

**EVALUATE CRITICAL CARE NURSES' COMPLIANCE TO THE EXTERNAL
VENTRICULAR DRAIN CARE BUNDLE FOR CRITICALLY ILL PATIENTS AT
KENYATTA NATIONAL HOSPITAL**

**BY
LEAH NAMBIRO NANYANGA
H56/40811/2021**

**A RESEARCH DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENT FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE IN
CRITICAL CARE NURSING OF THE UNIVERSITY OF NAIROBI.**

NOVEMBER 2023

DECLARATION

I, Leah Nanyanga Nambiro, declare that this dissertation is my original work and has not been presented in any other institution of higher learning or elsewhere for the credit award.

Signature.....

Name; **Leah Nambiro Nanyanga**

Reg. No. H56/40811/2021

Date.....09/11/2023


SUPERVISORS' APPROVAL

We, the research supervisors from the University of Nairobi, Department Of Nursing Sciences, hereby grant our approval and submit this research dissertation for examination.

Signed ... 

Date 10/11/2023

Ms. Hannah K. Inyama
Lecturer,
Department of Nursing Sciences,
University of Nairobi

Signed...  Date 09/11/2023

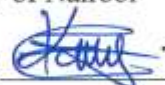
Dr. Matheka K. Emmah(BScN, MScN, PhD)
Senior Lecturer Department of Nursing Sciences,
University of Nairobi

Head of Department,

Dr. Emmah Matheka (BScN, MScN, PhD)

Senior Lecturer, Department of Nursing

University of Nairobi

Signature 

Date 09/11/2023



DEDICATION

I dedicate this thesis to my cherished husband, who has stood by me with unending support, patience, and love, providing me with the strength to conquer the challenges of this academic pursuit. To my dear mother, whose endless encouragement and selfless sacrifices has been a wellspring of inspiration throughout. To my committed friends, whose friendship, thought-provoking discussions, and shared determination have greatly enriched my educational journey. Your presence has played a pivotal role in shaping this achievement, and for that, I am profoundly thankful.

ACKNOWLEDGEMENT

I would want to sincerely thank the people and institutions that have been instrumental in helping me to successfully complete my thesis dissertation.

First and foremost, I extend deepest appreciation to my dedicated supervisors, Ms. Hannah K. Inyama and Dr. Emmah K. Matheka. Your guidance, expertise, and unwavering support have been instrumental in shaping this research. Your valuable insights and constructive feedback have enriched my work and encouraged me to strive for excellence.

I am immensely thankful to the entire faculty of the University of Nairobi, Department of Nursing, for providing me with a conducive academic environment and a wealth of knowledge. Your commitment to nurturing the next generation of healthcare professionals has been inspiring.

I would like to acknowledge the Kenya Defence Forces for their generous sponsorship of my education. Your belief in my potential and investment in my academic pursuits have been a source of motivation and pride.

I extend sincere gratitude to all the research participants who generously shared their time, experiences, and insights, without whom this study would not have been possible. Your willingness to contribute to the advancement of knowledge is deeply appreciated. In conclusion, I would like to thank the Kenyatta National Hospital Community for their assistance and collaboration with this study.

The journey has been challenging, but it has also been incredibly rewarding, thanks to the support and encouragement of my friends. Their contributions have been invaluable in helping me reach this milestone in my academic and professional life. Thank you all for being an integral part of this academic journey.

ABBREVIATIONS AND ACRONYMS

- CCN - Critical care nurse
- CCU -Critical care unit
- CI - Confidence interval
- CME - Continuous medical education
- CSF - Cerebrospinal Fluid
- ERI - External ventricular drain-Related Infection
- EVD -External Ventricular Drain
- ICP - Increased Intracranial Pressure
- ICU - Intensive care unit
- KNH - Kenyatta National Hospital
- LMICs -Lower middle income countries
- LOS - Length of stay
- PPE - Personal protective equipment
- SOPS - Standard Operating Procedures
- SSA - Sub-Saharan Africa
- TBI -Traumatic brain injury

OPERATIONAL DEFINITIONS

Care bundle: A set of interventions that when applied to managing a specific condition together they improve patients' outcome. The elements in a care bundle are best practices based on evidence

Complication: A secondary disease or condition aggravating an already existing one.

External ventricular drain: Also known as ventriculostomy, a device used temporarily for drainage of cerebrospinal fluid from the fluid filled cavities of the brain to a closed system outside the body.

EVD care bundle: A collection of standardized evidence-based care components that when used in management of EVD together may result to better outcome than when used separately.

LIST OF FIGURES

Figure 1 :Nursing process	13
Figure 2: Conceptual framework	14
Figure 3: distribution of knowledge	26
Figure 4: overall Knowledge score	27
Figure5:Overall practice management on EVDs	30

LIST OF TABLES

Table 1: Question distribution	17
Table 2: Knowledge of external ventTable 2:Knowledge of EVD among CCNs 1ricul	24
Table3: Knowledge classified using bloom	25
Table 4: Factors ass with EVD bundle	28
Table5: Practice on handling EVDs	29
Table6:Barriers to effect utili of EVD	31
Table7:resources available for EVD	Error! Bookmark not defined.

TABLE OF CONTENTS

DECLARATION	ii
DEDICATION	iv
ACKNOWLEDGEMENT	v
ABBREVIATIONS AND ACRONYMS	vi
OPERATIONAL DEFINITIONS	vii
LIST OF FIGURES	viii
LIST OF TABLES	ix
ABSTRACT	xiii
CHAPTER 1:	1
1.1 Background Information	1
1.2 Statement of the problem	2
1.3 Study Justification	3
1.4 Significance of the study	3
1.5 Main objectives	4
1.6 Specific objectives.....	4
1.7 Research questions	4
1.8 Assumptions	5
1.9 Theoretical framework	5
CHAPTER 2: LITERATURE REVIEW	6
2.1 Introduction	6
2.2 External ventricular drain.....	6
2.3 EVD care bundle	6
2.4 Critical care nurses knowledge on external ventricular drain care bundle use	7
2.4.1 Role of a nurse in external ventricular care bundle	7
2.5 Critical care nurses practice on EVD care bundle.....	8
2.6 Perceived barriers to the effective utilization of external ventricular drain care bundle	9
2.6.1. Personal Protective Equipment.....	9
2.6.2 Complex Bundles and Non-standardized Reporting	10
2.6.3 Poor Knowledge of Care Bundles	10
2.6.4 Inadequate Resources for external ventricular drain care bundle.....	11
2.7 Resources Available for EVD Management	11

2.7.1 Guidelines	11
2.7.2 Economic Considerations	11
2.7.3 Trained Nurses and CCNs.	12
CHAPTER 3: METHODOLOGY	15
3.1 Introduction	15
3.2 Study site	15
3.3 Study design	15
3.4 Study population	15
3.5 Selection of participants	16
3.5.1 Inclusion criteria	16
3.5.2 Exclusion criteria	16
3.6 Study variables	16
3.7 Recruitment and Consenting Procedures	17
3.8 Data collection.....	17
3.8.2 Pretesting	17
3.8.3 Research assistants	17
3.9 Study strengths and limitation.....	18
3.10. Quality control.....	18
3.11 Data management and analysis	18
3.11.1 Data collection method.....	18
3.11.2 Data management	19
3.11.3 Data analysis.....	19
3.11.4 Data presentation	20
3.12 Ethical consideration.....	21
CHAPTER FOUR: RESULTS	22
4.1 Sociodemographic characteristics of the study participants	22
4.2 The level of knowledge of external ventricular drain care among critical care nurses.....	23
4.2.1 Overall knowledge of external ventricular drainage care.....	25
4.2.2 Distribution of knowledge of EVD care.....	25
4.2.3 Overall knowledge score based on Bloom-modified cut-off points.....	26
4.2.4 Factors associated with knowledge of external ventricular drain care bundle among nurses.....	27

4.3 Critical Care Nurses’ practice level on the EVD care bundle among critically ill patients in KNH	29
4.3.1 Overall score on practice management when handling EVDs	30
4.4 Perceived barriers/challenges to the effective utilization of EVD care bundle by CCNs at KNH	31
4.5 Phase 2: In-depth interviews on available resources for EVD management in CCU, Kenyatta National Hospital	33
4.5.1 Guidelines for management of EVD	33
4.5.2 Training on management of EVD	34
CHAPTER FIVE: DISCUSSION, CONCLUSISON AND RECOMMENDATIONS	36
5.1 Introduction	36
5.2 Nurses’ knowledge of external ventricular drain bundle of care	36
5.3 Critical Care Nurses’ practice level on the EVD care bundle among critically ill patients	37
5.4 Perceived barriers to effective utilization of EVD care bundle by critical care nurses	38
5.5 Resources available for utilization of EVD care bundles	39
5.6 Conclusions	39
5.7 Policy and action recommendations.....	39
REFERENCES	41
APPENDICES	46
Appendix I: Work plan.....	46
Appendix II: Study budget	47
Appendix III; Informed consent for participants.....	48
Appendix IV: Consent form.....	51
Appendix V: Research questionnaire.....	52
Appendix VI: Observation Checklist	57
Appendix VII: Interview guides.....	59
Appendix IX: Letter of Approval ethics committee.....	61
Appendix X: Approval Letter from KNH.....	63

ABSTRACT

The External Ventricular Drain (EVD) care bundle, which entails insertion, maintenance, troubleshooting, and monitoring for issues related to EVD, is mostly the responsibility of nurses. Better results for EVD patients may be predicted by accurate and responsible nursing care.

Objective: To evaluate Critical Care Nurses' Compliance with the EVD Care Bundle for Critically ill Patients at Kenyatta National Hospital (KNH).

Methodology: The study was conducted at KNH's Critical Care Units. It will focus on critical care nurses from KNH. This was a mixed-methods study. A total of 81 nurses were included in the study. Data analysis will be carried out in R version 4.1.2. Quantitative continuous data e.g., the knowledge of EVD care bundle was summarized using medians and interquartile ranges. Categorical data e.g., the level of education, sex and specialization will be summarized using frequencies and proportions. Qualitative data was analyzed using manual thematic analysis.

Results: The majority of the respondents were aged 30 to 40 years 43.2% (n = 35), females were 75.3% (n = 61), those with higher diploma were 54.3% and 4.9% had a specialization in EVD care. Majority 48.1% (n = 39) of the nurses had good knowledge of EVD care bundle, 46.9% (n = 38) had fair knowledge and 5% had poor knowledge. Binary logistic regression and chi square tests showed that no factors were associated with knowledge of EVD care bundle ($P > 0.05$ chi-square) though ages < 30 and > 40 , being female, having a basic diploma and no specialization in EVD care were associated with higher odds of poor or fair knowledge of EVD care bundle. The majority 56% (n = 45) had a fair score on practice of EVD care and the rest had poor knowledge. Guidelines of EVD care and training on EVD care emerged as resources for utilization of EVD care guidelines

Conclusions: The study improves comprehension of the EVD care bundle, with most nurses having fair to good knowledge of it. However, the majority of nurses only demonstrated fair compliance with the EVD care bundle, primarily due to barriers like inadequate education, supervision, and complex guidelines.

CHAPTER 1: INTRODUCTION

1.1 Background Information

Neurologically intense patients with increased intracranial pressure, insertion of External Ventricular Drain (EVD) are regarded as the first life-saving procedure. Apart from its therapeutic functions, monitoring of Intracranial Pressure (ICP) continuous remains one of the key parameters for next treatment decision (Khalaveh et al., 2021). Though an important tool, EVD use has been associated with many complications including, hemorrhage, misplacement, dislodgement, blockage, and most significantly infection (Hagel et al., 2014). A studies have reported EVD-related infections of up to 48.1% (Chouhdari et al., 2021)

In the African context scarce information has been published on the same, however a study done in Ethiopia found the prevalence rate of EVD associated infections to be 25.8% out of a sample of 93 patients. In this study 11.8% of the patients died because of EVD related infections while 43% of the patients' died in total. The mortality rate from EVD associated complications was found to be 45.8% once diagnosed (Wondafrash & Tirsit, 2021).

Nurse's responsibilities in management and prevention of complications in a patient with EVD cannot be re-emphasized more, it has been documented that with proper training EVD related infection will be minimized (Fang et al., 2021). In fact, providing high-quality nursing care is thought to be extremely important for preventing problems like infection linked to EVD insertion (Whyte et al., 2020). Nurses are the primary health care professionals that solely take part in EVD care bundle. Their tasks after insertion of EVD include, monitoring for EVD associated complications, maintenance and troubleshooting. Proper and accountable nursing care may be able to predict better results when it comes to the management of patients who need CSF drainage (Chau et al., 2019).

EVD insertion plays a vital role in managing and monitoring ICP in individuals affected by intracranial hypertension and other severe neurological disorders. EVD insertion often leads to ERI, an outcome associated with intracranial hemorrhage, tumors, and hydrocephalus in patients presenting with Traumatic Brain Injury (TBI) (Sorinola et al., 2019). In developed countries, such as the United States of America (U.S.A), TBI is associated with an estimated 30% of all injury-related mortalities, with a \$76 billion annual cost of care related to TBI complications, including ERI (Sorinola et al., 2019). In African and sub-Saharan states, such as

Kenya, poor knowledge of ERI prevalence and reduced diagnosis may lead to a higher disease burden, with an estimated 24% incidence and 54% prognosis or survival rate from ERI (Jesuyajolu et al., 2022).

Management of patients who have an external ventricular drain remains a key nursing role, and patient outcome relies on nurse performance. Several studies have documented various reasons for EVD related complications but few have documented on predictors of nurse performance in regards to care of external ventricular drain (Aslam *et al.*, 2022a)

Anecdotal evidence suggests that this study has not been conducted in Kenya and no other study or trails on this topic have been published in the Kenya. This research will therefore provide a platform to explore the phenomenon using quantitative and qualitative research approach. The objective of this study is to evaluate the factors that impact the utilization of extraventricular drainage care bundle by (CCNs) at Kenyatta National Hospital.

1.2 Statement of the problem

External Ventricular Drain Insertion is a common and important lifesaving procedures in neurologic intensive care unit. In addition, placement of EVD is considered a gold-standard technique for the measurement of intracranial pressure (ICP) (Thamjamrassri et al., 2022).

