and improve management practices and monitoring, and has a positive and significant impact on nurse's knowledge (Akbari & Maniei, 2017:22). Therefore, rotation and exposure to neurocritical care for at least a year is essential in critical care areas to increase skills and competencies, knowledge and aid to reduce the monotony of work and focus on uniformity and performances of critical care nurses.

5.5 LIMITATIONS

5.5.1 Sample size

This study was limited to only one tertiary health facility. The results cannot be generalized as the response rate of n=57 (64%) was low and n=32 (36%) refused to participate in the study. Nurses from other tertiary institutions should have been included in order to make a wider generalised conclusion of findings.

One strength of the study was that it was conducted in a tertiary health facility where high volumes of patients are expected, as well as where professional experts are trained and best experts in knowledge could be found.

Because of the small sample size, it was difficult to conclude statistical significance with a possibility of low statistical conclusion validity which affected the statistical power which further then has an effect on the level of precision. Statistical power refers to the capacity to detect true relationships and affects statistical conclusion (Polit & Beck, 2018:152). As a result, with a small sample size there will be a risk of suspecting bias (Polit & Beck, 2018:167). Due to participants declining to participate, the knowledge score was affected. Within the group of participants declining, it is unknown which percentage of participants has a high knowledge score and who has a lower knowledge score; therefore, possible nonresponsive bias can be reported. Generalising the findings from the researcher's sample was interpreted carefully. Future research should include a larger sample size and demographical data groups for example age group, a total number of years of experience in nursing, length of time worked in neurocritical care and length of time in current discipline can be narrowed to smaller groups, in order to categorise participants as a bigger sample.

5.5.2 Cronbach's alpha coefficient

The tool did not lend itself to a Cronbach's alpha coefficient. According to McNeish (2018:422), Cronbach's alpha remains familiar, commonly reported in research as well as easily obtained in software but, the test is rarely an appropriate measure of reliability and stated that its assumptions are overly rigid and almost always violated. The tool was self-designed because the researcher's aim was to use the Likert-scale to investigate the clinical practices of critical care nurses. With regard to future research and studying purposes, the tool can be amended and a correlation matrix can be run, questions can be removed or adapted to measure certain constructs.

5.6 FUTURE RESEARCH

Future research might focus on nurses who frequently care for the TBI patients and the survey should include the trauma units, because of the initiation of care for the TBI patients. A survey can be conducted amongst all the nurses in CCUs to assess their knowledge regarding the basic components, to assess the GCS of the TBI patients. The research was limited to one hospital only. Further testing of recruitment strategies, as well as measurement tools amongst professional nurses in other public and private institutions are important for validity of the purposes of findings, as well as discovering other ways to boost the response rates to assess the knowledge and clinical practices. Nurses should be encouraged to participate in research and should overcome negative beliefs with regard to unfamiliar individuals conducting research, in order to enhance the development of evidence-based strategies to improve nursing practice.

5.7 SUMMARY

The aim of the research study was to determine the knowledge and clinical practice of professional nurses caring for patients with TBI and based on the aim at hand, the research questions were generated from the literature and BTF guidelines. Critical care nurses' knowledge and clinical practice were the main focus of the study. The approach was a quantitative research design. Information was obtained from articles, textbooks, internet sources and relevant literature was used to find information regarding the topic.

With reference to chapter 1 (Background and theoretical framework), chapter 2 (Literature review) and chapter 3 (Methodology), these resources have been carefully selected in support of literature. As highlighted in the problem statement, knowledge, skills and practices differ amongst critical care nurses and lack of standardization and discoordination can be confirmed across the CCUs.

Knowledge, experience and skills are of vital importance in order to care for the TBI patient and it is evident that nurses in their early stage of clinical practice lack experience. As a result, Benner's theory (1984) remains a useful guideline for nursing practices. In correlation with Benner's theory, it was congruent that the participants with none to three years' experience have the lowest knowledge score and this confirms that guidelines should be in place, in order for the novice to follow when providing care for the TBI patient. Furthermore, the experts have deepened levels of knowledge, experience and skills and therefore be deemed experts with their judgement and decision making in clinical practice. Another point of noting is that almost half of the participants worked in the neurocritical care setting less than one year. Benner's theory (1982) highlights that competent nurses mainly stay in the same areas for 2-3 years. Therefore, half of the participants fall into the category of advanced beginner which demonstrates acceptable performance, but needs support with regard to pre-service and in-service education as stated by Benner (1984:404).

