ASSESSMENT OF MECHANICAL VENTILATION PRACTICES AND ITS ASSOCIATED FACTORS AMONG INTENSIVE CARE NURSES AT MUHIMBILI TERTIARY TEACHING HOSPITALS.

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Dissertation submission in (Partial) fulfillment of the requirement for the degree of Master of Medicine in Anaesthesiology at

Muhimbili University of Health and Allied Sciences.

October, 2024

CERTIFICATION

The undersigned certifies that he has read and hereby recommends for examination by Muhimbili University of Health and Allied Sciences a dissertation entitled "**ASSESSMENT OF MECHANICAL VENTILATION PRACTICES AND ITS ASSOCIATED FACTORS AMONG INTENSIVE CARE NURSES AT MUHIMBILI TERTIARY TEACHING HOSPITALS**" in (partial) fulfillment of the requirement for the degree of masterof medicine (Anesthesiology) of the Muhimbili University of Health and Allied Sciences.

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Date…….

DECLARATION AND COPYRIGHT

I, Benedicto O. Mwampashi, declare that this dissertation is my original work and that it has not been presented to any other academic institution for a similar or any other degree award and is not previously or currently under copyright.

Signature …… Date ……

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DEDICATION

As always and with great love and affection to my beautiful wife, Dr. Ester whose tireless and endless sacrifice, encouragement and support fostered my academic excellence.
I also dedicate this work to all nurses working in critical care units all over the country.

ABSTRACT

Background: Although mechanical ventilation is a lifesaving intervention, if not properly done it can adversely affect patients leading to significant morbidity and mortality. Nurses caring for critically ill patients must demonstrate good knowledge and practice on mechanical ventilation to prevent ventilator related complications.

Aim of the study: To assess mechanical ventilation practices and its associated factors among intensive care nurses at Muhimbili Tertiary Teaching Hospitals.

Methodology: This was a hospital based cross-sectional study conducted at Muhimbili National Hospital and Muhimbili Orthopedic Institute- Intensive Care Units. The study included 81 nurses who were directly involved in care of mechanically ventilated patients, obtained through consecutive sampling technique. Adapted Questionnaire and Observational Checklist were used to capture the data. A score of ≥ 75% on the scored items was regarded as adequate practices from observational checklist and good knowledge from self-administered questionnaire. Data were processed and analyzed using Statistical Package for Social Sciences (SPSS) version 26. Proportions were used to summarize descriptive statistics and the Chi-square test ($p<0.05$) was used to establish statistical significance.

Results: Only 21% of nurses demonstrated good mechanical ventilation practices and four nurses (4.9%) had good knowledge. There was a statistically significant association between mechanical ventilation practices and continuing medical education (CME), good knowledge, increasing level of education, and utilization of mechanical ventilation management guidelines ($p <0.01$).

Conclusion and recommendations: The overall mechanical ventilation practices of intensive care nurses is unsatisfactory and there is a significant knowledge gap. Therefore, offering opportunities for post-graduate training in critical care nursing, emphasizing nurses' participation in CME programs and ensuring the availability and utilization of operational guidelines are crucial in improving the quality of mechanical ventilation practice.

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LIST OF ABBREVIATIONS

A/C	Assist Control
ARDS	Acute Respiratory Distress Syndrome
CME	Continuing Medical Education
COPD	Chronic Obstructive Pulmonary Diseases
CPAP	Continuous Positive Airway Pressure
ETT	Endotracheal Tube
FRC	Functional residual capacity
IE ratio	Inspiratory Expiratory ratio
ICU	Intensive Care Unit
MOI	Muhimbili Orthopedic Institute
MUHAS	Muhimbili University of Health and Allied Sciences
MNH	Muhimbili National Hospital
MV	Mechanical ventilation
PEEP	Positive End Expiratory Pressure
RR	Respiration rate
PS	Pressure support
SIMV	Synchronized Intermittent Mandatory Ventilation
Vt	Tidal volume
Ve	Minute Ventilation
WHO	World Health Organization

DEFINITION OF TERMS

MECHANICAL VENTILATION: Is a method used to artificially support the work of breathing (respiratory function) through invasive or noninvasive techniques by using a mechanical ventilator which can either replace or assist normal spontaneous breathing. Mechanical ventilation can be initiated for various indications like correcting hypoxia, hypercapnia, physiological stress, or respiratory failure. In intensive care units' mechanical ventilation (MV) can be over a prolongedtime whereas in operating theatres it can be initiated for a brief period (1).

MECHANICAL VENTILATOR: is a machine used for mechanical ventilation that will allow gaseous exchange to be maintained while other treatments are ongoing to improve the patient's clinicalcondition (2).

INTENSIVE CARE UNIT (ICU): Also known as a critical care unit is an organized system for theprovision of care to critically ill patients that provides intensive and specialized medical and nursing care, an enhanced capacity for monitoring, and multiple modalities of physiologic organ support to sustain life during a period of acute organ system insufficiency. Despite being a physicallocale in a health facility, care provided in this unit is more intense than that provided elsewhere by intense and more immediate interaction between members of the team and critically ill patient (3).

INTENSIVE CARE NURSE: WHO defines an ICU nurse as one who has completed specialist post-qualification education in critical care which builds upon prior general nursing education to help the nurse meet the complex needs of a critically ill patient (4) but, in this study intensive care nurses will be defined as nurses working in ICU and directly involved in the care of critically ill patients.

MECHANICAL VENTILATION PRACTICES: Involves proper setting of ventilator parameters before initiation of mechanical ventilation, adjusting the settings based on variable patients' needs and making critical and complex clinical decisions in adjusting settings based on patient physiologic changes and needs and troubleshooting alarms to suit individualized patient to prevent harm to them (5).

TIDAL VOLUME: The volume of air inspired in each breath. In the volume control mode of ventilation, the clinician sets the tidal volume and it remains constant commonly ranging from 6-8mls/Kg (6).

SENIOR NURSING STAFF: The person in charge of all nurses in a hospital(7). This study will be referring to nurses with postgraduate training in critical care responsible for supervising nurses and ensuring the quality of patient care

MECHANICAL VENTILATION MANAGEMENT: refers to the clinical practice of adjusting mechanical ventilator to support patients and it involves balancing oxygen and carbon dioxide levels, monitoring patient responses**,** and ensuring comfort while minimizing potential complications(8)**.**

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Mechanical ventilator support is one of the main indications for admission to the intensive care unit (ICU) (9).

Mechanical ventilation (MV) supports the respiratory function of critically ill patients and up to 90% of patients admitted to the intensive care unit (ICU) will require mechanical ventilation at some point during their stay in the ICU (10).

Although mechanical ventilation is a lifesaving intervention, it carries many risks like injury to the lungs, brain, and other organ systems (11). Also, it can alter the psychological and physiological aspects of the patients (12). If not properly done, mechanical ventilation can result in ventilator-associated pneumonia, ventilator-induced lung injury (VILI), long-term dependence on mechanical ventilation, and even death (13). Other complications include; oxygen toxicity, atelectasis, sepsis, and metabolic derangements which contribute to significant morbidity and mortality in patients undergoing mechanical ventilation (14,15). Most of these ventilator-related complications can be prevented with good practices in mechanical ventilation.

Intensive care nurses play a crucial role in improving the effectiveness of mechanical ventilation, preventing harm, and optimizing patient outcomes since their skills and knowledge enable them to fine-tune ventilator settings to maximize the benefits of ventilatory support while minimizing complications (16). In most circumstances, bedside nurses are expected to recognize issues arising during mechanical ventilation at first and adjust ventilator settings according to the individual patient's need or ask for senior help.

Generally, the mortality rate of critically ill patients is high accounting for more than 47% that was obtained in a study done in Rwanda where more than 85% of studied patients were mechanically ventilated (17) which could be due to the severity of patients' illness and or ventilator-related complications partly contributed by poor practice.

Therefore, the care of patients who need mechanical ventilation in the intensive care unit requires inter-professional teamwork and an acceptable level of competence among healthcare workers in intensive care units to ensure patient safety and minimize complications (18).

Tailoring the ventilator settings to suit individualized patient's needs while minimizing complications and harm to patients, requires good knowledge and practice (19). It is important for all healthcare workers in the ICU who are involved in the direct care of critically ill patients to have adequate knowledge and acceptable mechanical ventilation practice.

Mechanical ventilation poses a unique challenge to nurses as patients have different lung pathologies and ventilation needs (20). Studies have shown that the overall knowledge and practice of nurses regarding mechanical ventilation management is poor (9). However, nurses who care for mechanically ventilated patients must demonstrate good knowledge and practice to be able to recognize adverse events and carry out necessary interventions to prevent patient harm (18).

Upgrading education levels among intensive care nurses have shown to improve knowledge and practice regarding mechanical ventilation (9,18). Despite other factors, nurses are expected to have more improvement in their knowledge and practices after undergoing formal training in critical care(21–23) which incorporates care of mechanically ventilated patients and understanding of the ventilator machine physics(24). To further cement their skills and knowledge, on-job training have been reported to positively impact their performance in all aspects of patient care (25).

Ongoing support is needed for health workers in the frontline of service delivery to perform to their full potential and deliver quality patient care that meets the advancement in technology and updates in patient care (26,27).

Several other factors have been shown to improve mechanical ventilation practice and nursing practice in general if done correctly and hence patient safety. Those factors include; proper utilization of updated operational guidelines (28), the role of a nurse in the ICU (job position), and knowledge level regarding mechanical ventilation (9,18).

In Tanzania, significant steps have been made by the Government to ensure the availability of standard critical care units with facilities to offer mechanical ventilation to critically ill patients from district hospitals to Tertiary hospitals. Although the critical care specialty is growing in Tanzania, there is a limited number of critical care physicians, respiratory therapists, and critical care specialist nurses to meet the increasing demand(29).

Therefore, understanding the practices of nurses towards mechanical ventilation may be one step in improving the care of mechanically ventilated patients.

1.2 Problem Statement

Mechanical ventilation being sophisticated technology requires good knowledge and practice to ensure good outcomes and limit harm to the patients as it is associated with potentially adverse effects if not handled properly (14,30).