Worldwide, prevalence of EVD infection rate range between 0-22% resulting in significant rise in costs, length of hospital stay, and morbidity and mortality (Peter & Roman, 2016). A study done in UK and Ireland had an infection rate of 27% with the predominant factor associated with infection being number of cerebrospinal fluid sampling episodes. The infection rate declined to 10% after introduction of the care bundle ($p < 0.001$). The study concluded that introduction of a well implemented care bundle can significantly decrease EVD infection rates (Talibi et al., 2020).

The main health care workers in charge of EVD following insertion are nurses. Accurate and responsible nursing care may have better outcomes in patients requiring CSF drainage (Chau et al., 2019).

In KNH there were no standard protocol or EVD care bundles that were utilized when caring for a patient with an EVD in situ, the nurses were required to follow the neurosurgeons' standing

instructions on the care and management of the same. The available care predisposed the patients to high risk of infection and high mortality rate.

1.3 Study Justification

The study is rooted in the critical importance of adherence to the EVD care bundle in the care of critically ill patients. EVDs are used in critical care settings, and their improper management can lead to serious complications, including infections and neurological damage (Khalaveh, 2022). Complications associated with EVD are strongly linked with nursing care in terms of their level of knowledge and practices. Research conducted by Sobral et al (2018) underscores the potential of care bundles in reducing catheter-related infections and improving patient outcomes. However, at KNH there is an existing gap among the critical care nurses in compliance, understanding and utilization of this care bundles.

Furthermore, the study's relevance is underscored by the need for context-specific evidence to inform healthcare practices. KNH serves a diverse patient population, and factors such as resource availability and nurse education levels may influence compliance with care bundles. In a healthcare landscape where patient safety and quality of care are paramount, assessing nurses' adherence to EVD care bundles will provide valuable insights for targeted interventions and policy improvements. This research is thus vital in promoting evidence-based nursing practices and ultimately enhancing the well-being of critically ill patients.

1.4 Significance of the study

The study will be crucial in finding out whether ICU nurses have pre-requisite knowledge and practice in management of a patient with EVD. EVD care bundles are evidence-based guidelines designed to reduce infection rates, improve patient safety, and optimize clinical outcomes in neurocritical care settings (Talibi et al., 2020). By assessing nurses' compliance with EVD care bundles; this study can identify specific areas of improvement, gaps in knowledge, and barriers to adherence. The research findings will be vital in informing targeted interventions and educational programs that can enhance nurses' competency and ultimately improve patient care. A study in Sudan revealed that despite knowledge of EVD use in addressing neurological conditions, application decisions remain problematic due to poor knowledge of such complications in LMICs (Elzain et al., 2022)

Additionally, this study has broader implications for healthcare in Kenya and beyond. Ensuring compliance with EVD care bundles not only contributes to patient safety but also reduces healthcare costs associated with treating infections and complications. KNH serves as a major healthcare facility in East Africa, the findings of this research can serve as a model for other institutions in the region, ultimately contributing to the improvement of critical care practices and patient outcomes in resource-constrained settings. It would further, forms a basis of developing an EVD care bundle/ checklist tailored towards patients care at KNH

1.5 Main objectives:

To evaluate Critical Care Nurses' Compliance to the External Ventricular Drain Care Bundle for Critically Ill Patients at Kenyatta National Hospital.

1.6 Specific objectives

1. To determine the knowledge level by Critical Care Nurses on the EVD care bundle at KNH.
2. To assess the CCN's practice level on EVD care bundle among critically ill patients in KNH
3. To determine the perceived barriers/challenges to the effective utilization of EVD care bundle by CCNs at the Hospital.
4. To identify various resources available for EVD management in CCU, of the Hospital.

1.7 Research questions

The research aimed to address the following questions:

1. What was the level of knowledge of critical care nurses on EVD care bundle in the Critical Care Unit at Kenyatta National Hospital?
2. What was the current level of nurses' practice in terms of implementing the EVD care bundle for critically ill patients in the Critical Care Unit at Kenyatta National Hospital?
3. What were the barriers that hindered the utilization of the EVD care bundle by critical care nurses at Kenyatta National Hospital?
4. What were the available resources for managing patients with external ventricular drains in Kenyatta National Hospital CCU?

1.8 Assumptions

All nurse participants were expected to answer the questionnaires honestly and factually to the best of their knowledge.

1.9 Theoretical framework

The theoretical framework for this research proposal was built upon Jean Orlando's deliberative nursing process theory, which emphasizes the deliberate actions and decision-making processes in nursing care. The theory's core components—assessment, diagnosis, planning, implementation, and evaluation—directly aligned with the research objectives (Lekenit, 2020). A study conducted in Muhimbili, Tanzania, proposed the utilization of the nursing process as a means to improve the quality of patient care and outcomes for both patients and their family members. In this study Jean Orlando theory of nursing process was adopted as an organizational framework for nursing practice which encompassed all steps taken by the nurse in caring for a patient: assessment, nursing diagnoses, planning (with goals and outcome criteria), implementation of the plan (with patient teaching), and evaluation (Obonyo et al., 2019). Objective 1 sought to gauge CCNs' knowledge of the EVD care bundle, corresponding to the assessment phase. Objective 2 aimed to assess CCNs' practice regarding the EVD care bundle, reflecting the implementation phase. Objective 3 explored perceived barriers, echoing the theory's emphasis on perception and interpretation. Lastly, Objective 4 involved resource identification, aligning with the planning phase. Drawing upon Orlando's foundational work and contemporary nursing literature, this theoretical framework guides the investigation into CCNs' compliance with the EVD care bundle, facilitating a comprehensive understanding of nursing practice and patient care.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This section sought to conceptualize the study within a background of already existing literature. It reviewed literature on external ventricular drain, role of the nurse on external ventricular care bundle, studies done on the knowledge level by Critical Care Nurses (CCNs) on EVD care bundle, studies done on the practice level by CCNs on EVD care bundle, perceived barriers/challenges to the effective utilization of EVD care bundle, nurse care practice impacts on ERI prevalence and risk Factors and Resources Available for EVD Management.

2.2 External ventricular drain

A research conducted in the Netherlands has determined that EVD catheters serve as an efficient and generally secure approach for ventricular decompression and monitoring intracranial pressure. Nonetheless, there were avoidable complications associated with this procedure to some extent. The study indicated a significant number of complications that could be reduced by adhering to proper EVD insertion and management protocols. A total of 52 incidents involving EVD complications were recorded. Most of these were minor, including EVD blockages in 7 cases and CSF leakage from the EVD site in 4 cases. However, some were serious, such as documented cases of infection, which accounted for 32.3% of the sample, and EVD-related hemorrhage in 3 cases. Subarachnoid hypertension represented 38.1% of the conditions necessitating EVD use, while hemorrhagic stroke accounted for 19.4%, and hydrocephalus represented 40%. Additionally, EVDs were considered the gold standard for ICP monitoring. (Hoefnagel *et al.*, 2023)

2.3 EVD care bundle

Providing nurses with theoretical content and hands-on workshops for external ventricular drain care guidelines is an effective approach to enhance their practices and simultaneously improve patient outcomes. (Fang *et al.*, 2021). In Barcelona, Spain, a study found that an improved care bundle for managing EVDs, focusing on reducing sampling and implementing rigorous antiseptic practices during catheter placement, maintenance, and adjustments, led to a lower occurrence of ERI caused by bacteria. When healthcare staff received proper training and followed the protocol, the bundle's implementation also resulted in shorter ICU and hospital stays. (Rojas-Lora *et al.*, 2023)

In a specific investigation, it was observed that the occurrence of multiple external ventricular drain (EVD) insertions was strongly associated with an increased risk of infection. As a response to this finding, an EVD care bundle was developed and implemented. The implementation of the care bundle led to a markedly decrease in the crude infection rate, decreasing from 27% to 10%. Furthermore, there was a noticeable drop in the Kaplan-Meier rate after 14 days, which went from 33% to 10% (Talibi *et al.*, 2020).

A study titled "Impact of an external ventricular shunt (EVD) handling protocol on secondary meningitis rates" demonstrated a marked reduction in EVD-related infection rates following the implementation of a hospital-wide EVD handling protocol. Infections were more frequent in the pre-protocol group (23% vs. 9%, $p < 0.001$). The infection rate was 33 per 1000 drain-days before the protocol and 9 per 1000 drain-days after the protocol. Regression analysis in a matched cohort ($n=103$ in the pre-protocol group and $n=178$ in the post-protocol group) revealed that the pre-protocol period was independently associated with a higher infection risk (OR 2.69; 95%-CI 1.22–5.95, $p=0.01$). (Hoefnagel *et al.*, 2023)

2.4 Critical care nurses knowledge on external ventricular drain care bundle use

American Heart Association in a scientific statement revealed that a significant proportion of nurses (two-thirds) who were being assessed for their knowledge of external ventricular drain (EVD) care for pediatric patients with brain tumors were classified as having poor knowledge in this area.

According to research by Ackerman *et al.* (2022) titled "External Ventricular Brain Drains: Effect of Nursing Guidelines on Intern Nursing Students' Performance in Cairo, Egypt," 76% of students had satisfactory knowledge and practice while using EVDs, while 24% had competent knowledge and practice. In this study, the majority of nursing students didn't level the EVD or check.

2.4.1 Role of a nurse in external ventricular care bundle

Care bundle refers to standardized practices and protocols for EVD insertion and management. Its use is primarily to minimize complications such as infection. Documented findings from studies following EVD bundle implementation have shown significant decreases in infection rate (Talibi *et al.*, 2020). A retrospective study with 46 children subjected to EVD placement revealed that 28% of them ($n=13$) presented complications, the most frequent being related to infectious

causes (69% n= 31) and malfunctioning of the drainage valve (31% =14). In the same study Sobral et al 2018 concluded that the main complications related to EVD are related to nursing care, as well to their level of knowledge.

Champey et al. (2018) and his fellow researchers in their study techniques to lower external ventricular drain-related infections were examined. An EVD care bundle that includes CSF collection must be established and strictly followed in order to achieve a low incidence of EVD-related illnesses, according to a multicenter retrospective study. In this study, nurses had to adhere to stringent Standard Operating Procedures (SOPS) and underwent extensive training to achieve a high degree of EVD protocol compliance. To sum it up strict adherence to EVD protocol by nurses created a culture of safety thus reducing hospitalization time and minimized the risk of EVD related infections.

Assessment of physical status from head to toe and monitoring of ABCD are all part of nursing management for children with EVD. In order to spot a rise in increased intracranial pressure, evaluate your neurological health. Examine the insertion site and keep an eye out for any infection symptoms. A patient's position should be checked to avoid excess or under drainage. Check the EVD as necessary, record the amount, color, and any changes in CSF color that might indicate bleeding or infection (Altschul et al., 2020)

It is the nurse's duty to observe, judge, and record ICP in the ICU; doing so needs competence and training to guarantee that the right value of ICP is recorded. It is crucial to obtain accurate ICP measurements via EVD since ICP values might be inflated or underestimated as a result of poor operation. When EVD is used, discrepancies in clinical practice might be caused by a lack of understanding of CSF physiology and pathophysiology, which puts the patient at risk for unfavorable complications. The prevention of infections connected to EVDs is crucial, and nurses are essential to infection control (Fang et al., 2021).

2.5 Critical care nurses practice on EVD care bundle

The management of external ventricular drain (EVD) outflow is primarily a responsibility of nurses. According to a study by Ahmed et al. in 2021, that assessed EVD care practices of 100 nurses in Cairo, it was found that 76% of the nurses exhibited incompetent practices, while 24% demonstrated competent practices in EVD care (Ahmed et al., 2021). Additionally, a Taiwanese

study including 110 nurses found that the use of EVD care bundles increased from 12% to 100% after the deployment of instructional interventions (Tsai-Yun Hseih, 2018).

The impact of nurse care practices on EVD care and External Ventricular Drain-Related Infections (ERI) is a critical area of concern in healthcare. Findings by Champey et al. (2018), Kim et al. (2022), and Lu et al. (2019) emphasize the pivotal role of nurse practice and collaboration with surgeons in affecting ERI prevalence rates. These studies highlight the importance of aseptic techniques, hand hygiene, and maintaining a closed ventricular system, alongside frequent dressing changes, CSF sampling, and CSF leakage monitoring, as integral components of evidence-based care bundles for managing and preventing ERI in critically ill patients. Additionally, Bertuccio et al. (2023) underlines the significance of adhering to proper CSF sampling protocols, emphasizing hygiene best practices.

Furthermore, research by Wondafrash and Tirsit (2021) conducted revealed a high prevalence of ERI, with direct mortality rates associated with ERI underscoring the importance of effective EVD management. Meanwhile, studies by Albano et al. (2018) and Sam et al. (2018) demonstrated EVD to be a significant source of nosocomial infections, with implications for patient morbidity and mortality rates. These findings underscore the critical role of protocol implementation in reducing EVD-associated infections, as demonstrated in research by Walek et al. (2022) and the importance of nursing interventions, such as cutaneous antisepsis and subcutaneous tunneling. Additionally, the study by Bertuccio et al. (2023) suggests that continuous drainage in patients with severe Traumatic Brain Injury (TBI) and EVD is associated with improved outcomes and survival rates, highlighting the potential of nursing interventions to reduce ERI prevalence. Lastly,

2.6 Perceived barriers to the effective utilization of external ventricular drain care bundle

2.6.1. Personal Protective Equipment

CCNs have identified the insufficient or inadequate availability of personal protective equipment (PPEs) as a significant barrier to the successful implementation of an EVD care bundle. Addressing this concern, a study by Verbeek et al. (2020) review that encompassed 24 studies with a total sample size of 2278 participants. The review specifically examined the role of PPEs in enhancing care quality and adherence to protocols, particularly during health crises such as the Covid-19 pandemic. Major themes from the study included the fear and anxiety of

possible infections due to exposure. In the CCU, CCNs often interact with patients affected by various infectious conditions. Moreover, checking, assessing, and obtaining fluid samples substantially increase the possibility of infection, significantly reducing CCNs' ability and confidence to utilize care bundles in critical care settings. As (Verbeek et al., 2020), PPEs are perceived as crucial in implementing the care process. The availability of such equipment is essential in promoting adoption.