5.8 CONCLUSION

Safety of the TBI patient is of vital importance, therefore, accuracy in judgement to detect neurological deterioration plays a major role. Guidance from expert nurses, as well as educational interventions should be implemented in order to reduce the safety risks. Compliance with the Brain Trauma Foundation guidelines can enhance the outcome of TBI in critical care units (Kramer & Zygun, 2014:178). The study findings and recommendations to strengthen the current knowledge and practice of critical care nurses aim to improve the care of TBI patients' neurocritical care, as well as other critical care units.

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APPENDICES

Appendix 1: Ethical approval from Stellenbosch University

UNIVERSITEIT
STELLENBOSCH
UNIVERSITY

Health Research Ethics Committee (HREC)

Approval Notice

New Application

Ethics Reference #:0622

Title: Professional nurses' knowledge and clinical practice regarding the care of patients with a traumatic brain injury in a critical care unit within a tertiary hospital:Western Cape, South Africa

HREC Reference # : S17/07/120

Dear Jean Kiewiet

The New Application received on 18/07/2017 09:07 was reviewed by members of Health Research Ethics Committee via expedited review procedures on 13/12/2017 and was approved.

Please note the following information about your approved research protocol:

Protocol Approval Period: 13-Dec-2017 – 12-Dec-2018

Please remember to use your Project Id on any documents or correspondence with the HREC concerning your research protocol.

Please note that the HREC has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

After Ethical Review

Please note you can submit your progress report through the online ethics application process, available at: https://applyethics.sun.ac.za/Project/Index/685 and the application should be submitted to the Committee before the year has expired. Please see Forms and Instructions on our HREC website for guidance on how to submit a progress report.

The Committee will then consider the continuation of the project for a further year (if necessary). Annually a number of projects may be selected randomly for an external audit.

Translation of the consent document(s) to the language(s) applicable to your study participants should now be submitted to the HREC.

Provincial and City of Cape Town Approval

Please note that for research at a primary or secondary healthcare facility, permission must still be obtained from the relevant authorities (Western Cape Departement of Health and/or City Health) to conduct the research as stated in the protocol. Please consult the Western Cape Government website for access to the online Health Research Approval Process, see: https://www.westerncape.gov.za/general-publication/health-research-approval-process. Research that will be conducted at any tertiary academic institution requires approval from the relevant hospital manager. Ethics approval is required BEFORE approval can be obtained from these health authorities.

We wish you the best as you conduct your research.

Page 1 of 2

For standard HREC forms and instructions, please visit: Forms and Instructions on our HREC website Links Application Form Direct Link

If you have any questions or need further assistance, please contact the HREC office at 021 938 9677.

Yours sincerely,

Franklin Weber

HREC Coordinator

Health Research Ethics Committee 1 (HREC 1)

Federal Wide Assurance Number: 00001372

Institutional Review Board (IRB) Number: IRB0005239

The Health Research Ethics Committee complies with the SA National Health Act No. 61 of 2003 as it pertains to health research and the United States Code of Federal Regulations Title 45 Part 46. This committee abides by the ethical norms and principles for research, established by the Declaration of Helsinki and the South African Medical Research Council Guidelines as well as the Guidelines for Ethical Research: Principles, Structures and Processes 2015 (Departement of Health).

Appendix 2: Permission obtained from institution

Western Cape Government
Health

GROOTE SCHUUR HOSPITAL
Enquiries: Dr Bernadette Eick
E-mail : Bernadette.Eick@westerncape.gov.za

Mr J. Kiewiet
207 Savoy Gardens
Rose Street
MOWBRAY
7700

E-mail: jeancon01@yahoo.co.uk

Dear Mr Kiewiet

RESEARCH PROJECT: Professional Nurses' Knowledge And Clinical Practice Regarding The Care Of Patients With A Traumatic Brain Injury In A Critical Care Unit Within A Tertiary Hospital: Western Cape, South Africa

Your recent letter to the hospital refers.