Although intensive care nurses are front liners in the care of mechanically ventilated patients, the majority of them in developing countries have demonstrated poor practice (low level of competence) regarding mechanical ventilation management. In Ethiopia, only 24% of intensive care nurses had good practice (18) whereas in Rwanda only 1.6% of the nurses had an acceptable mechanical ventilation competence level (31). A study in South Africa found all studied intensive care nurses despite their age, experience, and qualification had low levels of mechanical ventilation knowledge and practice (12). In addition, a study done in Turkey showed that the practice of intensive care nurses towards mechanical ventilation is still challenging (20). In Yemen, only 15% of intensive care nurses demonstrated good mechanical ventilation practice (10).

There is a limited number of critical care specialist nurses and an extensive literature search found limited studies either locally or internationally regarding mechanical ventilation practices among intensive care nurses in Tanzania. Therefore, currently in our intensive care units, mechanically ventilated patients are most likely to be cared for by an intensive care nurse with general nursing education which does not adequately prepare them for practice in a critical care setting.

1.3 Rationale

The level of practice of nurses who care for mechanically ventilated patients in Tanzania is currently unknown and may vary due to the varying training backgrounds and years of experience of the nurses in the ICUs in the country.

As such it was important to quantify the level of practice of nurses caring for mechanically ventilated patients regarding mechanical ventilation in the ICU. Poor practice may have severe implications for the mechanically ventilated patients, which at best may lead to increased length of stay in the ICU, and at worst lead to increased mortality and morbidity of the patient. Further, quantifying the level of practice and associated factors among nurses in the ICU regarding mechanical ventilation will facilitate appropriate interventions about education programs, and clinical teaching programs in the ICU. Furthermore, findings from this study will serve as a starting point for future researchers in exploring more information as far as mechanical ventilation is concerned.

It is also a requirement for partial fulfillment of a Master of Medicine in Anesthesiology.

1.4 Research Questions

i. What is the level of practices of intensive care nurses on mechanical ventilation at Muhimbili Orthopedic Institute and Muhimbili National Hospital?
ii. What are the factors associated with intensive care nurses' mechanical ventilation practices at Muhimbili Orthopedic Institute and Muhimbili National Hospital?

1.5 Objectives

1.5.1 **Broad Objective**

To assess mechanical ventilation practices and its associated factors among intensive care nurses at Muhimbili Tertiary Teaching Hospitals.

1.5.2 **Specific Objectives**

i. To assess mechanical ventilation practices among intensive care nurses at Muhimbili Orthopedic Institute and Muhimbili National Hospital ICUs from August to December, 2023.
ii. To determine factors associated with mechanical ventilation practices among intensive care nurses at Muhimbili Orthopedic Institute and Muhimbili National Hospital ICUs from August to December, 2023.

1.6 Conceptual Framework

Practices of intensive care nurses towards mechanical ventilation can be determined or affected bya number of factors which as per this study will be broadly grouped into two categories which areindividual and institutional factors. The interplay of these two factors definitely determines the practice of intensive care nurses' practice towards mechanical ventilation.

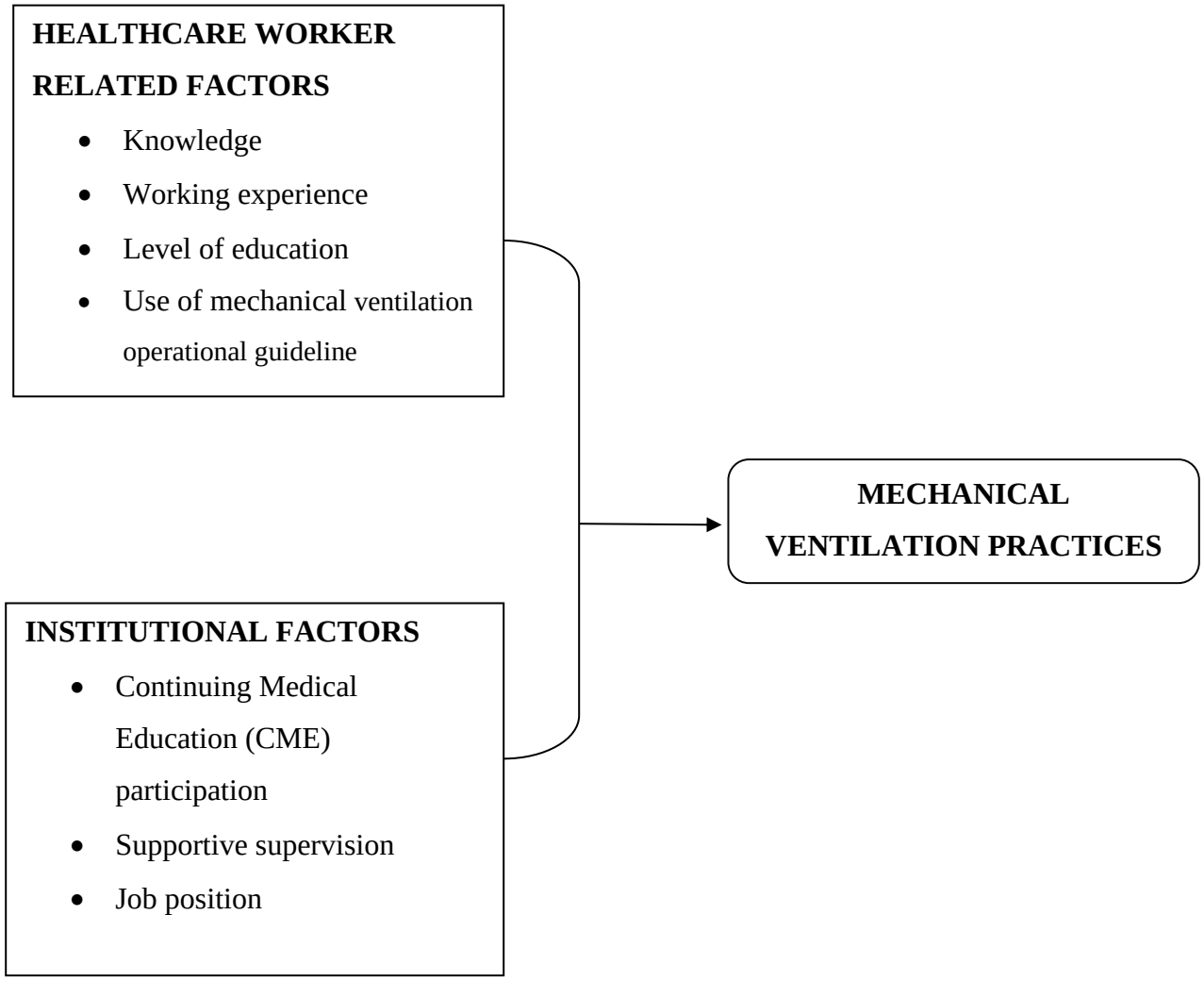


Figure 1: conceptual framework

Source: Conceptualized by author

CHAPTER TWO

2 .0 LITERATURE REVIEW

2.1 Study Overview and Research Gap Identification

One of the most important roles of nursing staff in the ICU is early diagnosis and prevention of complicationsrelated to mechanical ventilation (32). Even in developed countries where nursing education is advanced, mechanical ventilation practice among intensive care nurses remains a challenge (18,20,33). Poor mechanical ventilation practices are still reported not just among non-ICU certified nurses but also among qualified ICU nurses, according to a South African research (12).

Poor management of mechanical ventilation is associated with many complications such as ventilator-associated pneumonia and long-term MV dependence (18,31,34). To achieve adequate mechanical ventilation there must be skilled personnel especially critical care nurses who can demonstrate good practice and good knowledge of mechanical ventilation (12,19,35,36). The critical care nursing specialty is still growing in Tanzania and most ICU nurses aregeneral nurses who do not have formal training in critical care. This poses a challenge in providing critical care nursing services to patients especially those under mechanical ventilationat an acceptable standard. As per the researcher's knowledge and extensive literature search through different search engines, there is no published study in Tanzanian hospitals highlighting the practiceof ICU nurses on mechanical ventilation and the associated factors.

2.2 Mechanical Ventilation Practices

A hospital-based cross-sectional study was done in Ethiopian public hospitals by Abdulkadir et al among adult intensive care nurses aiming to assess knowledge, practice, and associated factors towards mechanical ventilation among ICU nurses. The study made use of an adopted standard checklist for mechanical ventilation practice and revealed that only 24% of the nurses demonstrated good mechanical ventilation practice (18).

In 2019, Mahoro conducted a descriptive cross-sectional study in ICUs of Rwanda University

teaching hospitals to assess the level of competence (practice) on mechanical ventilation among 62 ICU nurses. Among 62 nurses assessed, 93.5% did not have post-graduate specialist training on critical care and 38.7% had received on-job training. The study adopted a standard questionnaireand observational checklist for assessing practice and its associated factors with an acceptable level of competence or good practice indicator of 75% performance. In this study, only 1.6% of intensivecare nurses studied were judged as having good practice which was likely to affect negatively patients under mechanical ventilation (31).

A cross-sectional study was done by Botha in two tertiary hospitals in South Africa aiming to assess the level of nurses' competence on mechanical ventilation management. The study enrolled 136 ICU nurses from two tertiary hospitals and found that all nurses regardless of their age, work experience, qualification, and education level had poor knowledge and practice regarding mechanical ventilation as they scored below the competence indicator of 75% (12).

A descriptive cross-sectional study conducted in public hospitals ICUs in Yemen evaluated the knowledge and practice of intensive care nurses towards weaning criteria from mechanical ventilation by using questionnaires and an observational checklist. Concerning mechanical ventilation, the adopted observational checklist showed that, only 15% of intensive care nurses demonstrated good practice in mechanical ventilation (10).

Furthermore, a descriptive study carried out in Egypt involving nurses working as bedside nurses in four intensive care units of university hospitals reported practice among pediatrics and adult ventilated patients with COVID-19. The study used a purposive sampling technique and it involved all nurses with bachelor's degrees in nursing and having at least one year experience of working as bedside nurses and taking care of mechanically ventilated patients with or without COVID-19. The nurses' reported practice was assessed using a structured checklist and it was found that more than 50% of nurses had poor MV practice (37).