2.6.2 Complex Bundles and Non-standardized Reporting

Care bundles perceived as complex are poorly implemented. Subsequently, Gilhooly et al. (2019) conducted a scoping review of 348 articles examining the barriers and facilitators of the successful implementation of care bundles. From the study, major findings suggested that care bundles with a reduced number of simple elements had better uptake rates (Gilhooly et al., 2019). The research identifies a knowledge factor related to the perceived complexities of care bundles. As illustrated, care bundles assumed as complex have lower uptake rates, with Spearman's rho returning -0.47 on the association between adoption and bundle complexity (Gilhooly et al., 2019). As the authors suggest, a standardized approach to reporting the implementation strategies is necessary to increase such bundles' efficacy and uptake rates in clinical settings. As highlighted, knowledge and attitudes toward the bundles may hinder utilization.

2.6.3 Poor Knowledge of Care Bundles

In Sub-Saharan Africa (SSA), inadequate knowledge regarding care bundles directly affects implementation. In such a case, a systematic review of 61 articles on SSA examined the implementation methods in the region, with communicable diseases posing a significant challenge, despite adequate nursing efforts to address the issue (Barrera-Cancedda et al., 2019). From the findings, nurses faced numerous challenges in education, quality management, planning, and restructuring. At the same time, the authors recommended increased knowledge and nurse awareness related to which strategies, their combination, implementation context, and approaches to use when addressing communicable diseases (Barrera-Cancedda et al., 2019). As a result, inadequate knowledge of care bundles hinders nurse uptake and utilization of such bundles, especially in low-resource settings. The emphasis is on insufficient familiarity with what the nurses are supposed to do, as well as poor empowerment and resource limitations.

2.6.4 Inadequate Resources for external ventricular drain care bundle

As highlighted, low-resource settings adversely and significantly impact care bundle uptake and implementation. In such a case, Jesuyajolu et al. (2022) carried out a review on the use of makeshift external ventricular drains in African states. The research included three research articles, with the major findings suggesting resource challenges as a critical hindrance to care bundle uptake. Subsequently, in most settings, the standard and recommended catheter was replaced with cheaper options, including a 14-gauge central-line catheter (Jesuyajolu et al., 2022). The survival rate post-EVD insertion was estimated at 54%, with an incidence of 24% in post-EVD insertion (Jesuyajolu et al., 2022). As indicated, only an approximated half of the population with improvised, non-standard, or non-recommended EVD equipment survived post-EVD implementation. The study associations a high mortality and post-EVD infection rate with low-resource settings and the inadequacy of the required equipment.

2.7 Resources Available for EVD Management

2.7.1 Guidelines

Guidelines are the main components in the successful uptake of EVD management. In a review conducted by Chung et al. (2019), the availability of evidence-based approaches and guidelines was associated with a substantial impact on the uptake of EVD care bundles. In this instance, EVDs were managed less than optimally even though they are linked with significant patient benefits due to a lack of awareness of the availability and application of best care practices. (Chung et al., 2019). The primary conclusion is that EVD uptake remains poorly implemented in most care settings due to reduced or inadequate awareness and access to recommended evidence-based guidelines. The rationale is that for correct uptake, associated with reduced mortality rates and enhanced patient outcomes; guidelines should be available to ensure the care provided is standardized, evidence-based, and effective in attaining patient-centered quality goals and outcomes.

2.7.2 Economic Considerations

The financial aspect of EVD management remains critical in determining the efficacy and effectiveness of such processes. As a result, TBI rates continue increasing, with the costs involved in managing the conditions rising, especially in low-resource settings (Chau et al., 2019). The emphasis is on the correlations between EVD protocol uptake and equipment

availability. Reports in Nigeria and India have indicated substituting recommended tubes with improvised tubes, albeit with minimal challenges (Chau et al., 2019). C.T. imaging, as well as the required equipment after EVD insertion, is some of the challenges associated with reduced uptake in low-resource settings, such as SSA. At the same time, a significant number of cases requiring EVD placement are long-term, with costs increasing with time. Intensive care units are constrained and have an inadequate bed capacity, leading to high demand and scarcity of such resources.

2.7.3 Trained Nurses and CCNs.

Although widely used in critical care settings, EVDs are often poorly utilized, primarily due to inadequate nurses with the required management of such equipment. In such a case, nursing resources and personnel challenges are persistent and continuously hinder the uptake process and correct, evidence-based utilization of such components (Vieira et al., 2022). Although EVDs have numerous benefits, such advantages are adversely impacted, and the risk of complications is significantly increased due to incorrect use. For example, Vieira et al. (2022) state that poorly trained CCNs with inadequate experience in such settings often engage in excessive fluid drainage, with adequate evidence of accidental removal of EVDs available. At the same time, unintentional drain obstruction, excessive fluid drainage, and other errors are accountable for poor patient outcomes (Vieira et al., 2022). Hemorrhages and ventricular complications often result from inadequate nursing care resources and personnel.

2.12 Conceptual framework

The research's conceptual framework for deliberative nursing process theory highlighted the correlations between independent and dependent variables.

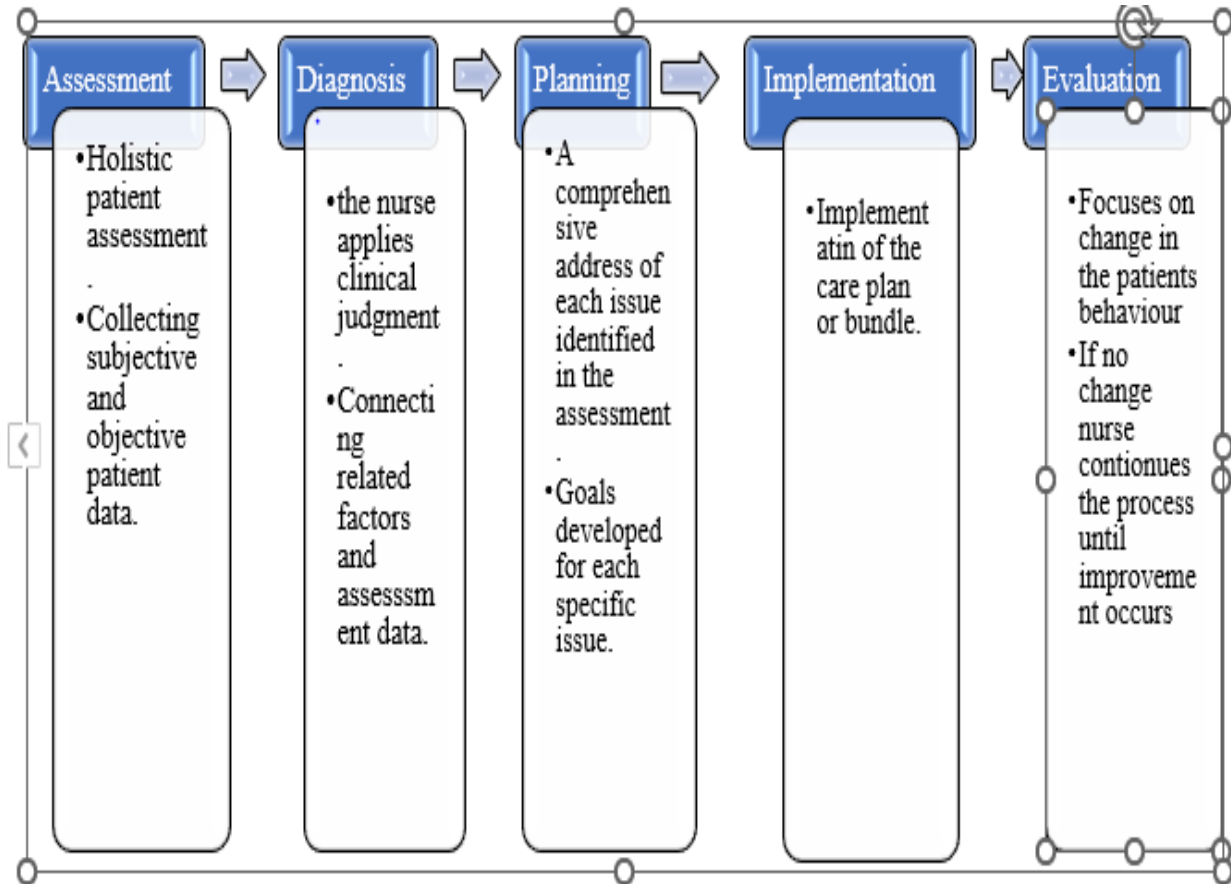


Figure 1 : Conceptual framework adopted from: (Nursing-Care-Plans-Edition-9-Murr-Alice-Doenges-Marilynn-Moorehouse-Mary, 2014.)

INDEPENDENT FACTOR

DEPENDENT VARIABLE

OUTCOMES

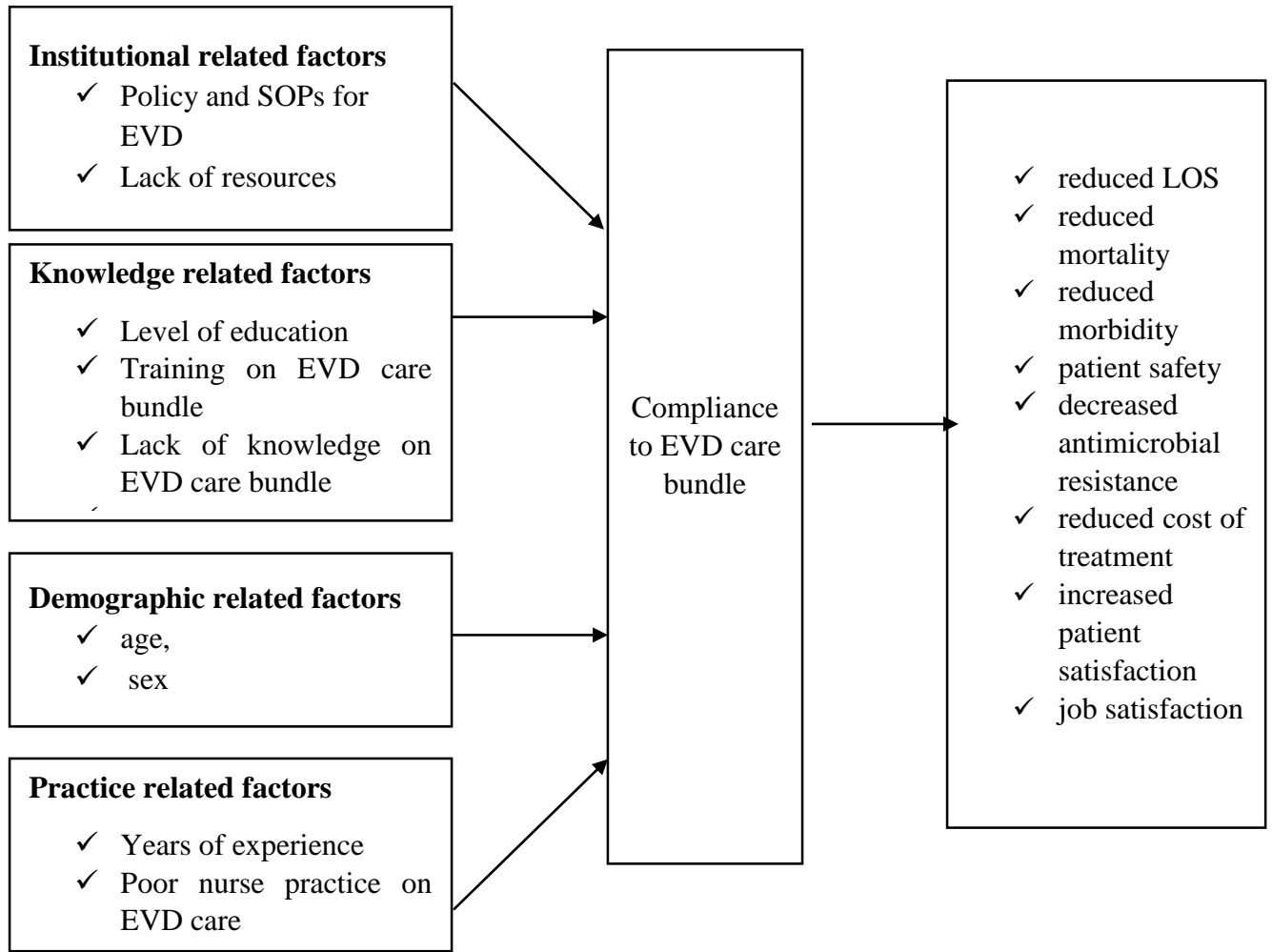


Figure 2: Conceptual Framework Leah N. N.2023

CHAPTER 3: METHODOLOGY

3.1 Introduction

This section presented the research design of the study, site of the study, study population, sample size determination and recruitment process, sampling technique, exclusion and inclusion criteria, data collection procedure and tools, data analysis and ethical considerations.

3.2 Study site

The study was carried out in the Main Critical Care Unit (CCU) and Neurosurgery CCU of KNH. KNH was the largest referral facility in Kenya containing roughly 2000 patients' beds and staff population of around 6000. The hospital was located 3km from Nairobi city Centre. The hospital serves local patients, as well as those from eastern and central Africa. It serves up to 600,000 out patients and 89,000 in-patients yearly.

The hospital has 61 ICU beds distributed as follows: 21 beds in main ICU, 41 beds in subsidiary ICU (Neonatal, Burns, Pediatric, Prime care, Neurosurgery, Medical, Cardiology, and Reproductive). Sixty percent of patients admitted to the main ICU have TBI and majority of them require EVD, mortality is estimated to be around 35%.

3.3 Study design

A mixed-method study that utilized both qualitative and quantitative data was employed. The quantitative aspect entailed collected data on nurses to answer the objectives on knowledge of nurses on use of EVD care bundles, practice level on EVD care bundle and the barriers to utilization of EVD care bundle. The qualitative aspect entailed data collected through in-depth interviews to answer the objective on resources available for utilization of EVD care bundle. The qualitative aspect of the study was exploratory in nature and the two datasets were not linked.

3.4 Study population

The study employed a census approach. The whole population of nurses who met the inclusion criteria was included in the study. The study population consisted of 82 Critical Care Nurses who were actively engaged in direct patient care within the Main Critical Care Unit and Neurology Critical Care Unit. All nurses involved are registered and with a minimum of Diploma in Nursing.

3.5 Selection of participants

3.5.1 Inclusion criteria

For our research, we carefully selected participants to ensure the study's accuracy and relevance. We established specific inclusion criteria, which were: Firstly, we included nurses who, at the time of the study, were actively working in the Intensive Care Unit (ICU). Secondly, we ensured that all participating nurses willingly consented to be part of our study. Lastly, we specifically targeted nurses who were engaged in direct patient care within the ICU.