You are granted permission to proceed with your research, which is valid until **12 December 2018.**

Please note the following:

a) Your research may not interfere with normal patient care.
b) Hospital staff may not be asked to assist with the research.
c) No additional costs to the hospital should be incurred i.e. Lab, consumables or stationary.
d) **No patient folders may be removed from the premises or be inaccessible.**
e) Please provide the research assistant/field worker with a copy of this letter as verification of approval.
f) Confidentiality must be maintained at all times.
g) Should you at any time require photographs of your subjects, please obtain the necessary indemnity forms from our Public Relations Office (E45 OMB or ext. 2187/2188).
h) Should you require additional research time beyond the stipulated expiry date, please apply for an extension.
i) Please discuss the study with the HOD before commencing.
j) Please introduce yourself to the person in charge of an area before commencing.
k) On completion of your research, please forward any recommendations/findings that can be beneficial to use to take further action that may inform redevelopment of future policy / review guidelines.
l) Kindly submit a copy of the publication or report to this office on completion of the research.

I would like to wish you every success with the project.

Yours sincerely

DR BERNADETTE EICK
CHIEF OPERATIONAL OFFICER
Date: 7 March 2018

C.C. Mr L. Naidoo, Mr A. Mohamed, Professor I. Joubert

G46 Management Suite, Old Main Building,
Observatory 7925
Tel: +27 21 404 6288 fax: +27 21 404 6125

Private Bag X,
Observatory, 7935
www.capegateway.go.v.za

Appendix 3: Participation information leaflet and declaration of consent by participant and investigator

TITLE OF THE RESEARCH PROJECT:

Professional nurses' knowledge and clinical practice regarding the care of patients with a traumatic brain injury in a critical care unit within a tertiary hospital: Western Cape, South Africa.

REFERENCE NUMBER: **S17/07/120**
PRINCIPAL INVESTIGATOR: Jean Kiewiet
ADDRESS: SICU, 3rd Floor, Building 61, JHAH, Dhahran, 31311, SAUDI ARABIA
CONTACT NUMBER: (h) +00966138999114 ext. 415
(w) +00966138778648
(c) 072 125 7300 (South African number)

You are being invited to take part in a research project that **aims to determine the knowledge and clinical practice of professional nurses' regarding the care of patients with a traumatic brain injury in a critical care unit, at Groote Schuur Hospital.** Please take some time to read the information presented here, which will explain the details of this project. Please ask the principle investigator any questions about any part of this project that you do not fully understand. It is very important that you are fully satisfied that you clearly understand what this research entails and how you could be involved. Also, your participation is **entirely voluntary** and you are free to decline to participate. If you say no, this will not affect you negatively in any way whatsoever. You are also free to withdraw from the study at any point, even if you do agree to take part.

This study has been approved by the **Health Research Ethics Committee at Stellenbosch University** and will be conducted according to the ethical guidelines and principles of the international Declaration of Helsinki October 2013, South African Guidelines for Good Clinical Practice and the Medical Research Council (MRC) Ethical Guidelines for Research.

What is this research study all about?

- *Neuro-Critical care is conceded to be complex.*
- *Due to high influx of patients with Traumatic Brain Injuries and limited space in Neuro-Critical Care units, nursing these patients in General Critical Care units can be challenging to critical care nurses.*
- *The aim is to investigate the knowledge and clinical practice of professional nurses regarding the care of patients with a Traumatic Brain Injury in a Critical Care Unit within a tertiary institution.*
- *The Study will be conducted at Groote Schuur Hospital and professional nurses working in the Critical Care department will participate and include both night and day shifts.*

Why have you been invited to participate?