2.3 Factors Associated with Mechanical Ventilation Practice.

2.3.1 **Knowledge of mechanical ventilation.**

Mechanical ventilation management requires a very good knowledge of the complex dynamic interaction between variable ventilator parameters. The knowledge mustbe incorporated with

correct clinical decisions to prevent ventilator-related complication (38). Studies done in India, Egypt, and America have shown that poor knowledge does not support the safe and efficient practice of mechanical ventilation (19,32,39).

A cross-sectional study done in Ethiopia revealed overall poor mechanical ventilation knowledgeamong adult ICU nurses accounting for 54% of nurses with poor knowledge (18) which was associated with poor practice towards mechanical ventilation identified in the same study. Knowledge was assessed using a standard self-administered questionnaire with a score of 75% or above being regarded as good knowledge.

A descriptive cross-sectional study done in Turkey among intensive care nurses of a university teaching hospital assessed the knowledge, attitude, and practice of intensive care nurses on mechanical ventilation. The authors reported that majority of the nurses had limited knowledge of mechanicalventilation practice (20) which contributed to incomplete practice towards MV at the expense of patient safety.

A quasi-experimental study performed in a university hospital (Trauma ICU) in Egypt also assessed the effectof an education program on nurses' knowledge and practice caring for patients on mechanical ventilation. It was discovered that, there was a positive association between knowledge and practice of mechanical ventilation. However, before the intervention, 44% of ICU nurses had poor knowledge of mechanical ventilation (19).

A study done by Khalaf in Mansoura Emergency Hospital ICU in Egypt demonstrated that 67% of ICU nurses had poor knowledge of mechanical ventilation (mean score 43.8% +/- 7.9) which negatively affected the practice of MV (40).

A positive correlation between knowledge and practice of mechanical ventilation has also been demonstrated in a cross-sectional study done in Yemen (10).

A pre-experimental study using educational intervention was conducted in Pakistan at accredited private tertiary care hospital among 30 nurses caring for mechanically ventilated patients for at least six months. The authors found that improving the level of nurses' knowledge regarding mechanical ventilation improves their quality of MV practices (24).

Also, a study in Baghdad recommended investing in knowledge among intensive care nurses to improve their quality of practice toward mechanical ventilation (41).

Another study done in Egypt among intensive care nurses where more than 50% of the nurses had unsatisfactory knowledge and practice regarding safe weaning from mechanical ventilators, recommended improving knowledge of the nurses that would in turn improve their quality of practice and patient care (16).

2.3.2 **Working experience**

A cross-sectional descriptive hospital-based study done in Rwanda to ascertain the level of competence of intensive care nurses and associated factors concluded that there was no significantassociation between working experience and practice of intensive care nurses on MV(31).

Another descriptive study done among 50 intensive care nurses of both paediatrics and adult ICUs in Egypt assessed the nurses' performance regarding safe weaning from mechanical ventilators and revealed an unsatisfactory level of knowledge (56%) and practice (58%). Working experience was significantly associated with knowledge which affected the level of practice towards MV (p-value= 0.001) (16).

An interventional study in Saudi Arabia to evaluate critical care providers' knowledge ofbasic mechanical ventilation management showed a significant association between working experience and mechanical ventilation management (p= 0.03) (38). Experienced critical care providers demonstrated adequate mechanical ventilation management both in pre and post-test evaluation.

In addition, a descriptive study from the University of Baghdad found a significant (p=0.03) association betweenworking experience and knowledge hence practice toward MV (41).

2.3.3 **Continuing Medical Education (CME)**

Staff training to update knowledge and practice is scientifically proven to improve the quality of practice and patient safety. A prospective cohort study in Germany concluded that continuing update of skills of the nurses resulted in good MV management practice (35). A Saudi Arabian

study suggested that critical care providers should undergo periodical, intensive MV management-related courses which would improve the knowledge, practice, and patient safety under mechanical ventilation (38).

A hospital-based cross-section study by Abdulkadir and colleagues done in Ethiopia evaluating knowledge, practice, and associated factors among intensive care nurses towards mechanical ventilation foundthat on-job training increased the odds of good knowledge and practice among participants(p= 0.002 and AOR- 2.29 CI 95%) (18).

Also, a prospective cohort study was conducted in Germany assessing the effect of staff training on the care of mechanically ventilated patients using pre-defined ventilator care bundles. The authors found significant improvement in the care of mechanically ventilated patients after staff training which led to reduction in number of days spent on mechanical ventilation(35).

However, a cross-sectional study in Rwanda evaluating the level of competence on MV among intensive care nurses by Mahoro did not find any significant association between training,number of training, and level of competence(practice) toward mechanical ventilation (31).

2.3.4 Level of education

In Baghdad, there was a significant association between the level of education and mechanicalventilation management (p=0.04). This was established in a cross-sectional study assessing the level of nurses' knowledge of essential care of mechanically ventilated patients and its associationwith their demographic characteristics (41).

Level of education was substantially related to knowledge and practice towards mechanical ventilation ($p < 0.05$) in a hospital-based descriptive cross-sectional study by Saritas and his colleagues in which the knowledge and practice improved with the increase in level of education (20).

In Ethiopia, Abdulkadir et al established the level of education as one of the independent factors associated with knowledge and practice towards mechanical ventilation with $p<0.05$. In this study, candidates with master's degrees were 7.3 times more likely to have good knowledge and practice as compared to those with lower levels of education (18).

Another descriptive cross-sectional study done in Ethiopia among intensive care nurses aiming

to assess their knowledge and practice concerning mechanical ventilation found a statistically significant association between levels of education and mechanical ventilatory practice which suggested upgrading levels of nurses education to improve the quality of care of mechanically ventilated patients(9).

2.3.5 Use of Operational Guidelines

There was a significant association between the use of operational manual guidelines and good knowledge/practice on mechanical ventilation management in an Ethiopian study done among intensive care unit nurses. Nurses using the guidelines as their reference in practice were two timesmore likely to have good knowledge and practice on MV as compared to those who did not use the guidelines (p=0.015) (18).

2.3.6 Supportive supervision

From a scientific point of view, supportive supervision from senior, experienced, and qualified staff results in significant improvement in the desired outcome. In mechanical ventilation practice, supportive supervision from senior, experienced, and qualified ICU nurses is expected to improvethe quality of practice toward MV as identified in the Ethiopian study (18). The study enrolled 330 nurses working in ICUs of public hospitals in Ethiopia, only 10% of them were assessed for quality of their practice and 62% of the participant acknowledged to have received support and supervision which reflected their quality of practice.

The Accreditation Council for Graduate Medical Education report based on the United States and Canada recommends augmented supervision to improve knowledge, skills, and patient safety. A systematic review study by the Council found that enhanced clinical supervision of trainees was associated with improved patient management, and healthcare providers' knowledge and skills(26). Also, a cluster-controlled trial study done in Mozambique concluded that regular supportive supervision is critical for motivating staff in resource-constrained settings which in turn improves the quality of patient care (27).

2.3.7 Job position

A cross-sectional study done in Rwanda tertiary teaching hospitals found a significant associationbetween job position (bedside nurse versus ward in charge) and MV practice among critical care nurses (p=0.000) in which bedside nurses had good practice regardless of the

qualification as compared to wards in-charge (31).

This study involved 62 nurses working in ICUs of University teaching hospitals in Rwanda obtained through consecutive sampling technique. More than 90% of the enrolled participants were non- ICU specialist nurses working as bedside nurse and directly involved in care of critically ill patients admitted in the ICUs.

CHAPTER THREE

3 .0 METHODOLOGY

3.1 Study design

Observational cross-sectional study.

3.2 Study duration

The study was conducted from August to December 2023.

3.3 Study setting

The study was conducted at the Intensive Care Units of Muhimbili National Hospital (adult medical and surgical ICUs) and Muhimbili Orthopaedic Institute which are both tertiary teaching hospital for MUHAS located in Dar es salaam, Tanzania. Muhimbili Orthopaedic Institute (MOI) offers specialized services in neurosurgery, orthopedics, and traumatology. Also, the hospital offers research and training/ capacity building on how to provide the best services to the community. The hospital has a total of 369 beds and an average of 4200 patients are operated per annum. MOI has an ICU with a total of 19 beds (18 for adults and 1 for paediatrics) each bed having a bedside monitor and a working mechanical ventilator. A total of 42 nurses are stationed in the unit, among them four are master's degree holders in critical care nursing and seven have postgraduate diplomas in critical care nursing. Three registrars (medical doctors) are stationed in the unit and seven specialists from the Anaesthesia and Critical Care department rotate in the unit.

Muhimbili National Hospital (MNH) is a National Referral Hospital, Research Center, and University Teaching Hospital with 1,500 bed capacity, attending 2,000 outpatients per day and it has 2,800 employees. The hospital has an adult medical and surgical ICU located in the same building with 24 beds capacity (11 beds in the surgical ICU, 13 beds in the medical ICU), and 14 mechanical ventilators (6 in the surgical ICU and 8 in the medical ICU). Critically ill patients with medical conditions are admitted to the medical ICU for close observation, interventions, and medical care whereas post-operative patients following major surgeries and those with

surgical conditions requiring close monitoring are taken care of in the surgical ICU. Both medical and surgical ICU admits an average of 300 critically ill patients per annum with more than 80% of the patients requiring mechanical ventilation support. There are 57 nurses and only one among them has master's degree in critical care nursing, 4 Intensivists, and 7 Medical officers(registrars) working in these units.

3.4 Study population

The study population involved nurses working in intensive care units of MNH and MOI.

3.5 Sampling techniques

Consecutive sampling technique was used in this study. This is a non-probability sampling technique in which every subject meeting the criteria of inclusion was selected until the required sample size was achieved. In this study, 81 intensive care nurses who met the inclusion criteria during the study period were enrolled for the study.

3.6 Sample size calculation

Kish and Leslie's formula was used to calculate the estimated sample size

$n = (z^2 p(100-p)) / \varepsilon^2$

n = Minimum required sample size

z = Percentage point of normal distribution (1.96) corresponding to 95% confidence interval.ε = Margin of error (5%).

p = expected proportion with the characteristic under study (24%).