3.5.2 Exclusion criteria

Firstly, we excluded nursing students who were undergoing clinical placements in the ICU during the study period. Secondly, critical care nurses who declined to participate in the study were excluded. Thirdly, nurses who were on leave during the study period did not form part of our participant group. Additionally, we excluded nurses who had less than six months of experience in the ICU. Lastly, nurses who had never interacted with an External Ventricular Drain (EVD) were not included in our study.

3.6 Study variables

3.6.1 Independent variables

These included demographic factors (age, sex), years of nursing experience, educational level. Knowledge factors which include level of training, lack of knowledge on or training on EVD care bundle. Institutional related factors include EVD policies, SOPs, lack of resources. Finally practice related factors like year of experience. The variables were considered to understand their potential influence on ICU nurses' experiences and practices related to EVD management.

3.6.2 Dependent variables

Compliance to the external ventricular drain care bundle by critical care nurses served as the dependent variable in the study. The specific variable was measured and analyzed to determine the extent to which critical care nurses adhere to established care protocols for external ventricular drains. The research aimed to identify factors influencing and affecting this compliance within the study context.

3.7 Recruitment and Consenting Procedures

A collaborative approach was adopted for the study; it involved obtaining the necessary authorization from the hospital administration to conduct the research. A meeting was held with the nursing service manager of the department and the participating nurses, discussion on researcher's intentions, study procedures, to ensure compliance with consent procedures. This collaborative discussion aimed to establish a mutual understanding and obtain support for the study.

3.8 Data collection

Data was collected by use of self-administered close ended questionnaire; with research participants filling them out while receiving guidance from the principal investigator. Additionally, an observation checklist was completed by the researcher after actively observing participants during their work. The principal researcher equally conducted in depth interviews, took notes and audio recordings from the participants.

3.8.1 Instruments of Study

The principal investigator created a self-administered questionnaire (see appendix V) for data collection. This questionnaire had three sections: one on nurses' experience and education, another on nurses' knowledge about EVD care bundles, and a third on nurses' perceived obstacles to using EVD care bundles. Nurse's demographics were also included. An observation checklist was used to assess nurses practice level (appendix III). An interview guide was used to get information on available resources from key informant (appendix IV).

3.8.2 Pretesting

The research tools underwent review by a biostatistician and were then pretested for completeness and clarity in the ICU. The researcher conducted a preliminary test, evaluating completeness, clarity, and comprehension, making necessary adjustments. This pretest assessed the time required to complete each questionnaire and ensured the questions were well understood. The pretest took place at KNH Pediatric ICU to maintain consistency and the same study settings. The nurses who participated in the pretest were excluded from the final survey.

3.8.3 Research assistants

Two assistants, who were also Higher Diploma critical care nursing students, were involved in data collection at the hospital. Before the study began, these assistants received training on the

research's purpose, objectives, how to use research tools, and interview techniques. Their training also covered the process of ensuring the completeness of the tools.

3.9 Study strengths and limitation

Strengths

Notable strength from the study included the study drawing its data directly from nurses actively working in critical care units responsible for managing patients with EVDs, hence ensuring that the findings closely mirror the real-world practices and challenges faced by healthcare professionals. Additionally, the utilization of a cross-sectional approach for both quantitative and qualitative data collection not only facilitated a comprehensive understanding of the subject but also proved to be a cost-effective and efficient method, saving valuable time in the research process.

Limitations

Although convenient due to a target of fewer than 10,000 nurses, a sample of 82 nurses may be inadequate to ensure transferability and generalization to other settings. Questionnaires were subjectively filled by nurses, increasing the possibility of biases, although the questions were standardized to minimize such effects.

3.10. Quality control

Before data collection, a pilot study was conducted, leading to necessary corrections. The principal researcher pretested the data collection questionnaire in the Pediatric ICU at KNH. The filled questionnaires were double-checked for completeness by the principal investigator before leaving the study site. Audio recordings were reviewed by the principal researcher to ensure accuracy before transcription. The questionnaires were stored in both hard and soft copies, and statistical analysis was performed with the assistance of a statistician to maintain data quality.

3.11 Data management and analysis

3.11.1 Data collection method

Following KNH-UON ERC approval, the researcher then sought the approval of hospital administration on data collection. Further, she sought the consent of the participants to fill the questionnaires and participate in practice observation checklist. Additional consent was for

audio-record the interviews using a tape-recorder to make sure that the information collected was correct. Both questionnaire and Interviews were done in English. They were conducted at a time and place that was convenient to the participant; free from distraction and one that enhanced privacy.

3.11.2 Data management

Quantitative data

The filled questionnaires and observational checklist were used. The questionnaire and observational checklist responses were coded and entered into excel spreadsheets. Every 10th entry in excel was counterchecked with the questionnaires to ensure the entry was correct. The data was then imported into R version 4.1.2 for cleaning, recoding and analysis. Data cleaning entailed removal of redundant variables, duplicates and wrong entries.

Qualitative data

The audio-recorded interviews were transcribed by an independent transcriber. The use of an independent transcriber was used to ensure that the transcripts were as original as possible and without any input from the study personnel. The transcribed material was produced in text form in word. The transcripts were then analyzed as described under data analysis. The transcripts were serialized as N1 to N8, N representing nurse and 1 the number of the interview conducted.

3.11.3 Data analysis

Demographic characteristics

The demographic characteristics of the study participants were analyzed using software, R version 4.1.2. Continuous variables such as age, years of experience, were summarized using medians and interquartile ranges. Frequencies and proportions were used to summarise categorical data, such as gender and educational attainment, with the findings displayed in a table.

Quantitative data

Quantitative continuous data e.g., the age of the participants was summarized using means and standard deviations if normally distributed or medians and interquartile ranges if skewed. Categorical data e.g., the level of education, sex and specialization was summarized using frequencies and proportions and presented in tables and charts. For the level of knowledge and

practice level of EVD care bundle, each correct question attracted one mark. The marks were then added up and converted into percentages. This was then summarized using means and standard deviations if normally distributed or medians and interquartile ranges if skewed. Barriers to utilization of EVD care bundle was summarized using frequencies and proportions, and presented in tables. The questionnaire responses were coded and entered into excel spreadsheets version 19. The data was then imported into R version 4.1.2 for cleaning, recoding and analysis.

Qualitative data

The study used manual thematic analysis approach. Colaizzi's seven-step approach for analyzing and managing phenomenological data were used to extract the themes. The steps involve the following: 1) Thoroughly reviewing and revisiting the field notes and transcripts. 2) Identifying and extracting significant statements that are relevant to the research question. 3) Formulating meanings and interpretations based on the extracted statements. 4) Grouping and organizing the formulated meaningful words into coherent themes. 5) Developing a descriptive account of the fundamental structures of the phenomenon being investigated. 6) Generating a comprehensive report that presents the core essence of the issue under study. 7) Validating the findings by seeking feedback from the participants, thereby ensuring the completion of the analysis process (Kim *et al.*, 2021)

Qualitative data obtained from interviews with ICU nurse team leaders, recorded in audio format, were translated, transcribed thematically, and then typed using Microsoft Office Word. These transcripts were then exported to NVivo (version 12) for qualitative data analysis. Analyzing the qualitative data involved identifying relevant themes aligned with the research objectives through content analysis. The findings from the responses of ICU nurse team leaders to the interview guide were discussed in relation to the existing literature. The qualitative data findings were presented in a narrative form (verbatim) and served to enhance the quantitative outcomes of the study.

3.11.4 Data presentation

The findings of the study i.e., demographic characteristics and, the themes and subthemes describing the knowledge, practice, perceived barriers of nurses in compliance to EVD care bundle were presented using pie charts, graphs and tables. The results were then presented to a

panel of examiners at the University of Nairobi, department of nursing. The results will also be published in the University of Nairobi repository for public access. A copy of the results will also be submitted to the critical care unit at Kenyatta National Hospital.

3.12 Ethical consideration

The researcher followed the necessary protocols to obtain ethical approval from both the University of Nairobi and Kenyatta National Hospital Ethics and Research Committee (Approval number P493/05/2023). Additionally, permission was sought from the hospital administration to conduct the study.

Informed consent was gotten from each participant after providing them with a detailed explanation of the study's purpose. Participants were made aware that they have the freedom to withdraw from the study at any point without any consequences. To ensure anonymity and confidentiality, no names were included on the questionnaires, and instead, unique serial numbers will be assigned to each participant.

Participants were given the reassurance that they are safe and that the hazards are negligible. In the unlikely event that any discomfort arose during the study, the researcher was to act promptly to offer the support that was required. They were informed that while there are no financial or other immediate rewards from this study, the management may still use it to enhance EVD care.

CHAPTER FOUR: RESULTS

4.1 Sociodemographic characteristics of the study participants

This study included a total of 81 nurses' staff at the KNH CCU. Of the 81 nurses, the majority 43.2% (n = 35) were aged between 30 to 40 years followed by those aged above 40 years at 34.6% (n = 28). The rest were aged below 30 years.

75.3% (n = 61) of participating nurses were females and the rest were males. In terms of academic qualifications, the majority 54.3% (n = 44) of the nurses were holders of a higher diploma, 27.2% (n = 22) were graduates and 12.3% (n = 10) were holders of a basic diploma. The rest were postgraduates.

Of the 81 nurses, 49.4% (n = 40) had worked for more than 10 years, 28.4% (n = 23) had worked for less than 5 years. The rest had worked for between 5 to 10 years. Four nurses out of the eighty-one had specialized in the care of patients with external ventricular drains (Table 1).

Table 1: Sociodemographic characteristic of study participants

Characteristic	Description	Frequency/Median	(%)/IQR
Age in years		35.0	30.0, 44.0
	Less than 30 years	18	22.2
	30 to 40 years	35	43.2
	More than 40 years	28	34.6
Gender	Female	61	75.3
	Male	20	24.7
Educational Qualification	Diploma	10	12.3
	Higher Diploma	44	54.3
	Bachelors	22	27.2

	Postgraduate	5	6.2
Experience in years	Less than 5 years	23	28.4
	5 to 10 years	18	22.2
	More than 10 years	40	49.4
Specialization in EVD care	Yes	4	4.9
	No	77	95.1

4.2 The level of knowledge of external ventricular drain care among critical care nurses

Table 2 below shows a set of questions used to test the nurses' knowledge of external ventricular drainage care. The frequency column indicates the number of nurses who answered correctly.

All the nurses (100%) responded positively that hand hygiene was a must when handling EVD-related tasks. Of the 81 nurses, 87.7% (n = 71) said it was necessary to wear sterile gloves when changing EVD dressings. When asked whether it was important to use aseptic techniques when performing EVD procedures, 96.3% (n = 78) of the nurses responded in the affirmative. All the nurses agreed that it was a necessity to do documentation after carrying out EVD care. Other correct responses were; aseptic techniques when obtaining cerebrospinal fluid sample 92.6% (n = 75), appropriate positioning of the patient's head 97.5% (n = 79) and keeping EVD drainage bag below the position of the patient's head 77.8% (n = 63) Table 2.

Table 2: Knowledge of external ventricular drainage care among critical care nurses (N = 81)

No	Statement	Frequency	Percent
1.	Proper hand hygiene when handling EVD-related tasks	81	100
2.	Wear sterile gloves during EVD dressing changes	71	87.7
3.	Aseptic technique when performing EVD procedures	78	96.3
4.	Documentation of EVD care procedures	81	100
5.	Cerebrospinal Fluid samples be obtained aseptically	75	92.6
6.	Appropriate positioning of the patient's head	79	97.5
7.	The EVD drainage bag should be kept below the level of the patient's head	63	77.8
8.	Potential complications associated with improper EVD care		
	Infections	77	95.1
	Fluid and electrolyte imbalance	32	39.5
	Blocked drain	74	91.4
	Excess drainage	74	91.4
	CSF leakage	70	86.4
9	When should you clamp the EVD?		
	Before the patient sits up	52	64.2
	While transporting the patient	65	80.2
	When changing the patient's position	61	75.3
	During procedures	54	66.7
10	Not a nursing responsibility to care for a patient with EVD		
	Replacing a ventricular drain	70	86.4
	Ensure proper alignment of the transducer	28	34.6
	Monitoring ICP readings	26	32.1
	Monitoring drainage	24	29.6

Nurses were also asked about the potential complications associated with improper handling of EVD drains where infection was selected by 95.1% (n = 77) of the respondents, fluid and electrolyte imbalance was considered not a complication of improper care of EVD by 39.5% (n = 32), blocked drainage was selected by 91.4% (n = 74), excess drainage by 91.4% (n = 74) and cerebrospinal fluid leakage by 86.4% (n = 70).

When asked when it is appropriate to clamp the EVD, 64.2% (n = 52) said before the patient sits up, 80.2% (n = 65) said while transporting the patient, 75.3% (n = 61) said when changing the patient's position. Clamping the EVD when doing procedures was selected by 66.7% (n = 54).

The role of nurses in EVD care, 86.4% (n = 70) said nurses replace ventricular drains, 34.6% (n = 28) said nurses ensure proper alignment of the transducer and 32.1% (n = 26) said it is the role of the nurses to monitor intracranial pressure readings. Monitoring of drainage was selected by 29.6% (n = 24) of the nurses.

4.2.1 Overall knowledge of external ventricular drainage care

The overall knowledge of external ventricular care was derived from the percentage score for individual nurses on the questions in Table 2 above. The knowledge was classified using Bloom's modified cut-off points.

Table3: Knowledge classified using Bloom's modified cut-off points.

Grade	Score
Poor	<60%
Fair	60-79%
Good	≥80%

4.2.2 Distribution of knowledge of EVD care

The density plot in Figure 1 below shows the distribution of knowledge of EVD care among critical care nurses. The scores were left skewed with a median of 75% and an interquartile range of 70% to 80%. The lowest score was 40% and the highest was 100%. The mean knowledge score was 76.2%.