- *Your input is valuable as a critical care nurse to determine clinical practice and knowledge of patients with traumatic brain injuries.*
- *Your feedback will contribute to improve current nursing practices and identify any gaps regarding the care for patients with a Traumatic Brain Injury .*
- *The outcome of the study will assist in developing clinical guidelines, for academics, colleges, universities and hospitals to improve training with regard to caring of the critically ill with neurosurgical conditions.*
- *To promote excellence of care in the critically ill, develop and enhance the knowledge, skills and creative thinking essential to good critical care practice.*
- *Build a solid base of evidence on which to build stronger practices.*

What will your responsibilities be?

- *To complete a consent form and questionnaire. One copy of consent form for researcher and one copy for the participant. Participant to place completed questionnaire and consent in sealed envelope and to finally place in the box provided. Researcher will not be able to identify participants by name because it is completely anonymous.*

Will you benefit from taking part in this research?

- *You have no specific benefit by participating in this study. There are no personal benefits, however in future critical care nurses will benefit as recommendations will be made to improve knowledge and clinical practice.*

Are there any risks involved in your taking part in this research?

- *No risks involved*

If you do not agree to take part, what alternatives do you have?

- *Participation is voluntary. You have a choice to participate or not to take part in the research project.*

Who will have access to your questionnaire or consent form?

- *All information pertaining to the research study will be treated confidentially. Identity of participant will remain anonymous even after publication of results.*
- *All data will be kept in a safe for 5 years and will be made available only to the supervisor, co-supervisor and Research Ethics Committee on request.*

What will happen in the unlikely event of some form of injury occurring as a direct result of you taking part in this research study?

- *To complete a paper-based questionnaire only. No risks are involved regarding physical injury.*

Will you be paid to take part in this study and are there any costs involved?

- *No you will not be paid to take part in the study. There will be no costs involved for you, if you do take part.*

Is there anything else that you should know or do?

- *After completion of the questionnaire that will approximately take 30 minutes to complete, please insert the sealed envelope for the questionnaire and completed consent form in provided boxes marked "questionnaires" and "consent."*
- *No compensation will be made for time utilized to complete questionnaires and consent forms.*
- *You can contact the Health Research Ethics Committee at 021-938 9207 if you have any concerns or complaints that have not been adequately addressed by the principle investigator.*
- *You will receive a copy of this information and consent form for your own record.*

Declaration by participant

By signing below, I …………………………………..………… agree to take part in a research study entitled, **Professional nurses' knowledge and clinical practice regarding the care of**

patients with a traumatic brain injury in a critical care unit within a tertiary hospital: Western Cape, South Africa.

declare that:

- I have read or had read to me this information and consent form and it is written in a language with which I am fluent and comfortable.
- I have had a chance to ask questions and all my questions have been adequately answered.
- I understand that taking part in this study is **voluntary** and I have not been pressurised to take part.
- I may choose to leave the study at any time and will not be penalised or prejudiced in any way.
- I may be asked to leave the study before it has finished or the researcher feels it is in my best interests, or if I do not follow the study plan, as agreed to.

Signed at (*place*) ....…........…………….. on (*date*) …………....……….. 2018.

....
Signature of participant **Signature of witness**

Declaration by investigator

I *(name)* ……………………………………………..……… declare that:

- I explained the information in this document to …………………………………..
- I encouraged him/her to ask questions and took adequate time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above
- I did/did not use an interpreter. (*If an interpreter is used then the interpreter must sign the declaration below.*

Signed at (*place*) ....…........…………….. on (*date*) …………....……….. 2018.

....
Signature of investigator **Signature of witness**

Declaration by interpreter

I *(name)* ……………………………………………..……… declare that:

- I assisted the investigator (*name*) ………………………………………. to explain the information in this document to (*name of participant*) ……………..……………………………….. using the language medium of Afrikaans/Xhosa.
- We encouraged him/her to ask questions and took adequate time to answer them.

- I conveyed a factually correct version of what was related to me.
- I am satisfied that the participant fully understands the content of this informed consent document and has had all his/her question satisfactorily answered.

Signed at (*place*) ....…........……………….. on (*date*) …………....………………..2018.