Findings from the study done by Abdulkadir assessing knowledge, practice and associated factorson mechanical ventilation among adult ICU nurses working in public hospitals in Ethiopia revealedthat only 24% of the nurses demonstrated good practice in mechanical ventilation (18).

$$n=\frac{(1.96)^2 X24(100-24)}{(5)^2}$$

=280

Sample size (n) is approximated to be 280.

Since, the study was conducted at MOI and MNH ICUs where the total number of nurses is 99

(42 from MOI and 57 from MNH) and an estimated sample size is 280, a sample size for a finite population was calculated.

Formula to calculate sample size for finite population: $n_C = n/ (1+n/N)$

Where N= finite population

n= estimated sample size of an infinite population

=280/ (1+280/99)

n_C=73.

The obtained sample size was adjusted for a 10% none response rate

=n×1/R

Where R (response rate) =90%

=73×1/0.9 =81

Therefore, after adjusting for 10% none response 81 intensive care nurses were enrolled.

The sample size was then distributed proportionally across the study population. This was obtained by calculating participants' percent contribution to the total population; then the obtained percent was drawn from the study population to get a representative sample. Thus, their distribution was as follows;

- Intensive care nurses at MNH adult ICUs- 49 (60.5%)
- Intensive care nurses at MOI ICU- 32 (39.5%)

3.6.1 Inclusion criteria

Intensive care nurses of Muhimbili National Hospital (medical and surgical ICU) and Muhimbili Orthopaedic Institute with more than six months of ICU working experience consented to participate in the study**.**

3.6.2 Exclusion criteria

Intensive care nurses who were not available during the study period.

3.7 Study variables

3.7.1 Dependent variable

Mechanical ventilation practice.

3.7.2 Independent variables

Knowledge, work experience, level of education, job position, use of operational guidelines, Continuing medical education (CME), and supportive supervision.

3.8 Data collection method, tools, and procedures

Data were collected using a standard questionnaire and observational checklist adopted from previous similar studies done in Ethiopia, Rwanda, South Africa, and Turkey (12,18,20,31). This tool was validated in previous studies using the item and content validity index and the reliable internal consistency of the clinical vignette with Cronbach's alpha of 0.88 and the composite reliability of 0.90 (12). The tool was compiled and adapted to this study.

The final questionnaire was composed of two sections; the first was made of socio-demographic data that may affect mechanical ventilation practice among ICU nurses. The second section was made of three clinical vignettes for evaluation of the level of nurses' knowledge on mechanical ventilation management regarding three categories of pathological conditions (health post-op patients, ARDS, and COPD requiring mechanical ventilation).

Vignette one concerns mechanical ventilation management in normal post-operative patients which had twelve questions with true and false options. Vignette two concerns the patient with ARDS, and Vignette three concerns the patient with COPD. Vignettes two and three had eight questions each with true and false options.

The standard questionnaires were given to available study participants in intensive care units of MNH (adult medical and surgical) and MOI by the principal investigator or trained research assistant during working hours (daytime). The study participants were required to answer

provided questions on the same day and the investigator/research assistant collected all filled questionnaires and checked for completeness. No study participant was allowed to leave with the questionnaire. The collected questionnaires were marked (knowledge questions) by the principal investigator, each correct response was scored 1 point and the sum of points was computed out of the total available questions to get a percentage score. A score of ≥75% was regarded as good or adequate knowledge while a score of less than 75% was regarded as poor or unsatisfactory knowledge of MV management (12,18,31).

The observational checklist was subcategorized into three parts with a total of 24 parameters being observed. The first part concerns initial ventilator testing and setting consisting of nine parameters, the second part concerns ventilator alarms cause identification and proper response which was observed with 13 parameters, and the last part concerns identification of ventilator graphics and troubleshooting which had two parameters. Parameters that did not apply to a given patient during observation were assessed through the use of images and short direct questions. The principal investigator and/or research assistant conducted real-time observation of the intensive care nurses on how they care for patients on mechanical ventilators based on listed parameters in the observational checklist. The correct response/action to each parameter was awarded one point and zero points to the incorrect response. All marks were summed up and calculated on percent and interpreted as follows, the score of ≥75% was regarded as good practice while a score of ≤75% regarded as poor mechanical ventilation practice(12,18,31).

3.9 Data quality control

The research assistants were trained by principal investigator to fill in the required data on the observational checklist. The principal investigator was available on a daily and weekly basis to observe the process of data collection. The principal investigator collected the questionnaires and observational checklist every week and checked for completeness and errors.

3.10 Data analysis

The questionnaires and observational checklist were coded and entered into the Statistical Package for Social Science (SPSS) version 26 which was used for analysis. The categorical

variables were summarized using frequency distribution tables and statistical diagrams. The proportion of dependent variable findings was summarized into two subcategories which are good practice and poor practice depending on participants' score(cut point 75%) from the observational checklist. Also, descriptive statistics was used to summarize the findings for independent variables such as nurses' knowledge of mechanical ventilation which was categorized into good and poor knowledge depending on participants' scores from the questionnaire (cut point for good knowledge ≥75%). The chi-square test was used to measure the association between variables and a p-value < 0.05 used to declare the level of statistical significance.

3.11 Ethical consideration

The Research and Ethics Committee of MUHAS provided its approval for the project's ethical conduct. For the study to be conducted at MOI and MNH, permission was sought from MOI and MNH directorate of research services. The study participants were provided with information regarding the aim of the study, the significance of participating in the study, and the whole process of data collection. Upon agreement, they were providedwith a written informed consent to be signed.Confidentiality was ensured to all the study participants during the study period.

Participation in the study was completely voluntary and each participant was allowed to withdraw his/her participation at any point during the study period.

3.12 Research Findings Dissemination

This dissertation will be available at the MUHAS repository for future researchers. To further the goals of teaching and research, research findings will also be shared during departmental clinical meetingsat MOI and MNH, and the MUHAS Scientific Conference. Additionally, the results will be submitted to a peer-reviewed journal for publication.

CHAPTER FOUR

4 .0 RESULTS

4.1 Sociodemographic characteristics of participants

This study enrolled a total of 81 critical care nurses from MOI and MNH, 63% (51/81) of the nurses were females. The majority of participants 51.9% (42/81) were aged between 25-34 years. Only one nurse with a master's degree consented to participate in the study while 59.3% (48/81) of the nurses had diplomas in nursing and two had advanced/postgraduate diploma in critical care.

Table 1: Sociodemographic characteristics of intensive care nurses at Muhimbili National Hospital and Muhimbili Orthopaedic Institute, 2023 (n=81).

Variable	Category	Frequency (%)
Gender	Male	30 (37)
	Female	51 (63)
Age Category	25-34 years	42 (51.9)
	35-44 years	33 (40.7)
	45-54 years	6 (7.4)
Job position	Bedside nurse	80 (98.8)
	Ward In charge	1 (1.2)
Level of education	Diploma	48 (59.3)
	Bachelor's degree	30 (37)
	Specialty in critical care (master/postgraduate diploma)	3 (3.7)
Profession	Comprehensive/general nursing	78 (96.3)
	Critical care nursing	3 (3.7)
ICU working experience	6 months to 3 years	26 (32.1)
	4-6 years	40 (49.4)
	≥7 years	15 (18.5)

4.2 Training, mentorship, and mechanical ventilation guidelines utilization among study participants

The majority of ICU nurses 80.2% (65/81), reported to have attended at least one mechanical ventilation-related training. Also, 81.5% (66/81) reported receiving supportive supervision from senior nursing staff. However, only 28.6% (21/81) of participants made use of mechanical ventilation management guidelines. The Majority of participants 91.4% (74/81) were allowed to adjust or manipulate mechanical ventilator settings (Details are shown in Table 2 below).

Table 2: Facility-related characteristics of intensive care nurses at Muhimbili National Hospital and Muhimbili Orthopedic Institute, 2023(n=81).

Variable and categories	Frequency (%)
Ever participated in mechanical ventilation training	
Yes	65 (80.2)
No	16 (19.8)
Frequency of mechanical ventilation CME participation	
Every year (annually)	16 (19.8)
Every rotation when new nurses come to the ICU	13 (16)
Occasionally/ Never participated	42 (64.2)
Given adequate supportive supervision from senior nursing staff	
Yes	66 (81.5)
No	15 (18.5)
Utilizes mechanical ventilation management guideline	
Yes	21 (25.9)
No	60 (74.1)
Allowed to adjust/manipulate mechanical ventilator settings	
Yes	74 (91.4)
No	7 (8.6)

4.3 Overall mechanical ventilation practices

Findings from this study have shown that only 21% (17/81) of all observed intensive care nurses at MOI and MNH demonstrated good mechanical ventilation practice.

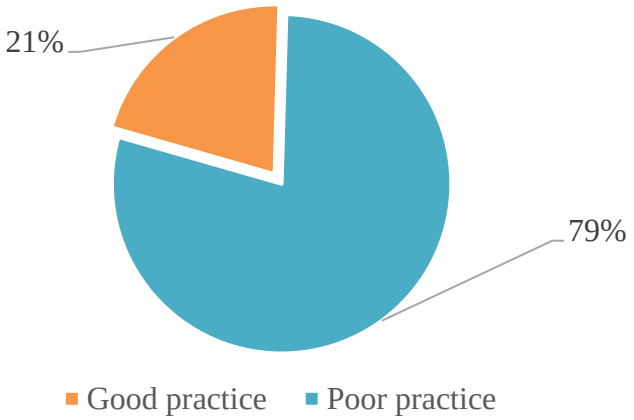


Figure 2: Mechanical ventilation practices of intensive care nurses at Muhimbili National Hospital and Muhimbili Orthopedic Institute, 2023 (n=81)

Regarding the observation of initial ventilator setting and testing, the study found that 91.4% (74/81) of nurses performed ventilator testing before connecting to the patient and initiating MV. Majority of participants, 96.3% (78/81) set tidal volume in safe limits for every patient. The pressure limit was not set by 28.4% (23/81) of the nurses while mechanically ventilating patients. Also, the I: E ratio for asthmatic and COPD patients was incorrectly set by 55.6% (45/81) of all observed nurses as presented in Figure 3 below.