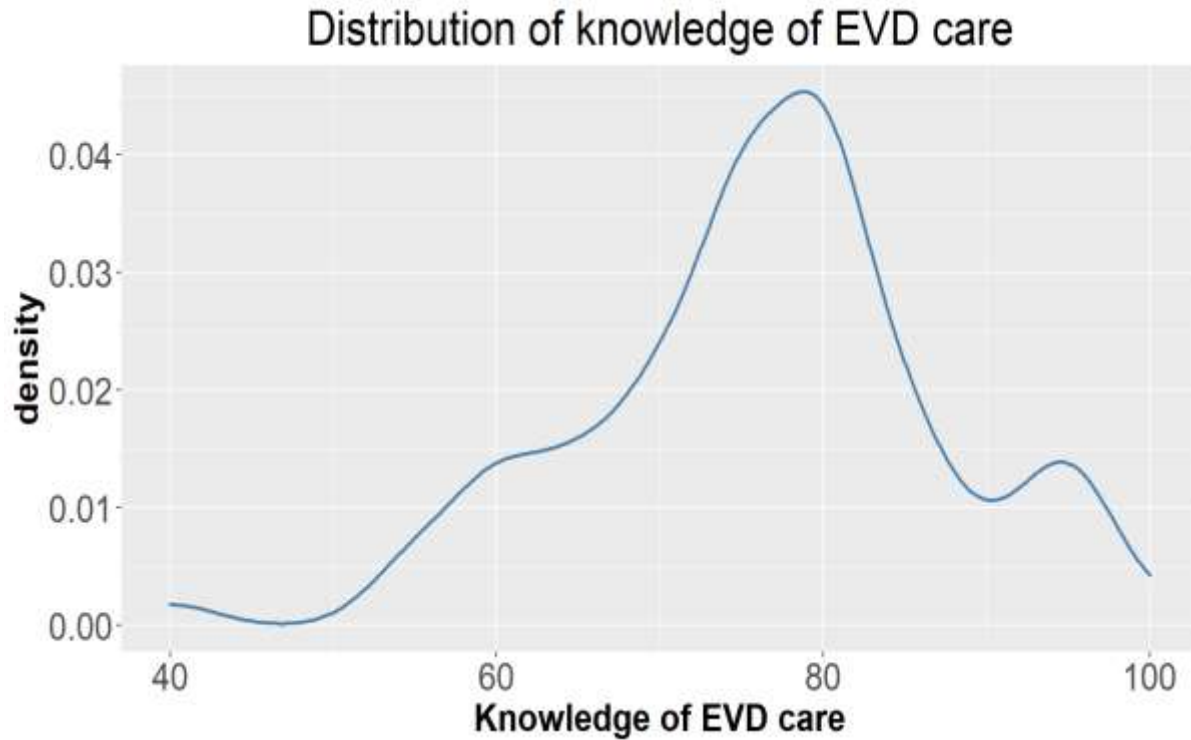


Figure 3: Density plot showing the distribution of knowledge of EVD care

4.2.3 Overall knowledge score based on Bloom-modified cut-off points

Based on the above scoring system, the majority 48.1% (n = 39) of the nurses got a good score followed by those with a fair score at 46.9% (n =38). The rest got a poor score.

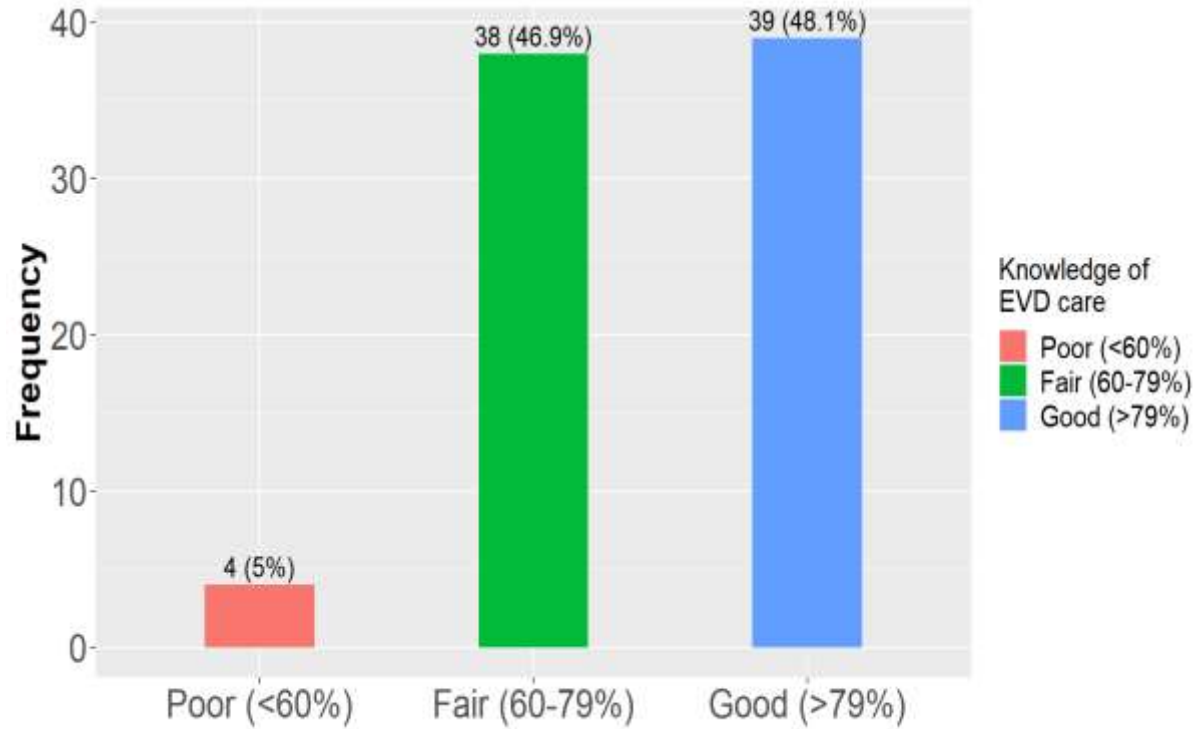


Figure 4: Overall knowledge score based on Bloom-modified cut-off points

4.2.4 Factors associated with knowledge of external ventricular drain care bundle among nurses

None of the assessed factors was significantly associated with knowledge of EVD care ($p > 0.05$) at 5% significance level. However, the odds ratios demonstrate varying levels of knowledge of EVD care bundle among the various levels of the factors. The odds of having poor to fair knowledge among nurses aged between 30 to 40 years were 4% less than those of nurses aged less than 30 years, OR 0.94 (95% CI 0.30, 2.94). Nurses who were aged above 40 years were 33% more likely to have poor to fair knowledge compared to nurses aged below 30 years, OR 1.33 (95% CI 0.41, 4.38)

Table 4: Factors associated with knowledge of external ventricular drain care bundle among nurses (N = 81)

Factor	Description	Knowledge of EVD care		Crude OR (95% CI)	P value
		Poor to fair	Good		
Age in years	Less than 30 years	9	9	<i>Reference</i>	
	30 to 40 years	17	18	0.94 (0.30, 2.94)	0.93
	More than 40 years	16	12	1.33 (0.41, 4.38)	0.64
Gender	Female	34	27	1.89 (0.68, 5.28)	0.22
	Males	8	12	<i>Reference</i>	
Level of education	Diploma	6	4	<i>Reference</i>	
	Higher Diploma	24	20	0.8 (0.20, 3.23)	0.75
	Bachelors and above	12	15	0.53 (0.12, 2.33)	0.40
Specialization in EVD care	No	40	37	1.08 (0.144, 8.07)	0.94
	Yes	2	2	<i>Reference</i>	
Experience in years	≤5 years	10	13	<i>Reference</i>	
	6 to 10 years	11	7	2.04 (0.58, 7.17)	0.26
	>10 years	21	19	1.44 (0.51, 4.03)	0.49

The odds of poor to fair knowledge of EVD care bundle among female nurses was 89% more than that of male nurses, OR 1.89 (95% CI 0.68, 5.28). In terms of level of education, higher levels of education reduced the odds of poor to fair knowledge of EVD care. Nurses with higher diplomas were 20% less likely to have poor to fair knowledge of EVD care compared to those with diploma level education, OR 0.8 (95% CI 0.20, 3.23) while those with bachelor's degree and above were 47% less likely to have poor to fair knowledge of EVD care bundle compared to those with a basic diploma, OR 0.53 (95% 0.12, 2.33).

The odds of poor to fair knowledge of EVD care bundle was increased by 8% among nurses who were not specialized in EVD care compared to those who were specialized, OR 1.08 (95% CI 0.144, 8.07) Table 3.

4.3 Critical Care Nurses' practice level on the EVD care bundle among critically ill patients in KNH

Table 5 below shows responses to common practices when handling patients with EVDs or carrying out EVD-related procedures. These statements aimed to find out whether nurses practice the right way when carrying out procedures.

The majority 80.2% (n = 65) of the nurses practiced hand hygiene before interacting with the EVD system. In terms of PPEs, all the nurses (100%) used appropriate PPEs when caring for patients with EVDs or carrying out EVD procedures. Other areas that attracted 100% practice level were; headboard angle between 15 and 30, keeping the head in a neutral position aligned to the cervical spine and assessing the EVD catheter dressing for cleanliness, integrity and proper adhesions. Change of the dressing aseptically if it was soiled, loose or as per hospital policy was practiced by 44.4% (n = 36) of the respondents.

Table5: Practice management when handling external ventricular drains (N = 81)

Practice areas	Frequency	Percent (%)
<u>EVD Management</u>		
1. Hand hygiene and PPE		
Hand hygiene before interacting with the EVD system	65	80.2
The nurse wears appropriate PPEs	81	100
2. Patient position procedure		
Headboard angle between 15 and 30	81	100
Keeps the head in a neutral position aligned to the cervical spine	81	100
3. Change of patient dressing procedure		
Assesses the EVD catheter dressing for cleanliness, integrity and proper adhesions	81	100
Changes the dressing aseptically if it is soiled, loose or as per hospital policy	36	44.4
4. Tubing care procedure		
Aseptic technique while handling tubing, handling kept to a minimum	57	70.4

Drainage bag emptied when reaches $\frac{3}{4}$ of its volume capacity	17	21.0
Check for signs of catheter obstruction	55	67.9
5. Documentation procedure		
The nurse accurately documents EVD care observations and interventions in the patient's medical records	66	81.5
The nurse document CSF output and other relevant measurements	81	100
Nurse documents CSF appearance (clear, cloudy)	71	87.7
Drain levelled (e.g., tragus/mid sagittal line)	0	

4.3.1 Overall score on practice management when handling EVDs

The overall score was based on Bloom's modified cut-off points. The majority 56% (n = 45) demonstrated fair practice in managing external ventricular drains. The rest demonstrated a poor practice of EVD management (Figure 3).

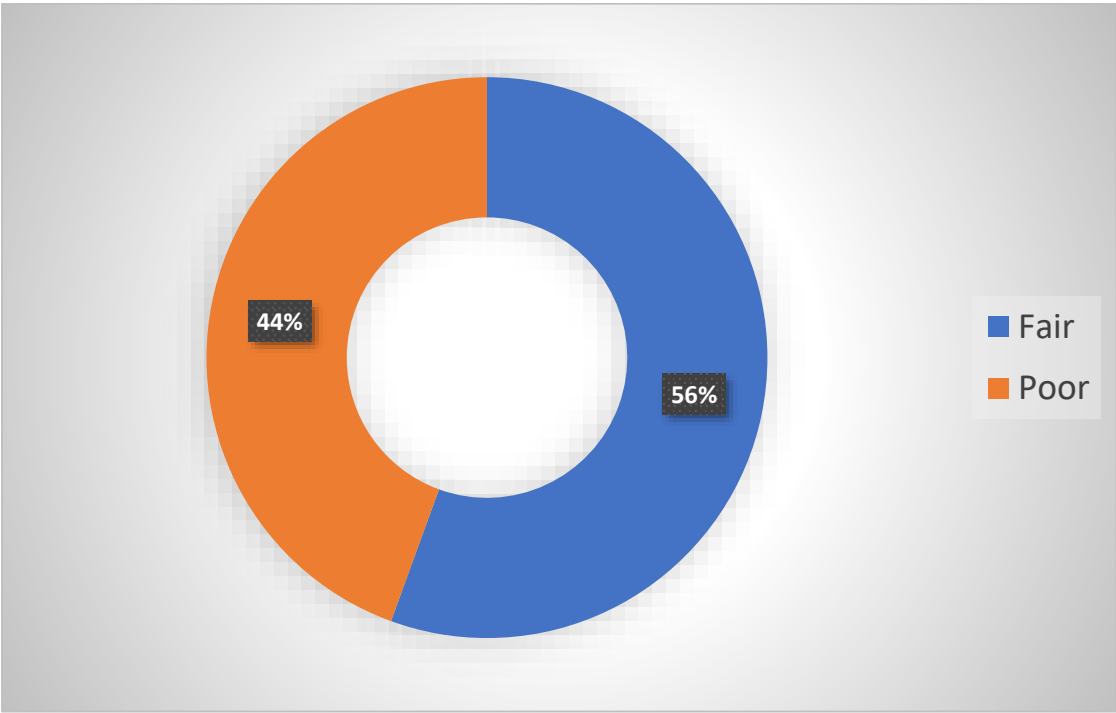


Figure5: Overall practice management of external ventricular drains

4.4 Perceived barriers/challenges to the effective utilization of EVD care bundle by CCNs at KNH

The nurses were given a set of statements to rank in terms of being barriers to the utilization of the EVD care bundle. On whether implementing the EVD care bundle was time-consuming, 54.3% (n = 44) of the nurses disagreed, 29.6% (n = 24) strongly disagreed, 3.7% (n = 3) were undecided, 8.6% (n = 7) agreed and 3.7% (n = 3) strongly agreed. Whether there was adequate resource available for EVD care, those who strongly disagreed, undecided or strongly agreed were 12.3% (n = 10), 32.1% (n = 26) disagreed and 30.9% (n = 25) agreed.