....	....
Signature of interpreter	Signature of witness

Appendix 4: Instrumentation/questionnaire

PROFESSIONAL NURSES' KNOWLEDGE AND CLINICAL PRACTICE REGARDING THE CARE OF PATIENTS WITH A TRAUMATIC BRAIN INJURY IN A CRITICAL CARE UNIT WITHIN A TERTIARY HOSPITAL: WESTERN CAPE, SOUTH AFRICA

INSTRUCTIONS

The questionnaire consists of 9 pages and will take you approximately 20-30 minutes to complete. There are **4 sections** namely: **Section A** *(Demographical data)*, **Section B**: *(Knowledge about traumatic brain injury) and* **Section C**: *(Clinical practices of professional nurses)*. **Section D**: (Guidelines and in-service training). Place the completed questionnaire in an envelope provided and post sealed questionnaire in the questionnaire box provided.

PLEASE INDICATE WITH (X) WHEN ANSWERING APPLICABLE QUESTIONS e.g.

Yes	X
No	

SECTION A: DEMOGRAPHICAL DATA

1. Gender

1.1	Male	
1.2	Female	

2. Age group

2.1	21-30	
2.2	31-40	
2.3	41-50	
2.4	51-60	
2.5	60 +	

3. Qualification

3.1	Diploma in Nursing	
3.2	Degree in Nursing	
3.3	Honours degree in Nursing	

3.4	Master's degree in Nursing	

4. Intensive care qualification

4.1	Postgraduate ICU	
4.2	ICU short course	
4.3	None	

5. Total number of years of experience in nursing

5.1	0-3 years	
5.2	4-6 years	
5.3	7-10 years	
5.4	11-14 years	
5.5	15-19 years	
5.6	20 + years	

6. Employment

6.1	Permanently employed at the hospital	
6.2	Nursing agency worker	
6.3	Contract worker	

7. Clinical discipline

7.1	Surgical ICU	
7.2	Respiratory ICU	
7.3	Cardiothoracic ICU	
7.4	Coronary care	
7.5	Neurosurgical ICU	
7.6	Other	

8. Length of time in current discipline

8.1	Less than 1 year	
8.2	1-5 years	
8.3	6-10 years	
8.4	More than 10 years	

9. Length of time worked in neurocritical care

9.1	Nil	
9.2	Less than 1 year	
9.3	1-2 years	
9.4	3-5 years	
9.5	More than 5 years	

SECTION B: KNOWLEDGE ABOUT NURSING PATIENTS WITH A TRAUMATIC BRAIN INJURY

Select the most appropriate answer by indicating (X). Only choose one option per statement.

No.	Item	Agree	Disagree
10.	A severe head injury is classified as a Glasgow Coma Score of 8 and below		
11.	Localising refers to: Patient will move hand above the clavicle after applying supra orbital pressure or pinching trapezius muscle		
12.	A good flexion response on pain stimuli is characterised by flexing of the elbow, often accompanied by lifting the elbow clear of the body		
13.	A dilated pupil represents cerebral oedema or herniation on the same side of the dilated pupil		

14.	Bradycardia, widening pulse pressure, irregular respiration and rise in blood pressure are signs of Cushing's response		
15.	Central fever is a concept defined as a fever caused by trauma or lesion that involves the medulla oblongata and the base of the brain		
16.	Rectal temperature are one of the most acurrate routes of monitoring core temperatures		
17.	Hyperthermia can increase ICP (intracranial pressure)		
18.	During intracranial hypertension, the target level of Partial Pressure of Carbon Dioxide (PCO2) is 4 to 4.6 kpa		
19.	On intracranial pressure monitoring, 3 waveforms are reflected on the monitor		
20.	Cerebral perfusion pressure (CPP) is calculated as, (Systolic Pressure – ICP)		
21.	Intracranial pressure (ICP) compliance can be described as (P1 curve is smaller than P2 and P3 curve)		
22.	Brain tissue monitoring (Licox) is used to monitor brain oxygenation. A value less than 20 mmHg is associated with poor outcome of patients with traumatic brain injury		
23.	Patient's positioning affects an intracranial pressure reading		
24.	Reverse Trendelenburg position is one fastest, least invasive ways to acutely lower intracranial pressure		
25.	Extra-ventricular drain (EVD) should always be lower than the patient in order to facilitate draining of cerebrospinal fluid		
26.	Normal ICP parameter is (15mmHg)		