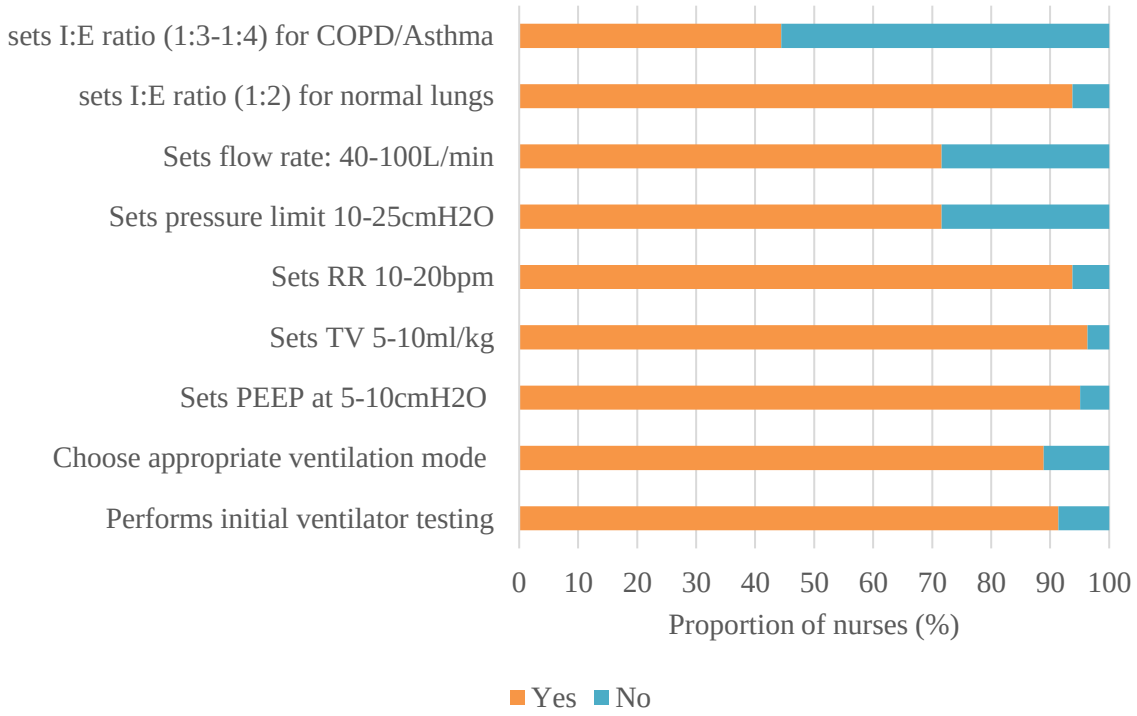


Figure 3: Observation of nurses' practice on setting and testing ventilators before initiation.

Majority of nurses (77.8%) did not adjust the inspiratory time (T_i) during high-peak airway pressure alarms. Among the studied participants, 43.2% of them did not correctly manage the patient and troubleshoot the machine when patients were fighting with ventilators. Moreover, 65.4% of nurses did not check and adjust the rate and trigger sensitivity settings during high respiratory rate (RR) alarms. Only 45.7% of the nurses adjusted the set tidal volume high alarm limit during high tidal volume alarms. The details of nurses' ability to identify and troubleshoot the alarms is presented in Table 3 below.

Table 3: Observation of nurses' practice on alarms identification and troubleshooting.

Variable	Category	Frequency (%)
Identifies and removes the root cause of high P_{peak}- alarm	Yes	44 (54.3)
	No	37 (45.7)
Adjust T_i if set too short during high peak airway pressure	Yes	18 (22.2)
	No	63 (77.8)
Reassure, sedate/give anti-pain if the patient is fighting a ventilator	Yes	46 (56.8)
	No	35 (43.2)
Identify and remove the root cause of low peak airway pressure	Yes	33 (40.7)
	No	48 (59.3)
Check and readjust mode and control settings during low Ppeak	Yes	27 (33.3)
	No	54 (66.7)
Check and adjust alarm settings during low peak airway pressure	Yes	39 (48.1)
	No	42 (51.9)
Adjust the set tidal volume high alarm limit during high TV alarm	Yes	37 (45.7)
	No	44 (54.3)
Check and adjust mode and control settings during high TV alarm	Yes	32 (39.5)
	No	49 (60.5)
Check Ve high alarm limit and adjust it during high Ve alarm	Yes	34 (42)
	No	47 (58)
Check and adjust RR, TV, and P_{insp} if set too high in high Ve alarm	Yes	33 (40.7)
	No	48 (59.3)
Correct if there is auto-triggering during high Ve alarm	Yes	18 (22.2)
	No	63 (77.8)
Check and adjust rate and trigger sensitivity settings in high RR alarm	Yes	28 (34.6)
	No	53 (65.4)
Give analgesia if there is pain causing high RR alarm	Yes	71 (87.7)
	No	10 (12.3)
Check upper limit alarm and adjust during high RR alarm	Yes	45 (55.6)
	No	36 (44.4)

The study findings also, showed that more than 95% of all observed ICU nurses were unable to identify abnormal ventilator graphics (waveforms) and take appropriate actions. The details of the observed parameter are shown in the figure below.

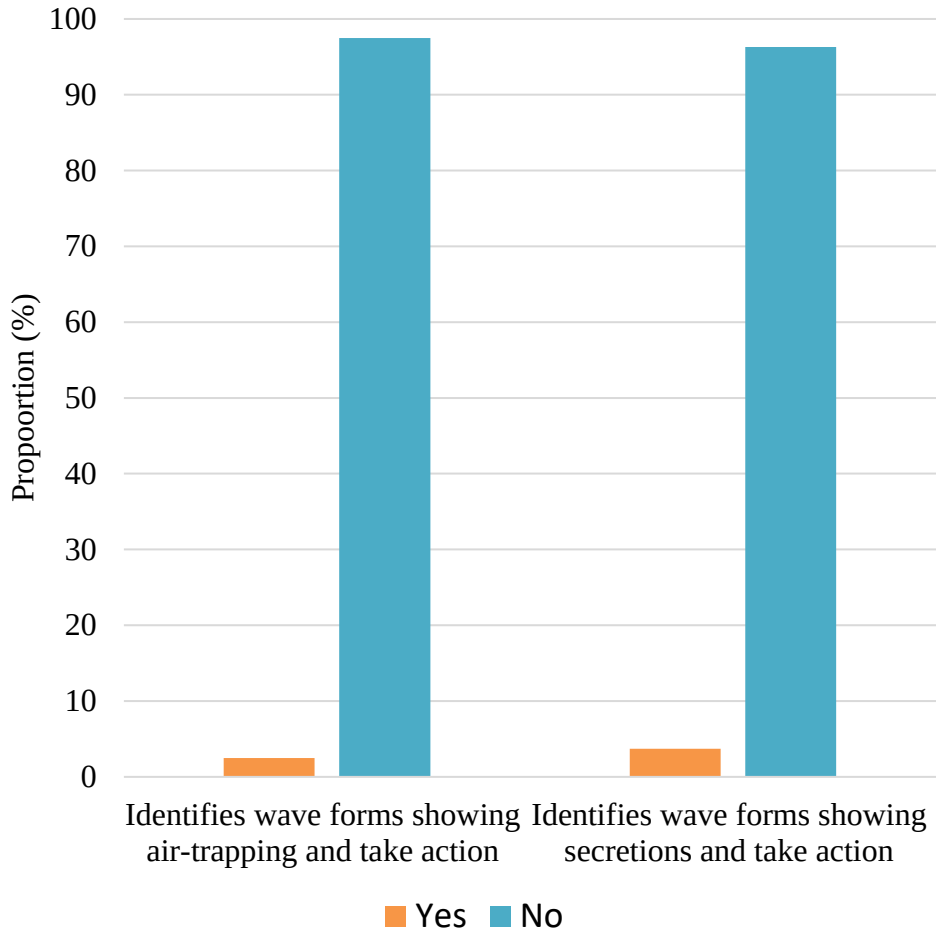


Figure 4: Observation of nurses' practice on identification of ventilator graphics and troubleshooting.

4.4 Knowledge of intensive care nurses regarding mechanical ventilation management.

The study findings demonstrated that 95.1% (77/81) of nurses have poor knowledge of mechanical ventilation management as shown in Figure 2 below.

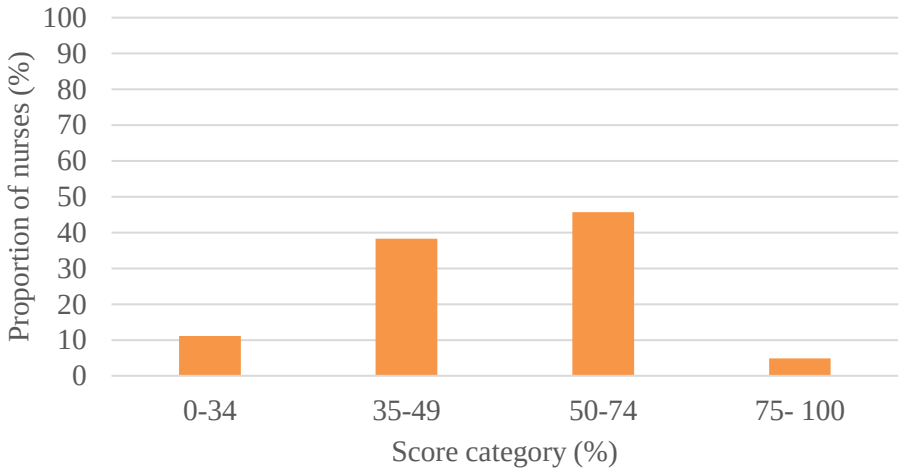


Figure 5: Overall knowledge of intensive care nurses regarding mechanical ventilation at MOI and MNH, 2023.

4.4.1 Knowledge regarding mechanical ventilation management in healthy post-operative patients.

The score in knowledge questions regarding mechanical ventilation in healthy post-operative patients ranged from 0-91.6% with an average score of 53.1% (standard deviation; 17.4%). The performance of the participants is presented in Figure 3 below.