Table6: Perceived barriers to the effective utilization of EVD care bundle (N = 81)

Perceived Barriers	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
Implementing EVD care bundle is time consuming	24 (29.6%)	44 (54.3%)	3 (3.7%)	7 (8.6%)	3 (3.7%)
Adequate resources are available for EVD care	10 (12.3%)	26 (32.1%)	10 (12.3%)	25 (30.9%)	10 (12.3%)
There is clear communication regarding EVD care bundle protocols	11 (13.6%)	30 (37%)	10 (12.3%)	21 (25.9%)	9 (11.1%)
There is a lack of awareness about the importance of EVD care bundle	8 (9.9%)	24 (29.6%)	2 (2.5%)	37 (45.7%)	10 (12.3%)
Staffing levels are sufficient to provide thorough EVD care	16 (19.8%)	27 (33.3%)	8 (9.9%)	22 (27.2%)	8 (9.9%)
There is a lack of proper training on EVD care bundle implementation	9 (11.1%)	13 (16%)	9 (11.1%)	37 (45.7%)	13 (16%)
Adhering to the EVD care bundle is integrated well into our daily routine	10 (12.3%)	24 (29.6%)	14 (17.3%)	28 (34.6%)	5 (6.2%)
There is a high level of teamwork and collaboration when implementing the EVD care bundle	5 (6.2%)	27 (33.3%)	7 (8.6%)	32 (39.5%)	10 (12.3%)
There is a need for more support from management to prioritize EVD care	3 (3.7%)	10 (12.3%)	4 (4.9%)	30 (37%)	34 (45.7%)

bundle adherence.					
EVD care bundle guidelines are easily accessible and understandable	11 (13.6%)	32 (39.5%)	12 (14.8%)	15 (18.5%)	10 (12.3%)
Workload demands make it difficult to consistently follow the EVD care bundle	4 (4.9%)	25 (30.9%)	7 (8.6%)	33 (40.7%)	12 (14.8%)
There is adequate supervision and feedback on EVD care bundle practices.	10 (12.3%)	36 (44.4%)	14 (17.3%)	16 (19.8%)	5 (6.2%)
The EVD care bundle's effectiveness in improving patients' outcomes is evident	3 (3.7%)	16 (19.8%)	7 (8.6%)	34 (42%)	21 (25.9%)
There is a lack of standardized documentation for EVD care bundle procedures.	4 (4.9%)	17 (21%)	10 (12.3%)	41 (50.6%)	9 (11.1%)
Nurses are motivated to adhere to the EVD care bundle due to its benefits.	10 (12.3%)	24 (29.6%)	15 (18.5%)	24 (29.6%)	8 (9.9%)
There is a need for ongoing education and training about the EVD care bundle.	3 (3.7%)	10 (12.3%)	2 (2.5%)	20 (24.7%)	46 (56.8%)
conflicts between different care protocols hinder EVD care bundle	9 (11.1%)	22 (27.2%)	15 (18.5%)	24 (29.6%)	13 (16%)
The physical layout of the CCU supports EVD care bundle implementation	12 (14.8%)	20 (24.7%)	11 (13.6%)	31 (38.3%)	7 (8.6%)

On whether there was clear communication regarding EVD care bundle protocols, 13.6% (n = 11) strongly disagreed, 37% (n = 30) disagreed, 12.3% (n = 10) were undecided, 25.9% (n = 21) agreed and 11.1% (n = 9) strongly agreed. In response to whether adherence to the EVD care bundle was integrated well into daily routine, 34.6% (n = 28) of the nurses agreed, 29.6% (n = 24) disagreed and 17.3% (n = 14) were undecided. The availability of teamwork in taking care of patients with EVD attracted 39.5% (n = 32) who agreed, 33.3% (n = 27) disagreed and 12.3% (n = 10) strongly agreed. The rest is shown in table 4 above.

4.5 Phase 2: In-depth interviews on available resources for EVD management in CCU, Kenyatta National Hospital

Table 7 below shows the resources that according to the nurses assisted in the provision of care for patients with EVDs. Two major themes were identified; guidelines for management of EVD and training on management of EVD.

Table 7: Resources available for EVD management in CCU, Kenyatta National Hospital

Objective	Theme	Subthemes
Resources available for EVD management in CCU, Kenyatta National Hospital	Guidelines for management of EVD	Positioning the patient’s head Drainage monitoring Hygiene when handling EVDs
	Training on management of EVD	Continuous medical education Sensitizations and presentations Basic training

4.5.1 Guidelines for management of EVD

Nurses reported that they were given guidelines/instructions on how to take care of the patients with EVD by the surgeons. They said that they were also guided by the neurology charts and also infection prevention and control guidelines. The subthemes that emerged from this theme were; positioning of the patient’s head, drainage monitoring and hygiene when handling EVDs.

Positioning of the patient’s head

Positioning of the patient is central in managing patients with external ventricular drains. The reported that the position of the head is supposed to be at the same level with the pressure reading. These guidelines and instructions according to the nurses were provided by the surgeons.

“Yes, we do have guidelines provided by the neurosurgeons. Firstly, we have the positioning, we don’t just put it anywhere. There is a way we do the simulating and positioning, i.e., the

positioning of the head should be directly at the same level to the pressure reading, you can't put it above or below the head". [N1]

Another nurse reported that they do not have an EVD care bundle. She/he reported that they follow the guidelines provided in the neurology chart.

"Of course, we got the neuro chart, the monitoring of an EVD is incorporated with a fluid management chart. We do not have a special chart for EVD monitoring". [N2]

Drainage monitoring

For effective management of external ventricular drains and for optimal care of the patient, the amount of cerebrospinal fluid drained should be closely monitored. The amount of fluid drained varies depending on age and severity of the patient's condition. Nurses reported that the guidelines given by the surgeon provide s for the amount of fluid to be drained and that this is critical in their work.

"Another guideline by the surgeons is about emptying of the effluents; you have to observe closely to avoid excess drainage e.g., you cannot empty more than 200 MLS in 24hours. This instruction is critical in optimizing patient care". [N1]

Hygiene when handling EVDs

Nurses reported that hygiene through aseptic techniques was central in the management of EVDs. One nurse said that infection prevention and control protocols in the hospital played a critical role in preventing infections when caring for patients with an EVD.

"We also rely on infection prevention protocols and guidelines written materials for more information on caring for patients with EVD". [N5]

"Hygiene is also part of it, you have to at least try and use sterile equipment to avoid introducing infections". [N3]

4.5.2 Training on management of EVD

Training on management of patients with EVDs also came out as a resource for taking care of patients with EVDs. Training provides the requisite knowledge to help nurses care for patients with external ventricular drains. Three subthemes emerged from the theme on training; basic training, continuous medical education and basic training.

Basic training

One nurse reported that the basic training has provided the necessary knowledge to care for patients with EVDs. The nurse said that s/he does not face much challenges because of the basic knowledge for caring for EVD patients.

“I would say not much challenges because we have the basic knowledge of caring for EVD patients. If it is just monitoring the EVD then there is not much challenges”. [N4]

Continuous medical education

Continuous medical education (CMEs) was lauded as one way through which nurses get to learn about EVD care. CMEs are a common way of sharing information in the hospital. Nurses reported that they do access information on EVD care through CMEs mostly carried out by the neurologists.

“Maybe CMEs, we talk with the neuros they have periodical times when they conduct CMEs”. [N6]

Sensitizations and presentations

Nurses also reported that they conduct their own sensitizations and presentations on various topics including EVD care. Through this, nurses get to learn the various ways of caring for patients with EVDs though the sensitizations they said were not carried out frequently.

“We also do our own sensitizations and presentations though not frequently” [N2]

CHAPTER FIVE: DISCUSSION, CONCLUSISON AND RECOMMENDATIONS

5.1 Introduction

External Ventricular Drain (EVD) care is an advanced field of specialization in nursing for neurological patients. EVD bundle of care guidelines plays a critical part in refining nurses' practices pertaining management of patients with EVD (Aslam et al., 2022). This section discusses the compliance of EVD care bundle among critical care nurses at the KNH, intensive care unit.

5.2 Nurses' knowledge of external ventricular drain bundle of care

The overall knowledge score in our study was 48.1% (good>79%), 46.9% (fair-60 to 79%) and 5% (poor<60%). These results show that the majority, 51.9% of the nurses scored fair and below.

The findings regarding low level of knowledge among Critical care nurses in the study were consistent with prior research in this field. A study done in Egypt Cairo found less than one third of nurse interns had competent knowledge in regards to using EVDs in management of patients (Ahmed et al., 2021). Similarly, these results were matched with those of Rychik et al. (2019), who carried out a study entitled "Evaluation management of the child and adult with Fontan circulation: a scientific statement from the American heart association" and found that two thirds of the studied nurses had unsatisfactory knowledge regarding EVD among children with brain tumor.

The study revealed, less than one quarter of the nurses in intensive care could not mention electrolyte imbalance as one of the complications of EVD insertion despite it being one of the key complications, similarly in another study by Ackerman et al.(2022) level of knowledge was measured by ability of nurses to monitor patients on EVD by reading and interpreting the leveling of CSF, majority of the interns did not know how to check for CSF level or forgot to check the CSF level despite it being a basic procedure in EVD management thus their level of knowledge was rated low.

We assessed various nurse related factors to determine their effect on knowledge of EVD care. Our results did not reveal any significant associations between the factors (age of the nurses, gender, level of education, specialization in EVD care and clinical experience in years, p

values > 0.05) and nurses' knowledge of EVD care bundle. Despite the lack of significance, the results showed that being aged above 40 years, female nurse, having a basic diploma compared to higher diploma or bachelors, lack of training in EVD care and more than five years of clinical experience increased the odds of poor or fair knowledge of EVD care among the nurses. In Alomar et al. study, there was no association between the knowledge of EVD care and demographic characteristics e.g., age, gender, specialization and years of practice and these findings are similar to the current study (Alomar et al., n.d.). Similarly to the results of Shehab et al. (2018), whose study titled "Impact of an Educational Program on Nurses' Knowledge and Practices Regarding Care of Traumatic Brain Injury Patients at the Intensive Care Unit at Suez Canal University Hospital" indicated that there were no statistically significant differences between nurses' overall knowledge and their age and years of experience.

Regarding training in EVD care and knowledge results in this study showed a close relationship whereby all trained nurses in terms of care had vast knowledge. These findings are similar with a Taiwan study, which similarly observed that the implementation of instructional interventions aimed at enhancing knowledge led to an increase in the utilization of EVD care bundles (Tsai-Yun Hseih 2018).

5.3 Critical Care Nurses' practice level on the EVD care bundle among critically ill patients

Care, identifying problems, and monitoring for EVD-related problems has become a nursing duty. Correct and responsible nursing care may have the ability to lead to better outcomes in patients in need of CSF drainage (Muralidharan, 2015).

In the current study, 56% of the respondents scored fair (60-79%) on practice and 44% scored poorly (<60%). Aslam and colleagues have reported a practice competency level of 6.7% before the implementation of EVD care guidelines (Aslam et al., 2022). The differences in the two studies could be possibly as a result of the scoring used. While poor score for our study is less than 60%, it has been capped at 75% in the Aslam study. The practice in our current study had fair practice and that was due to lack of standardized SOPs and relying on neurosurgeons for instructions on management of EVDs.

N. A. et al. (2021) in their assessment of nurses' performance in managing EVDs among children with tumors reported that 76% of the nurses were competent. This report is not

consistent with our findings and this could be due to differences in study settings. The current study was conducted in a general ICU and nurses may take long before encountering cases with EVD contrary to the cited study.

The areas that attracted the highest correct responses from the nurses were; use of personal protective equipment e.g., use of sterile gloves when carrying out EVD procedures, keeping the headboard between 15-30⁰ angle, keeping the head in neutral position, assessing EVD catheter for cleanliness and documentation of CSF output

5.4 Perceived barriers to effective utilization of EVD care bundle by critical care nurses

The current study revealed that continuous medical education on EVD care was strongly required, there was lack of supervision and feedback on EVD care practice, guidelines on EVD care were not easily accessible and understandable, there was not enough support from the management on EVD care and implementation of EVD care guidelines were considered time consuming. Contrary to the current study where EVD care guidelines were considered time-consuming, it has been demonstrated that implementation of EVD care guidelines play an important role in the effective care of patients with EVDs including reduction of infections (Reiter et al., 2023). Similar to the sections above, literature on barriers to effective utilization of EVD care is highly limited

Majority of the respondents strongly agreed that lack of education on EVD impacted on their ability to utilize EVD care bundle thus the need to train on the same. This results were in tandem with systematic review of 61 articles on SSA that examined the implementation methods in the region, with communicable diseases posing a significant challenge, despite adequate nursing efforts to address the issue (Barrera-Cancedda et al., 2019). From the findings, nurses faced numerous challenges in education, quality management, planning, and restructuring. At the same time, the authors recommended increased knowledge and nurse awareness related to which strategies, their combination, implementation context, and approaches to use when addressing communicable diseases (Barrera-Cancedda et al., 2019). As a result, it was concluded that inadequate knowledge and education on care bundles hinders nurse uptake and utilization of such bundles, especially in low-resource settings.

The barriers mentioned above have a significant role in the effective care of EVD care. It is therefore necessary that there be continuous medical education on care of patients with EVDS, improve supervision and enhance feedback on EVD care practices among staff, and increase accessibility and understandability of EVD care bundles. A prior study has underscored the importance of ongoing training and education to improve the provision of care to patients with EVDs admitted in hospitals. (Alrashidi et al., 2023).

5.5 Resources available for utilization of EVD care bundles

Guidelines and training on EVD care in form of continuous medical education and sensitization emerged as resources for utilization of EVD care bundles. A significant improvement in the practice of EVD management after implementation of EVD care guidelines has been reported which is in support of the current study (Aslam et al., 2022). Alomar et al. have also emphasized continuous education in nursing practice as it enhances nurses' knowledge of external ventricular care (Alomar et al., n.d.) which is in agreement with our finding of continuous medical education being one of the resources for utilization of EVD care bundle. In this study, the lack of trained specialized nurses in the utilization of EVDs contributed to the low proper utilization of EVDs. These results align with those of a study conducted by Viera et al. (2022), which concluded that challenges related to nursing resources and personnel persistently and continuously hinder the uptake process and the correct, evidence-based utilization of EVDs

5.6 Conclusions

The study improves comprehension of the EVD care bundle, with most nurses having fair to good knowledge of it. However, the majority of nurses only demonstrated fair compliance with the EVD care bundle, primarily due to barriers like inadequate education, supervision, and complex guidelines.

5.7 Policy and action recommendations

Ongoing Education and Training: KNH should implement regular training programs, including continuous medical education (CMEs) and sensitizations, to reinforce EVD care knowledge and skills among nurses.

Standardized Documentation: Develop standardized documentation protocols for EVD care procedures to ensure consistency and accuracy in patient records.