27.	Extra-ventricular drain (EVD) should be kept open at all times		
28.	I need more training/information regarding nursing a patient with raised intracranial pressure		

SECTION C: PRACTICES OF PROFESSIONAL NURSES CARING FOR PATIENTS WITH A TRAUMATIC BRAIN INJURY

In this Section please indicate with (X) the most appropriate answer regarding the practices of nursing traumatic brain injury patients in your Critical Care Unit. Only choose one answer per statement as below.

No.	Item	Never	Rare	Sometimes	Frequent	Always
29.	We aim for systolic blood pressures 90mmHg and higher in traumatic brain injury patients					
30.	We target CPP value, >60 mmHg for brain perfusion					
31.	We monitor End tidal carbondioxide (ETCO2) in my CCU					
32.	Hyperosmolar therapy (mannitol or hypertonic saline) is used to control raised ICP					
33.	Hyperventilation is used as temporary measurement for reducing elevated ICP					
34.	Propofol infusion is used for control of raised ICP					
35.	Feeding is initiated at least 24 hours post-injury					

36.	Intermittent pneumatic cuffs for DVT prophylaxis is available to all patients					

SECTION D: GUIDELINES AND IN-SERVICE TRAINING

In this Section please indicate with (X) the most appropriate answer regarding the the guidelines and in-service training in your Critical Care Unit. Only choose one answer per statement as below.

No	Item	Never	Rare	Sometimes	Frequent	Always
37.	Guidelines and protocols are available in my unit with regard to the management of raised intracranial pressure					
38.	There are frequent in-service training and informative sessions about monitoring equipment and nursing care of patients with raised intracranial pressure monitoring					

Thank you for participating in this study.

Please place completed questionnaire in envelope provided and put in a sealed questionnaire box.

Please feel free to contact me at any stage if you are experiencing unclarity pertaining to the questions asked or want to withdraw from participation.

Jean Kiewiet

Email: jeancon01@yahoo.co.uk

+27 72 125 7300 or

+00966138999114 ext. 415 (Saudi Arabia)

Ms D. Hector

(Supervisor) Stellenbosch University
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Ms A Damons
(Co-supervisor) Stellenbosch University
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Appendix 5: Declaration by language editor

Lona's Language Services

English/Afrikaans
Afrikaans/English

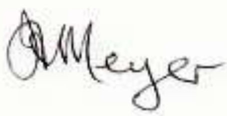
3 Beroma Crescent Beroma Bellville
Tel 0219514257
Cell 0782648484
Email illona@toptutoring.co.za

* Translations * Editing * Proofreading
* Transcription of Historical Docs
* Transcription of Qualitative Research
* Preparation of Website Articles

TO WHOM IT MAY CONCERN

This letter serves to confirm that the undersigned
ILLONA ALTHAEA MEYER
has edited the language in this thesis for grammatical correctness.

Signed



Ms IA Meyer
30 August 2019

FOR: Jean Kiewiet

TITLE: Professional nurses’ knowledge and clinical practice regarding patients with a traumatic brain injury in a tertiary hospital

Re-edited on 11 November 2019

Appendix 6: Declaration by formatter

Lize.net
COMMUNICATION (Pty) Ltd

To whom it may concern

This letter serves as confirmation that I, Lize Vorster, performed the technical formatting of Jean Kiewiet's thesis entitled:

Professional nurses' knowledge and clinical practice regarding patients with a traumatic brain injury in a tertiary hospital

Technical formatting entails complying with the Stellenbosch University's technical requirements for theses and dissertations, as presented in the Calendar Part 1 – General or where relevant, the requirements of the department.

Yours sincerely

Lize Vorster
Language Practitioner

Vygie street 9, Welgevonden Estate, Stellenbosch, 7600 * e-mail: lizevorster@gmail.com * cell: 082 856 8221