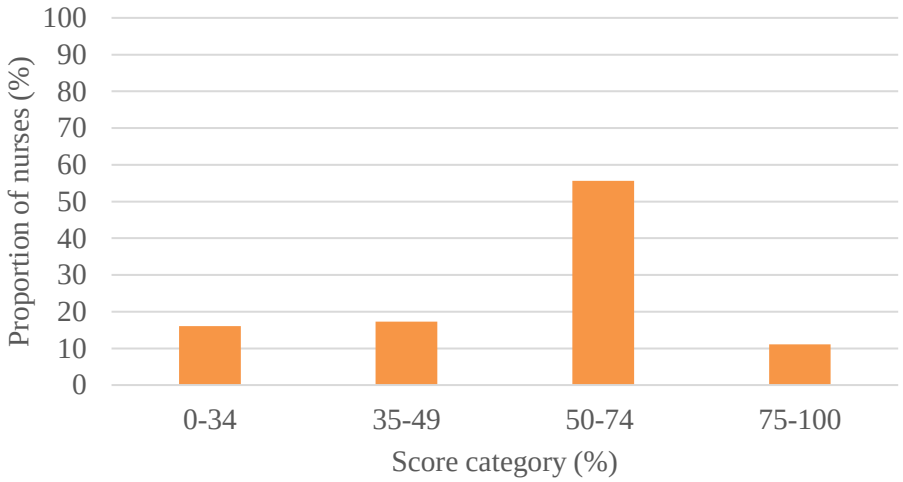


Figure 6: Knowledge of intensive care nurses regarding mechanical ventilation management of healthy post-operative *patient.*

4.4.2 Knowledge regarding mechanical ventilation management in patients with ARDS.

Nurses' knowledge regarding mechanical ventilation management in patients with acute respiratory distress syndrome (ARDS) was also tested in a given questionnaire. In this category, the minimum score was 12.5%, the maximum 87.5%, the average score of 53.2%, and the standard deviation of 17.6%.

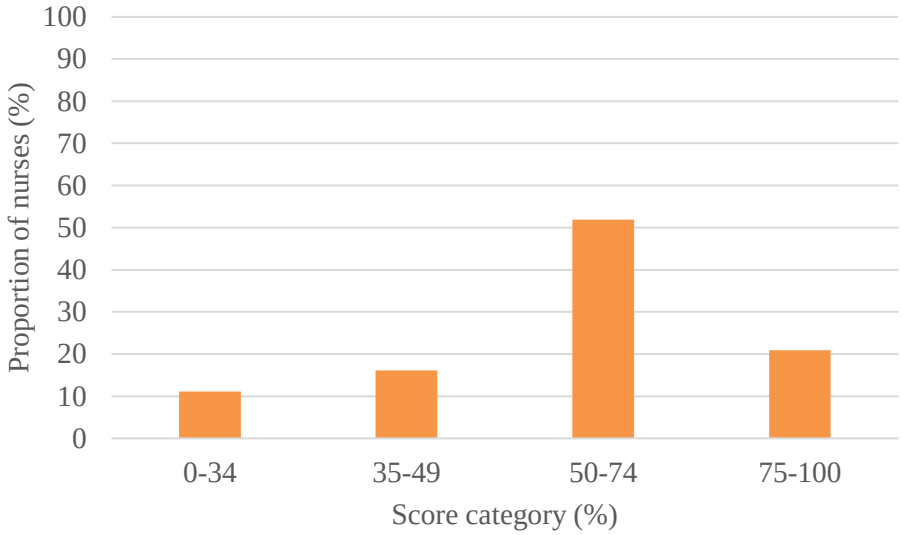


Figure 7: Knowledge of intensive care nurses regarding mechanical ventilation management in patients with ARDS.

4.4.3 Knowledge regarding mechanical ventilation management in COPD patients

Minimum score of nurses in questions regarding mechanical ventilation management in patients with COPDs was 0%, maximum 75%, mean score of 36.5% and standard deviation of 19%.

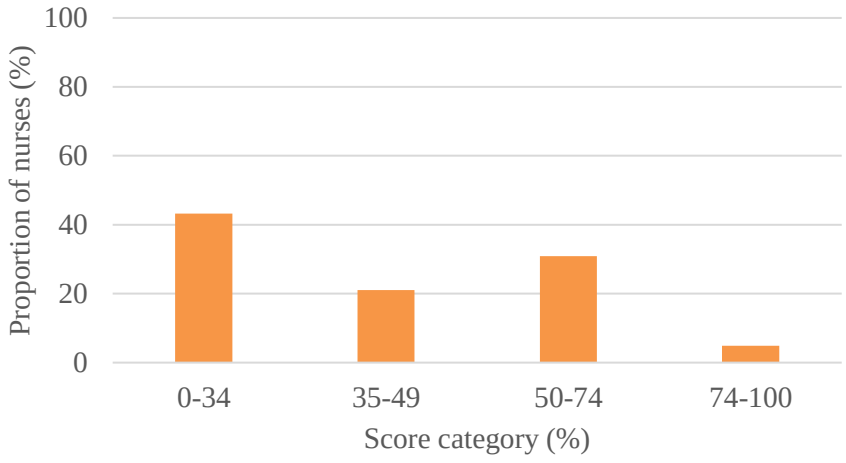


Figure 8: Knowledge of intensive care nurses regarding mechanical ventilation management in COPD patients.

4.5 Factors associated with mechanical ventilation practice

A statistically significant association was found between mechanical ventilation practice and knowledge of intensive care nurses, level of education, utilization of mechanical ventilation management guidelines, and continuing medical education (CME) ($p<0.001$). All nurses with good knowledge had good practice compared to nurses with poor knowledge. Additionally, most nurses with bachelor's degrees and specialty training in critical care demonstrated good practice compared to diploma holders. Moreover, nurses who attended CMEs more often and those who were utilizing mechanical ventilation management guidelines demonstrated good practice as compared to their counterparts.

On the other hand, the study found no statistically significant association between mechanical ventilation practice and working experience, supportive supervision, and job position based on their p-values which were ≥ 0.05. Thus, they do not play a part as factors that affect mechanical ventilation practice in this study.

Table 4: Cross-tabulation (Chi2) of factors influencing mechanical ventilation practices

Variable	Mechanical ventilation practice		P value
	Good (%)	Poor (%)	
knowledge			
Adequate	4 (100)	0 (0)	0.000
Inadequate/unsatisfactory	13 (16.9)	64 (83.1)	
Job position			
Bedside nurse	16 (20)	64 (80)	0.051
Ward In charge	1 (100)	0 (0)	
Mechanical ventilation CME participation			
Every year (annually)	11 (68.8)	5 (31.2)	0.000
Every rotation when new nurses come to ICU	4 (30.8)	9 (69.2)	
Occasionally/ never	2 (3.8)	50 (96.2)	
Level of education			
Diploma	3 (6.2)	45 (93.8)	0.000
Bachelor degree	12 (40)	18 (60)	
Masters or Advanced diploma in critical care	2 (66.7)	1(33.3)	
Given adequate supportive supervision			
Yes	14 (21.2)	52 (92.8)	0.917
No	3 (20)	12 (80)	
Utilization of mechanical ventilation management guidelines			
Yes	14 (66.7)	7 (33.3)	0.000
No	3 (5)	57 (95)	
ICU working experience			
6 months to 3 years	5(19.2)	21 (80.8)	0.262
4 years to 6 years	11 (27.5)	29 (72.5)	
≥ 7 years	1 (6.7)	14 (93.3)	

CHAPTER FIVE

5 .0 DISCUSSION

This chapter discusses the findings in the context of study objectives, conceptual framework, and existing literature.

5.1 Mechanical Ventilation Practice.

The overall score of participants about their practices of mechanical ventilation was poor accounting for only 21% of participants having good practices. This finding is almost similar to the study done in Ethiopia by Abdulkadir and his colleagues which found 24% of intensive care nurses had good practice (18). Also, a descriptive cross-sectional study done in Ethiopia found that 41.1% of the nurses working in intensive care units of public hospitals had good practice (9). In Rwanda, only 1.6% of intensive care nurses demonstrated an adequate level of mechanical ventilation practice from a study by Mahoro (31). In 2012, a study conducted in South Africa found that all assessed intensive care nurses had poor mechanical ventilation practice (12). In Yemen, Al-Gunaid and his colleagues found that 51% of intensive care nurses had good mechanical ventilation practice (10).

It's striking to note the significant variation in the percentage of nurses with good practice across different studies, ranging from as low as 1.6% to a maximum of 51%. The disparities in findings across different regions cited may be attributed to differences in resource availability, educational infrastructure, and support systems for professional development. These findings underscore the urgent need for interventions to improve the competence of ICU nurses in mechanical ventilation management since inadequate practice could lead to serious complications including, prolonged ventilation duration, and increased mortality rates.

5.2 Factors Influencing Mechanical Ventilation Practices

5.2.1 **Knowledge**

This study found that, all nurses with adequate knowledge demonstrated good practices of mechanical ventilation. This finding is in line with several other studies suggesting that poor knowledge does not support safe and efficient mechanical ventilation management (20,32,39,41,42). Generally, nurses must have in-depth scientific knowledge regarding

mechanical ventilation to improve the quality of care to critically ill patients.

The study highlighted a significant gap in mechanical ventilation knowledge among ICU nurses, with only a small percentage of 4.9% having good knowledge. The percentage of nurses with good knowledge in this study is very small compared to other studies. A study done by Maurya and colleagues in India found that 53.4% of nurses had average knowledge(43) which however covered only aspects related to ventilator-associated complications contrary to this study. Another study conducted in Egypt found that 44% of intensive care nurses had unsatisfactory knowledge of weaning criteria from mechanical ventilators. Also, 76% of intensive care nurses in Ethiopia were found to have poor knowledge(18). Several other studies were done in Baghdad (41), Egypt (19,40), Turkey (20), and America (39), demonstrated poor mechanical ventilation knowledge among critical care providers ranging from 26% to 66% of unsatisfactory knowledge regarding mechanical ventilation management. This huge gap of knowledge identified in this study compared to other studies may be attributed to lack of on-job training among studied participants. In addition there are differences in the representative sample as this study enrolled only ICU nurses but a study by Wilcox and colleagues(39) enrolled physicians which might have favored their knowledge performance. Also, some comparative studies covered mechanical ventilation knowledge in only a few aspects like knowledge on ventilator-associated complications by Maurya and colleagues(43) and knowledge on weaning criteria by Shehab and his colleagues(44) contrary to this study which assessed knowledge from multiple perspectives.