Supportive Management: Hospital management should provide increased support, resources, and supervision to prioritize EVD care adherence among nursing staff.

Quality Assurance: Healthcare facilities should establish mechanisms for ongoing quality assurance and performance

REFERENCES

- Ackerman, K., Mohammed, A., Chinthala, L., Davis, R. L., Kamaleswaran, R., & Shafi, N. I. (2022). Features derived from blood pressure and intracranial pressure predict elevated intracranial pressure events in critically ill children. *Scientific Reports*, *12*(1), 21473. <https://doi.org/10.1038/s41598-022-25169-3>
- Alomar, S. A., Bandah, S. T., Noman, G. A., Kadi, M., Abulnaja, G. A., & Abdullah, G. (n.d.). The Impact of Nursing Education on Emergency Bedside External Ventricular Drain Insertion for Patients With Acute Hydrocephalus. *Cureus*, *15*(1), e34262. <https://doi.org/10.7759/cureus.34262>
- Alrashidi, Q., Al-Saadi, T., Alhaj, A. K., & Diaz, R. J. (2023). The Role of Nursing Care in the Management of External Ventricular Drains on the Neurosurgical Ward: A Quality Improvement Project. *World Neurosurgery*, *176*, 265-271.e2. <https://doi.org/10.1016/j.wneu.2023.05.016>
- Altschul, D., Hamad, M. K., Kobets, A., Fluss, R., Lin, C., Boyke, A. E., Liu, J., Thomas, R., Unda, S. R., Altschul, D., Hamad, M. K., Kobets, A., Fluss, R., Lin, C., Boyke, A. E., Liu, J., Thomas, R., & Unda, S. R. (2020). A Retrospective Quality Analysis of External Ventricular Drain Infection Rates Following Stroke Diagnoses and Other Brain Injuries: Comparison of Emergency Room and ICU/OR Setting. *Cureus*, *12*(3). <https://doi.org/10.7759/cureus.7173>
- Aslam, H., Afzal, M., Sarwar, H., & Khan, S. (2022). Effect of External Ventricular Drain Care Guidelines on Nursing Practice and Complications among Patients with Post-Traumatic Hydrocephalus. *Pakistan Journal of Medical and Health Sciences*, *16*(2), 1128–1131. <https://doi.org/10.53350/pjmhs221621128>
- Barrera-Cancedda, A. E., Riman, K. A., Shinnick, J. E., & Buttenheim, A. M. (2019). Implementation strategies for infection prevention and control promotion for nurses in Sub-Saharan Africa: A systematic review. *Implementation Science*, *14*(1), 111. <https://doi.org/10.1186/s13012-019-0958-3>

- Champey, J., Mourey, C., Francony, G., Pavese, P., Gay, E., Gergele, L., Manet, R., Velly, L., Bruder, N., & Payen, J.-F. (2018). Strategies to reduce external ventricular drain–related infections: A multicenter retrospective study. *Journal of Neurosurgery*, *130*(6), 2034–2039. <https://doi.org/10.3171/2018.1.JNS172486>
- Chau, C. Y. C., Craven, C. L., Rubiano, A. M., Adams, H., Tülü, S., Czosnyka, M., Servadei, F., Ercole, A., Hutchinson, P. J., & Koliass, A. G. (2019). The Evolution of the Role of External Ventricular Drainage in Traumatic Brain Injury. *Journal of Clinical Medicine*, *8*(9), 1422. <https://doi.org/10.3390/jcm8091422>
- Chouhdari, A., Darazam, I. A., Farahani, M. S., Mokhtari, M., Goharani, R., Amirdosara, M., & Hajiesmaeili, M. (2021). Is External Ventricular Drain Infection Predictable in Neurosurgery Patients? A Following-up Study in Iran. *Archives of Neuroscience*, *8*(1), Article 1. <https://doi.org/10.5812/ans.103075>
- Chung, D. Y., Olson, D. M., John, S., Mohamed, W., Kumar, M. A., Thompson, B. B., & Rordorf, G. A. (2019). Evidence-Based Management of External Ventricular Drains. *Current Neurology and Neuroscience Reports*, *19*(12), 94. <https://doi.org/10.1007/s11910-019-1009-9>
- Elzain, M. A., Ahmed, M. M., & Salim, A. D. (2022). External ventricular drainage: Indications and outcome among Sudanese Children. *Sudanese Journal of Paediatrics*, *22*(1), 36–46. <https://doi.org/10.24911/sjp.106-1642444214>
- Fang, W., Wei, A., Zhu, Y., You, W., Wang, H., Wen, L., & Yang, X. (2021). Contribution of Patient Care Technicians to the Prevention of External Ventricular Drain Infection: A Retrospective Study. *The Journal of Neuroscience Nursing: Journal of the American Association of Neuroscience Nurses*, *53*(1), 44–48. <https://doi.org/10.1097/JNN.0000000000000561>
- Gilhooly, D., Green, S. A., McCann, C., Black, N., & Moonesinghe, S. R. (2019). Barriers and facilitators to the successful development, implementation and evaluation of care bundles in acute care in

- hospital: A scoping review. *Implementation Science*, 15, 14(1), 47.
<https://doi.org/10.1186/s13012-019-0894-2>
- Hagel, S., Bruns, T., Pletz, M. W., Engel, C., Kalff, R., & Ewald, C. (2014). External Ventricular Drain Infections: Risk Factors and Outcome. *Interdisciplinary Perspectives on Infectious Diseases*, 2014, 708531. <https://doi.org/10.1155/2014/708531>
- Jesuyajolu, D., Aremu, G., Olukoya, O., Obiekwe, K., Okeke, C., Edeh, E., Moti, T., & Zubair, A. (2022). A Scoping Review of the Use of Improvised External Ventricular Drains in Africa. *Cureus*, 14(9), e28748. <https://doi.org/10.7759/cureus.28748>
- Khalaveh, F., Fazel, N., Mischkulnig, M., Vossen, M. G., Reinprecht, A., Dorfer, C., Roessler, K., & Herta, J. (2021). Risk Factors Promoting External Ventricular Drain Infections in Adult Neurosurgical Patients at the Intensive Care Unit—A Retrospective Study. *Frontiers in Neurology*, 12, 734156. <https://doi.org/10.3389/fneur.2021.734156>
- Muralidharan, R. (2015). External ventricular drains: Management and complications. *Surgical Neurology International*, 6(Suppl 6), S271–S274. <https://doi.org/10.4103/2152-7806.157620>
- N. A., A., S. S., A.-R., S. E., H., & A. E., A. (2021). Assessment of Nurses Performance Regarding External Ventricular Drain among Children with Brain Tumor. *Egyptian Journal of Health Care*, 12(3), 945–955. <https://doi.org/10.21608/ejhc.2021.193546>
- Peter, S., & Roman, B. (2016). External Ventricular Drainage Infections: A Single-Centre Experience on 100 Cases. *Journal of Neurology & Neurophysiology*, 7(4). <https://doi.org/10.4172/2155-9562.1000392>
- Reiter, L. A., Taylor, O. L., Jatta, M., Plaster, S. E., Cannon, J. D., McDaniel, B. L., Anglin, M., Lockhart, E. R., & Harvey, E. M. (2023). Reducing external ventricular drain associated ventriculitis: An improvement project in a level 1 trauma center. *American Journal of Infection Control*, 51(6), 644–651. <https://doi.org/10.1016/j.ajic.2022.08.029>

- Sorinola, A., Buki, A., Sandor, J., & Czeiter, E. (2019). Risk Factors of External Ventricular Drain Infection: Proposing a Model for Future Studies. *Frontiers in Neurology*, 10. <https://www.frontiersin.org/articles/10.3389/fneur.2019.00226>
- Talibi, S. S., Silva, A. H., Afshari, F. T., Hodson, J., Roberts, S. A., Oppenheim, B., Flint, G., & Chelvarajah, R. (2020). The implementation of an external ventricular drain care bundle to reduce infection rates. *British Journal of Neurosurgery*, 34(2), 181–186. <https://doi.org/10.1080/02688697.2020.1725436>
- Thamjamrassri, T., Yuwapattanawong, K., Chanthima, P., Vavilala, M. S., Lele, A. V., & EVDPoP Study Collaborators. (2022). A Narrative Review of the Published Literature, Hospital Practices, and Policies Related to External Ventricular Drains in the United States: The External Ventricular Drain Publications, Practices, and Policies (EVDPoP) Study. *Journal of Neurosurgical Anesthesiology*, 34(1), 21–28. <https://doi.org/10.1097/ANA.0000000000000694>
- Verbeek, J. H., Rajamaki, B., Ijaz, S., Sauni, R., Toomey, E., Blackwood, B., Tikka, C., Ruotsalainen, J. H., & Balci, F. S. K. (2020). Personal protective equipment for preventing highly infectious diseases due to exposure to contaminated body fluids in healthcare staff. *Cochrane Database of Systematic Reviews*, 4. <https://doi.org/10.1002/14651858.CD011621.pub4>
- Vieira, T. W., Sakamoto, V. T. M., Araujo, B. R., Pai, D. D., Blatt, C. R., & Caregnato, R. C. A. (2022). External Ventricular Drains: Development and Evaluation of a Nursing Clinical Practice Guideline. *Nursing Reports*, 12(4), 933–944. <https://doi.org/10.3390/nursrep12040090>
- Whyte, C., Alhasani, H., Caplan, R., & Tully, A. P. (2020). Impact of an external ventricular drain bundle and limited duration antibiotic prophylaxis on drain-related infections and antibiotic resistance. *Clinical Neurology and Neurosurgery*, 190, 105641. <https://doi.org/10.1016/j.clineuro.2019.105641>

Wondafrash, M., & Tirsit, A. (2021). Prevalence of Ventriculostomy Related Infections and Associated Factors in Low Income Setup. *Ethiopian Journal of Health Sciences*, 31(6), 1257–1266.
<https://doi.org/10.4314/ejhs.v31i6.22>

APPENDICES

Appendix I: Work plan

Activity	December 2022	January 2023	February 2023	March 2023	April 2023	May 2023	June 2023	July 2023	August 2023	September 2023	October 2023	November 2023
Topic identification												
Concept paper Development												
Proposal writing												
UON/KNH ERC review												
Pretest and data collection												
Data analysis and presentation												
Report writing												
Defence of thesis at School of Nursing												
Dissemination/submission/publication												

Appendix II: Study budget

Component	Items	Quantity	Duration	Amount (Ksh)
Personnel	Internet cost	-	-	5000
	Literature review	-	Two weeks	10000
	Transcription cost	-	One week	10000
	Statistician fee		Two week	30000
Printing and photocopying	Interview guide	20	Data collection period	2000
	Questionnaire	60		2000
	Consent form	20	Data collection period	1000
	Proposal documents	5	Within the study period as needed	3000
	Thesis document	5		10000
Stationary	Notebooks	3	300	300
	Pens	8	200	200
	Flash disc	1	500	500
Other costs	Research assistants	2	Within the study period as necessary	20000
	Audio-recorder	1	Before data collection	8000
	Transport allowance	1	Two weeks	5000
	Meal allowance	1	Two weeks	1000
	Conference and Publication cost	-	-	40000
	KNH UON ERC Fee			2000
Subtotal				160700
Contingency cost		10%		16070
Total				176770

Appendix III; Informed consent for participants

Title of the study to Evaluate Critical Care Nurses' Compliance to the External Ventricular Drain Care Bundle for Critically Ill Patients at Kenyatta National Hospital

Principal investigator: Leah Nambiro Nanyanga,

Introduction

I am Leah Nanyanga currently a student at the School of Nursing, University of Nairobi, pursuing a Master of Science degree in Nursing(Critical Care). As part of my academic program, I am conducting a research study titled "Evaluate Critical Care Nurses' Compliance to the External Ventricular Drain Care Bundle for Critically Ill Patients at Kenyatta National Hospital."

Purpose of the Study

The primary aim of this study is to investigate and analyze the determinants affecting the compliance to Extraventricular Drain (EVD) care bundle among CCN's at KNH. This research project aims to fill a gap in existing knowledge, as no similar study has been conducted in the local context.

By examining the factors that affect the utilization of the EVD care bundle, this study seeks to contribute valuable insights to the field of critical care nursing. The findings will provide evidence-based recommendations and interventions that can enhance the implementation and effectiveness of EVD care bundle practices.

Risks

Participation in this study does not involve any financial or physical risks. However, it may require a few minutes of your time from your busy schedule to complete the questionnaire.

Benefits of the Study

The study participation will involve no monetary compensation. Its outcomes will bring significant benefits to patient care and nurse performance specifically related to the management of external ventricular drains. The findings derived from this research project hold the potential of enhancing the quality of care provided to patients with external ventricular drains and elevating the competencies of nurses in this specific domain. Through your participation in the study there will be advancement of nursing practices and patient outcomes in critical care settings.

Confidentiality

All information that will share by answering the questionnaire will be kept in confidence. All filled questionnaire will be kept locked in cabinet with the principal researcher only having access.

Voluntary Participation

Participating in this study is entirely voluntary, and you retain the freedom to withdraw from the study at any time without incurring any repercussions or penalties. Your choice to participate or withdraw will not have any impact on your current or future affiliation with the University of Nairobi or Kenyatta National Hospital. We will ensure the utmost privacy and confidentiality throughout the study, and your personal information will be treated with the highest level of confidentiality.

Questionnaire procedure

You must read and comprehend the instructions before you can answer the questionnaire because it is self-administered.

Sharing of results

Results of this research will be shared in research forums and will be possibly published in health journals

Contact person

If you have any queries or require further information regarding this research, please do not hesitate to contact the researchers and supervisors whose details are provided below.

1. Investigator

Name: Leah Nambiro Nanyanga

Phone No: 0705195496

Email: leah_nn@students.uonbi.ac.ke

Department of Nursing Sciences.

University of Nairobi.

2. Supervisors

Name: Ms. Hannah K. Inyama

Phone No: 0723065246

Email: hinyama@uonbi.ac.ke

Physical address: Department of Nursing Sciences
Faculty of Health Sciences, University of Nairobi.
Kenya National Hospital Campus.

Name: Dr. Emmah K. Matheka

Phone No: 0710105771

Email: ekanini@uonbi.ac.ke

Physical address: Department of Nursing Sciences
Faculty of Health Sciences, University of Nairobi
Kenya National Hospital Campus.