5.2.2 **Level of education**

Higher levels of education equip nurses with advanced knowledge, skills, and critical thinking abilities, which are essential for delivering high-quality care in intensive care settings. The research indicates that there is a positive association between the level of education attained by ICU nurses and the quality of their practice, specifically in the domain of mechanical ventilation. As nurses pursue higher levels of education, such as advanced diplomas or master's degrees in critical care, the quality of their practice tends to improve. The study has shown that 66.7% of intensive care nurses with master/advanced diplomas in critical care had good practice as compared to 6.2% of ICU nurses with diplomas who had good practice. The research findings suggest that this association between education level and practice quality holds true across

various geographical settings, as evidenced by studies conducted in Baghdad, Ethiopia, and Turkey(18,20,41). Therefore, these findings underscore the importance of investing in education and training for ICU nurses, particularly in the realm of critical care.

5.2.3 **Work experience**

No significant difference in quality of practice between experienced and less experienced nurses was found in this study. Among ICU nurses with experience of 7 years or more and between 4 years to 6 years, 93.3% and 75% respectively had poor practice (p=0.262). Also, Mahoro and colleagues in a cross-sectional study done in Rwanda found no significant improvement in the quality of mechanical ventilation practice for ICU nurses' years of work experience (p0.067)(31). This similarity in study findings suggests that, unless nurses continue to learn, and are responsible for their learning, years of experience will not influence their quality of mechanical ventilation management (practice).

5.2.4 **Guidelines**

The study has shown a positive association between the use of mechanical ventilation management guidelines and good practice. This finding is consistent with Abdukadir and his colleagues' findings which concluded that the use of operational guidelines has a direct influence in the quality of mechanical ventilation practice(18). Use of operational guidelines has been proven to increase the quality of practice among nurses as far as mechanical ventilation is concerned (45). Therefore, the use of operational guidelines should be mandatory in all critical care units to improve the quality of patients' care and minimize complications.

Moreover, only 65.4% of intensive care nurses enrolled in this study used guidelines for mechanical ventilation management which is almost similar to studies done in Ethiopia and Turkey where 72.2% and 71% of ICU nurses were not using ventilation guidelines(18,20). On the other hand, in New Zealand 66.5% of intensive care nurses made use of mechanical ventilation management guideline(46). This inconsistency could be attributed to setting differences, ICU organization, and policies that mandates the use of guideline for every nurse caring for mechanically ventilated patient.

5.2.5 **Continuing Medical Education (CME)**

The findings from this study show that intensive care nurses who attended on job training

(continuing medical education) more frequently demonstrated good practice (62.5%) as compared to those with occasional or no record of attending training (1.9%). This shows that attending CME more frequently is likely to improve the practice of nurses towards mechanical ventilation as it was statistically significant with $p<0.01$. This finding is consistent with studies done in South Africa (12), Kenya (25), Egypt (37), Saudi Arabia (38) Thailand (28), and Germany (35). The results also tally with findings from studies done in Italy (36), and France (34) showing that increasing the number of training sessions among nurses based on professional needs and effective assessment of their learning process impact positively their competence and patients' quality of care. Continuous training can help reduce the occurrence of medical errors by providing healthcare staff with the essential skills and information to detect and manage potential risks and complications(21). Furthermore, frequent participation in continuing medical education (on job training) is effective in increasing the knowledge and skills of staff caring for patients(47).

On the other hand, a study done in Rwanda found no significant association between training and improvement in the quality of practice(31). This difference can be explained by other factors that affect the impact of training such as attitude and overworking due to staff shortage.

5.2.6 **Supportive supervision**

The study found no statistically significant association between adequate supportive supervision and mechanical ventilation ($p=0.567$). Among nurses who reported getting adequate supportive supervision 80.3% of them had poor practice. These findings do not tally with comparative studies done in Ethiopia, Mozambique, and one Systematic Review which concluded that supportive supervision had a positive impact in improving patients' quality of care, staff motivation, knowledge, and skills(18,26,27). This discrepancy may be due to other factors that affects practice in our settings such as attitude, quality of supportive supervision, shortage of staff leading to overworking, exhaustion, and burnout.

5.2.7 **Job position**

Only one nurse in-charge participated in the study and had good mechanical ventilation. Among bedside nurses, 80% of them had poor mechanical ventilation practices. The study found no statistically significant association between job position and quality of mechanical ventilation

practice (p=0.051). These findings are different from a study done in Rwanda which found a statistically significant association between job position and quality of practice in which bedside nurses had good practice as compared to the ward in-charge(31). This difference may be because bedside nurses engage directly more often in the care of mechanically ventilated patients than the ward in-charge who also has to participate in administrative activities. However, in our setting, there is a significant shortage of ICU nursing staff that makes the ward in-charge engage more often in the care of patients to cover the gap despite administrative duties.

5.3 Study strengths, limitations, and mitigations

5.3.1 Study strengths

This study involved a real-time direct observation of nurses' mechanical ventilation management practice in ICU patients thereby providing the actual data of their current level of practice.

Additionally, the study adopted a structured questionnaire and observational checklist which have been validated and used in other African and European countries, providing a standardized approach to data collection, and enhancing the reliability and comparability of the study findings.

Conducting the study in two tertiary teaching hospitals in Tanzania enhances its relevance and applicability to similar healthcare settings, thereby facilitating the translation of findings into practice.

The study contributes to the existing literature by providing empirical data on mechanical ventilation practices among intensive care nurses in Tanzania, filling a gap in knowledge and serving as a foundation for future research in this area.

5.3.2 **Study limitations and mitigations**

The study was cross-sectional which provided only a snapshot, that only participants present during the study period were involved. However, the extension of the data collection period to five months accommodated the calculated sample size despite the leave schedule, night shifts, and excuses from duty.

Furthermore, the study did not explore the association between duration of hospital stay, outcomes, and complications developed by patients under mechanical ventilation which remains an area for future studies.

CHAPTER SIX

6 .0 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

This study underscores a critical issue of mechanical ventilation practices among intensive care unit (ICU) nurses. The findings reveal a concerning trend, with only a minority of ICU nurses demonstrating good mechanical ventilation practice despite its pivotal role in patient care within the ICU setting. Additionally, the study observed a significant gap in knowledge regarding mechanical ventilation, with only a small fraction of nurses possessing satisfactory knowledge in this domain.

However, amidst this challenge, the study identified several key factors that are associated with improved mechanical ventilation practice among ICU nurses. Specifically, increasing level of education, regular participation in continuing medical education (CME), as well as good knowledge and utilization of operational guidelines emerge as crucial determinants.

These findings accentuate the importance of targeted interventions aimed at addressing knowledge gaps and enhancing educational opportunities for ICU nurses. Implementing comprehensive educational programs, promoting continuous learning initiatives, and ensuring adherence to operational guidelines are vital strategies to improve mechanical ventilation practice within the ICU setting.

6.2 Recommendations

We recommend developing and implementing targeted educational programs aimed at enhancing ICU nurses' understanding and proficiency in mechanical ventilation. These programs should cover core principles of ventilation management, advanced techniques, and evidence-based practices. Also, offering opportunities for post graduate training in critical care nursing, hands-on training, workshops, and simulation exercises to reinforce learning and skills acquisition.

Additionally, we recommend encouraging and supporting ICU nurses' frequent participation in continuous medical education (CME) activities focused on mechanical ventilation. Providing them an access to relevant workshops, conferences, and online courses to ensure ongoing learning and skill development. Also, establishing incentives and recognition programs to motivate nurses to engage in CME activities regularly.

Also, we recommend emphasizing the importance of adhering to operational guidelines and protocols for mechanical ventilation to ensure that guidelines are easily accessible and regularly updated to reflect current best practices. This emphasis should consider provision of training and resources to familiarize nurses with the content and application of operational guidelines in their clinical practice.

Moreover, we recommend other studies in this domain to involve multi-center and enroll more study participants who take decisions on mechanically ventilated patients, like general practitioners and residents within ICUs in Tanzanian hospitals, pre and post-test study designs to test for knowledge/skills acquisition and retention.

Lastly, we recommend further studies in this arena to explore outcome and complications of mechanically ventilated patients which was not covered in this study.

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APPENDICES

Appendix I: Information sheet

INTRODUCTION

Dear colleague, greetings!

My name is Benedicto Obeth Mwampashi, and I am a second-year Mmed-Anaesthesiology resident at Muhimbili University of Health and Allied Sciences (MUHAS). As part of my course requirement, I am planning to conduct research titled "*Mechanical Ventilation Practice and its Associated Factors Among Intensive Care Nurses at Muhimbili Tertiary Teaching Hospitals"*.

Kindly asking for your participation in this study.PURPOSE OF THE STUDY

This study aims at evaluating mechanical ventilation practice and associated factors among intensive care nurses at Muhimbili Orthopedic Institute and Muhimbili National Hospital in Dar es salaam, Tanzania.

CONFIDENTIALITY

Your research records and information will be strictly CONFIDENTIAL to the extent permitted by law. All collected data will be used for research purposes only and no names of participants will be written in either questionnaire or checklist. Without your written consent, personal informationwon't be disclosed.

PARTICIPATION

Participation in this study is voluntary and will involve answering questions from a provided standard questionnaire which will assess the factors associated with the practice of mechanical ventilation and the observation part which will involve the actual practice of mechanical ventilators. You are free to ask any question, if you are unwilling to participate in the study you are free to leave at any time and no penalty will be imposed on you. Signing a consent form will be regardedas agreement to your voluntary participation in the study.

RISKS AND DISCOMFORTS

There are no risks anticipated from this study.