3. Ethics Committee

KNH-UON Ethics and research committee

P.O. Box 20723-00202, Nairobi.

Email: uonknh_erc@uonbi.ac.ke

Appendix IV: Consent form

Participant's statement

I have reviewed and comprehended the contents of this consent form. I have also had the opportunity to address any concerns or questions with the researcher and have received satisfactory responses. I have been sufficiently informed about the potential advantages and risks related to my participation in this study. I acknowledge that my involvement is entirely voluntary, and I retain the right to withdraw from the study at any time without facing adverse repercussions.

I understand that signing this consent form in no way diminishes my legal rights as a study participant.

Participant's Signature: _____ Date: _____

Researcher's statement:

I, mentioned below, hereby confirm that the participant mentioned above has fully understood the study and willingly consented to partake. I have provided a detailed elucidation of all relevant information regarding the study to the participant.

Researchers name.....

Signature.....

Date

Appendix V: Research questionnaire

Title: To Evaluate Critical Care Nurses' Compliance to the External Ventricular Drain Care Bundle for Critically Ill Patients at KNH

Directions: I kindly request your participation in providing demographic information about yourself. This information will aid me in characterizing the profiles of nurses involved in this study. Kindly respond to each question.

SECTION A: SOCIAL AND DEMOGRAPHIC DATA

- a. Age in years.....**
- b. Gender**
 1. Male
 2. Female
- c. Educational level**
 1. diploma
 2. higher diploma
 3. Graduate
 4. Post-graduate.
- d. Years of experience**
 1. 1 to 5 years
 2. 6 to 10 years
 3. 11 to 15 years
 4. > 15 years
- e. Have you done a specialized course on EVD management?**
 1. Yes
 2. No
- f. Approximate number of patients with EVD attended to**
 1. <100
 2. 100 to 500
 3. 500 to 1000
 4. >1000
 - 5.

2. SECTION B: Knowledge of EVD care bundle checklist

Indicate whether the following statements are true or false. Tick the correct answer in space provided.

No	Question Statement	True	False
9.	Proper hand hygiene is essential when handling EVD-related tasks		
10.	Sterile gloves should be worn during routine EVD dressing changes		
11.	It is necessary to use an aseptic technique when performing EVD-related procedures		
12.	Documentation of EVD care procedures vital for patient safety		
13.	CSF (Cerebrospinal Fluid) samples be obtained aseptically from the EVD system		
14.	Positioning the patient's head appropriately crucial for EVD care		
15.	The EVD drainage bag should be kept below the level of the patient's head		
16.	What are the potential complications associated with improper EVD care?		
	a) Infection		
	b) Fluid and electrolyte imbalance		
	c) Blocked drain		
	d) Excess drainage		
	e) CSF leakage		
9	When should you clamp the EVD		
	a) Before the patient sits up		

	b) While transporting the patient		
	c) When changing the patient's position		
	d) During procedures		
10	In caring for a patient with EVD, which of the following is not a nursing responsibility		
	a) Replacing a ventricular drain		
	b) Ensure proper alignment of the transducer		
	c) Monitoring ICP readings		
	d) Monitoring drainage		

SECTION C: PERCEPTION OF CHALLENGES TOWARDS UTILIZATION OF EVD CARE BUNDLE DURING MANAGEMENT OF PATIENTS WITH EVD.

Please express your level of agreement or disagreement with the following statements concerning critical care nurses, using the provided five-point Likert scale.

1. Strongly disagree (**SD**)
2. Disagree (**D**)
3. Undecided (**U**)
4. Agree (**A**)
5. Strongly Agree (**SA**)

No	Nurse Perception	SD	D	U	A	SA
1.	Implementing EVD care bundle is time consuming					
2.	Adequate resources are available for EVD care					
3.	There is clear communication regarding EVD care bundle					

	protocols					
4.	There is a lack of awareness about the importance of EVD care bundle					
5.	Staffing levels are sufficient to provide thorough EVD care					
6.	There is lack of proper training on EVD care bundle implementation					
7.	Adhering of EVD care bundle is integrated well into our daily routine					
8.	There is high level of teamwork and collaboration when implementing the EVD care bundle					
9.	There is need for more support from management to prioritize EVD care bundle adherence.					
10.	EVD care bundle guidelines are easily accessible and understandable					
11.	Workload demands make it difficult to consistently follow the EVD care bundle					
12.	There is adequate supervision and feedback on EVD care bundle practices.					
13.	The EVD care bundle's effectiveness in improving patients outcome is evident					
14.	There is lack of standardized documentation for EVD care bundles procedures.					
15.	Nurses are motivated to adhere to the EVD care bundle due to its benefits.					
16.	There is need for ongoing education and training about the EVD care bundle.					

17.	conflicts between different care protocols hinder EVD care bundle					
18.	The physical layout of the CCU supports EVD care bundle implementation					

Appendix VI: Observation Checklist

Observation checklist on the Management of Patient with EVD

Please mark the corresponding box to indicate whether the following activities were completed, not completed, or deemed unnecessary. If you have any comments on the performance, please feel free to share.

	Check list	Done	Not Done	Not Necessary	Comment(s)
B	<u>EVD Management</u>				
	1. Hand hygiene and PPE				
	i. Did the nurse perform hand hygiene before interacting with the EVD system				
	ii. Did the nurse wear appropriate PPE, including gloves and mask when handling the EVD system?				
	2. Patient position procedure				
	i. Head board angle between 15 and 30				
	ii. Keeping the head in neutral position aligned to cervical spine				
	3. Change of patient dressing procedure				
	i. Did the nurse assess the EVD catheter dressing for cleanliness, integrity and proper adhesions?				
	ii. Did the nurse change the dressing aseptically if it was soiled, loose or as per hospital policy				
	4. Tubing care procedure				
	i. Aseptic technique while handling tubing, handling kept to a minimum				
	ii. Drainage bag emptied when reaches $\frac{3}{4}$ of its volume capacity				
	iii. Check for signs of catheter obstruction				

	5. Documentation procedure				
	i. Did the nurse accurately document EVD care observations and interventions in the patient's medical records?				
	ii. Did the nurse document CSF output and other relevant measurements at appropriate intervals (CSF appearance, drain level, patient position and state, drain status)?				
	iii. CSF appearance (clear, cloudy)				
	iv. Drain leveled (e.g. tragus/mid sagittal line)				

Appendix VII: Interview guides

Introduction to nurse's interviews

I'm a graduate student pursuing an MscN with a concentration on Critical Care Nursing. I'm here to see how your department's employees, particularly the nurses, manage EVD cases. As a result, I would like to speak with you for about 30 minutes and learn about your management of EVD experiences. Keep in mind that taking part in the interview is entirely optional. You are free to let me know at any time if you do not wish to participate in the interview or your contribution. After the interview, feel free to ask me any questions you may have.

Thank you

Leah Nambiro Nanyanga (Principal investigator)

NURSES

Introduction

Would you mind sharing your experiences dealing with EVD patients that were hospitalized to this unit?

Probing questions:

1. What resources or references do you typically rely on when it comes to understanding and implementing the EVD care bundle?
2. What are the key protocols, guidelines, or care bundles you use when managing external ventricular drains in critically ill patients?
3. How do you access information about the latest advancements in external ventricular drain management and care?
4. What challenges do you encounter in accessing necessary resources for effective external ventricular drain management, and how do you overcome these challenges?
5. How do you adapt external ventricular drain management strategies to address variations in patient acuity, available resources, and institutional policies?
6. In your view, are the resources and training for EVD management at your current institution adequate? If not, what improvements would you suggest?

Appendix IX: Letter of Approval ethics committee



UNIVERSITY OF NAIROBI
FACULTY OF HEALTH SCIENCES
P O BOX 19676 Code 00202
TELEGRAMS: varsity
Tel:(254-020) 2726300 Ext 44355



KENYATTA NATIONAL HOSPITAL
P O BOX 20723 Code 00202
Tel: 726300-9
Fax: 725272
Telegrams: MEDSUP, Nairobi

KNH-UoN ERC

Email: uonknh_erc@uonbi.ac.ke
Website: <http://www.erc.uonbi.ac.ke>
Facebook: https://www.facebook.com/uonknh_erc
Twitter: [@UONKNH_ERC](https://twitter.com/UONKNH_ERC) https://twitter.com/UONKNH_ERC

Ref: KNH-ERC/A/466

6th September, 2023

Leah Nambiro Nanyanga
Reg. No. H56/40811/2021
Dept. of Nursing Sciences
Faculty of Health Sciences
University of Nairobi

Dear Leah,



ETHICAL APPROVAL-RESEARCH PROPOSAL: EVALUATE CRITICAL CARE NURSES' COMPLIANCE TO THE EXTERNAL VENTRICULAR DRAIN CARE BUNDLE FOR CRITICALLY ILL PATIENTS AT KENYATTA NATIONAL HOSPITAL (P493/05/2023)

This is to inform you that KNH-UoN ERC has reviewed and approved your above research proposal. Your application approval number is **P493/05/2023**. The approval period is 6th September 2023 –5th September 2024.

This approval is subject to compliance with the following requirements:

- i. Only approved documents including (informed consents, study instruments, MTA) will be used.
- ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by KNH-UoN ERC.
- iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to KNH-UoN ERC 72 hours of notification.
- iv. Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to KNH-UoN ERC within 72 hours.
- v. Clearance for export of biological specimens must be obtained from relevant institutions.
- vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.
- vii. Submission of an executive summary report within 90 days upon completion of the study to KNH-UoN ERC.

Protect to discover

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) <https://research-portal.nacosti.go.ke> and also obtain other clearances needed.

Yours sincerely,



PROF. BEATRICE K.M. AMUGUNE
SECRETARY, KNH-UoN ERC

c.c. The Dean, Faculty of Health Sciences, UoN
 The Senior Director, CS, KNH
 The Chairperson, KNH- UoN ERC
 The Assistant Director, Health Information Dept., KNH
 The Chair, Dept. of Nursing Sciences, UoN
 Supervisors: Ms. Hannah K. Inyama, Dept. of Nursing Sciences, UoN
 Dr. Emmah K. Matheka, Dept. of Nursing Sciences, UoN

Protect to discover

Appendix X: Approval Letter from KNH

KNH/R&P/FORM/01



KENYATTA NATIONAL HOSPITAL
P.O. Box 20723-00202 Nairobi

Tel.: 2726300/2726450/2726565
Research & Programs: Ext. 44705
Fax: 2725272
Email: knhresearch@gmail.com

Study Registration Certificate

1. Name of the Principal Investigator/Researcher
LEAH NAMBIRO NANYANGA

2. Email address: leah.nanyanga@gmail.com Tel No. 0705195496

3. Contact person (if different from PI): N/A

4. Email address: N/A Tel No. N/A

5. Study Title
Evaluate critical care nurses compliance to External Ventricular Drain care Bundle for critically ill patients at Kenyatta National Hospital.

6. Department where the study will be conducted Anesthesia
(Please attach copy of Abstract)

7. Endorsed by Research Coordinator of Department where study will be conducted.

Name: _____ Signature _____ Date _____

8. Endorsed by KNH Head of Department where study will be conducted. 2023

Name: Dr. Kennedy Mwangi Signature _____ Date 07/09/2023

9. KNH UoN Ethics Research Committee approved study number P493/05/2023
(Please attach copy of ERC approval)

10. I LEAH NAMBIRO NANYANGA commit to submit a report of my study findings to the Department where the study will be conducted and to the Department of Medical Research.

Signature _____ Date 07/09/2023

11. Study Registration number (Dept/Number/Year) Anesthesia 1186/2023
(To be completed by Medical Research Department)

12. Research and Program Stamp

All studies conducted at Kenyatta National Hospital must be registered with the Department of Medical Research and investigators must commit to share results with the hospital.



KENYATTA NATIONAL HOSPITAL
P.O. Box 20723-00202 Nairobi

Tel.: 2726300/2726450/2726565
Research & Programs: Ext. 44705
Fax: 2725272
Email: knhresearch@gmail.com

Study Registration Certificate

1. Name of the Principal Investigator/Researcher
LEAH NAMBIRO NANYANGA
2. Email address: leahnanyanga@gmail.com Tel No. 0705191496
3. Contact person (if different from PI) N/A N/A
4. Email address: _____ Tel No. _____
5. Study Title
Evaluate central care nurses' compliance to the external Venhuda-
drain care bundle for critically ill patients at Kenyatta
National hospital
6. Department where the study will be conducted NEURO ICU
(Please attach copy of Abstract)
7. Endorsed by Research Coordinator of Department where study will be conducted.
Name: Lesson Joel Signature: [Signature] Date 11.9.23
8. Endorsed by KNH Head of Department where study will be conducted.
Name: Lesson Joel Signature: [Signature] Date 11.9.23
9. KNH UoN Ethics Research Committee approved study number P493/05/2023
(Please attach copy of ERC approval)
10. I LEAH NAMBIRO NANYANGA commit to submit a report of my
study findings to the Department where the study will be conducted and to the Department of
Medical Research.
Signature: [Signature] Date 08/09/2023
11. Study Registration number (Dept/Number/Year) CCU 137
(To be completed by Medical Research Department) 137 2023
12. Research and Program Stamp _____



All studies conducted at Kenyatta National Hospital **must** be registered with the Department of Medical Research and Investigators **must commit** to share results with the hospital.

test

ORIGINALITY REPORT

14% SIMILARITY INDEX **12%** INTERNET SOURCES **6%** PUBLICATIONS **7%** STUDENT PAPERS

PRIMARY SOURCES

- | | | |
|---|---|----|
| 1 | erepository.uonbi.ac.ke
Internet Source | 2% |
| 2 | erepository.uonbi.ac.ke:8080
Internet Source | 1% |
| 3 | Submitted to University of Nairobi
Student Paper | 1% |
| 4 | www.researchgate.net
Internet Source | 1% |
| 5 | pjmhsonline.com
Internet Source | 1% |
| 6 | Ahmed N. A., Al-Rafay S. S., Hassan S. E., AbdEL-hamid A. E.. "Assessment of Nurses Performance Regarding External Ventricular Drain among Children with Brain Tumor", Egyptian Journal of Health Care, 2021
Publication | 1% |
| 7 | bmcneurol.biomedcentral.com
Internet Source | 1% |
| 8 | www.coursehero.com
Internet Source | |



[Handwritten signature]

09/11/2023

[Handwritten signature]

10/11/2023