BENEFIT

This study will help to identify the current situation of mechanical ventilation practice and associated factors at MOI and MNH which will help the stakeholders in setting interventions thatwill improve critical care nursing practice on mechanically ventilated patients. Since the study is academic in nature, no monetary reward should be expected by participation.

PERSON TO CONTACT

If you have any questions or inquiries about the study, please contact: PRINCIPAL INVESTIGATOR

Dr. Benedicto O. Mwampashi

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CO-SUPERVISOR: Dr. Edwin Lugazia

E-mail: elugazia@gmail.com

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OR

Director of Research, Innovations and Publications Muhimbili University of Health and Allied SciencesDr. Nahya Salim Masoud

P. O Box 65001, Dar es Salaam,Tel. no: +255-22-2152489

Appendix II: English version consent form

I agree to participate in this study named "Mechanical Ventilation Practice and Associated FactorsAmong Intensive Care Nurses at Muhimbili Tertiary Teaching Hospitals" by signing this paper. Ihave read and comprehended the contents of this form, and I have been given a thorough explanation of the research and my rights as a volunteer.

I hereby approve my consent to take part in the study with my signature.

Signature.....…

Date.....

Appendix III: Swahili version consent form

FOMU YA RIDHAA

Ninakubali kwa hiari yangu kushiriki katika utafiti huu uliopewa jina la "Mechanical Ventilation Practice and Associated Factors Among Intensive Care Nurses at Muhimbili Tertiary Teaching Hospitals" kwa kusaini fomu hii. Nimesoma na kuelewa vizuri yaliyomo katika fomu hii na utafiti huu. Aidha, nimepewa ufafanuzi wa kutosha kuhusu ushiriki wangu na haki zangu kama mshiriki.

Hivyo basi, ninathibitisha kuwa nimeridhia kushiriki katika utafiti huu kwa hiari yangu.
Sahihi……
Tarehe……

Appendix IV: English Version Questionnaires

PART I. QUESTIONS ON SOCIODEMOGRAPHIC CHARACTERISTICS

S. N	Questions	Categories	Remark
1	Sex	A. Male B. Female	
2	Age	…..	
3	Job position	A. bedside nurse B. ward in-charge C. Runner D. others (specify……)	
4	Profession	A. Comprehensive/General Nursing B. Critical care nursing	
5	Level of education	A. Diploma B. Degree C. Masters D. Advanced diploma -critical care	
6	Years of ICU work experience	A. 6months–3 years B. 4–6 years C. 7–9 years D. 10 or more years	
7	Ever participated on training related to mechanical ventilation	A. Yes B. No	

8	How often does your hospital give training/education regarding MV	A. Every year B. At every rotation when new nurses come to ICU C. Occasionally D. Never	
9	Are you given adequate support and supervision by your senior nursing staff when caring for the ICU patient?	A. Yes B. No	
10	Do you use guidelines for Mechanical ventilation management	A. Yes B. No	
11	Is it allowed for you to adjust/manipulate MV in your facility?	A. Yes B. No	

PART II. CLINICAL VIGNETTES

VIGNETTE ONE: HEALTHY POST OPERATIVE PATIENT

With regard to SIMV;

1. The ventilator cycles with each respiratory effort made by the patient T ( ) F ( )

2. The ventilator supplements each breath with positive pressure T ( ) F ( )

3. The ventilator delivers a preset number of ventilator breaths per minute ONLY T ( ) F ( ).

4. The ventilator delivers a preset number of ventilator bpm and allows the patient to breathe spontaneously between ventilator breaths. T ( ) F ( ).

Regarding PSV;

5. PSV breaths always have the same tidal volume T ( ) F ( )

6. PSV is not used when weaning patients from the ventilator T ( ) F ( )

7. PSV breaths are triggered and cycled by the ventilator T ( ) F ( )

8. PSV aids in ventilation and is adjusted in response to C02 levels. T ( ) F ( )

With regard to weaning from mechanical ventilator, patients with the following are ready to be weaned;

9. Patient still dependent on inotropic support to maintain hemodynamic stability
T ( ) F ( ).

10. RR rate > 10 and <30 breaths per min T ( ) F ( )

11. Temp 36 degrees. T ( ) F ( )

12. $PC0_2$ 33-35mm/Hg T ( ) F ( )

VIGNETTE TWO: ARDS

With regard to mechanically ventilating the patient with ARDS:

1. The TV should be calculated as 4-8mls/kg/ideal body weight T ( ) F ( )

2. The patient airway pressure should not exceed 45cm/H20 T ( ) F ( )

3. High PEEP levels are often required to prevent shearing injury of the lung T ( ) F ( )

4. The patient with ARDS usually has non-compliant (stiff) lungs T ( ) F ( )

With regards to PEEP, the effect of optimal PEEP at alveolar level of the lungs includes the following:

5. Decreases the risk of barotraumas T ( ) F ( )

6. Decreases the FRC of the lung T ( ) F ( )

7. Opens up the alveoli and prevents alveolar collapse at the end of expiration T ( ) F ( )

8. Decreases oxygenation T ( ) F ( )

VIGNETTE THREE: CHRONIC OBSTRUCTIVE AIRWAYS DISEASE.

The following ventilator setting combinations would be the most appropriate for patients with COPDs.

1. V/C SIMV, O2 100%, Peak Flow 40 liters, Mandatory rate 22 bpm, PS 15cm/H2O, PEEP 5 cm H20, TV 400mls, trigger sensitivity -2cm/H2O, IE 1;2 T ( ) F ( )

2. P/C SIMV, Pressure limit 35cm/H20, Ti 0.8seconds, PS 15cm/ H_20, PEEP 5 cm/H_20, 02 100% Mandatory respiratory rate 22. T ( ) F ( )

3. Spontaneous mode, PEEP 7.5cm/H20 and Pressure support 25cm/H20. T ( ) F ( )

4. V/C SIMV, Peak Flow 40L Mandatory rate 10 bpm, PS 15 Cm/H20, PEEP 7.5 cm/H20, 35% 02, IE 1:4 T ( ) F ( )

The following would be adjustments to the ventilator settings to PREVENT Auto- PEEP from occurring.

5. Increase the respiratory rate T ( ) F ( )

6. Decrease the respiratory rate T ( ) F ( )

7. Increase the inspiratory time T ( ) F ( )

8. Decrease the expiratory time T ( ) F ( )

Appendix IV: Observational checklist

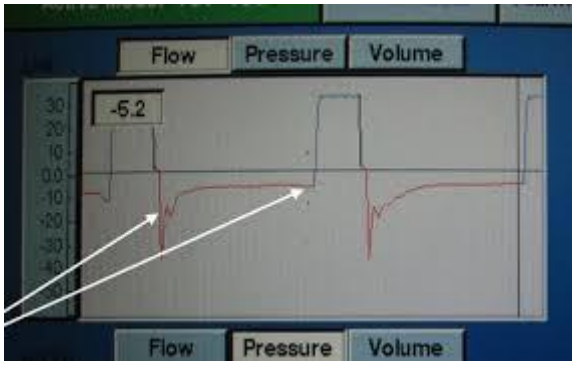
S.N	Tasks		Yes	No	Remark
1	Performs ventilator testing before initiation				
2	Sets MV settings properly				
	A. Can choose appropriate ventilation mode (A/C, SIMV, CPAP, PS)				
	B. Sets PEEP at 5-10cmH_2O				
	C. Set TV 5-10ml/kg				
	D. Sets RR 10-20bpm				
	E. Sets pressure limit 10-25cmH_2O				
	F. Flow rate: 40-100L/min				
	G. I:E ratio	1:2 for normal lung			
		1:3-1:4 for COPD and Asthma			
3	Identifies cause and responds to MV alarms correctly				
	1. High peak pressure alarm	A. Identifies and removes the root cause of: -High airway resistance (secretions, kinked ETT, water in the patient circuit, patient biting the tube)			
		B. Adjust T_i if set too short			
		C. Reassure, sedate, or give anti-pain if the patient is fighting the vent.			
		A. Identify and remove the root cause (Gas leak, Tube disconnection)			

	2. Low peak pressure	B. Check and readjust mode and control settings (if Inspiratory flow set too low and /or Ti set too long in volume mode)			
		C. Check and adjust alarm settings			
	3. High TV alarm	A. Adjust the set TV high alarm limit (if high TV alarm limit set too close to the actual TV)			
		B. Check and adjust mode and control settings (eg. In pressure mode if the pt's actual demand is greater than expected)			
	4. High VE alarm	**A.** Check minute ventilation high alarm limit and adjust it			
		B. Check and adjust RR, TV, and inspiratory pressure if set too high			
		C. Correct if there is auto-triggering			
	5. High RR	A. Check and adjust rate and trigger sensitivity settings			
		B. Give analgesia if there is pain			
		C. Check the upper limit alarm and adjust			
4	Checks ventilator graphics				
5		**A.** Identifies waveforms showing air-trapping and act to correct it			

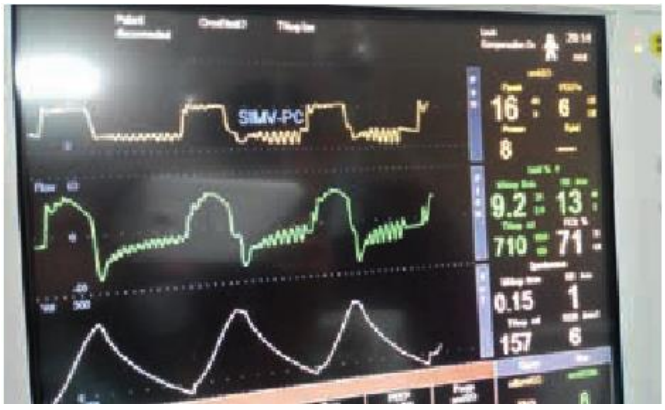
Identifies ventilator graphics (waveform) abnormalities	**B.** Identifies waveforms showing secretions and act to correct it			

Appendix VII: Extension of observational checklist

What is the abnormality shown in the figure below and what actions will you take to solve ….



What is the abnormality in ventilator graphic below and solution….



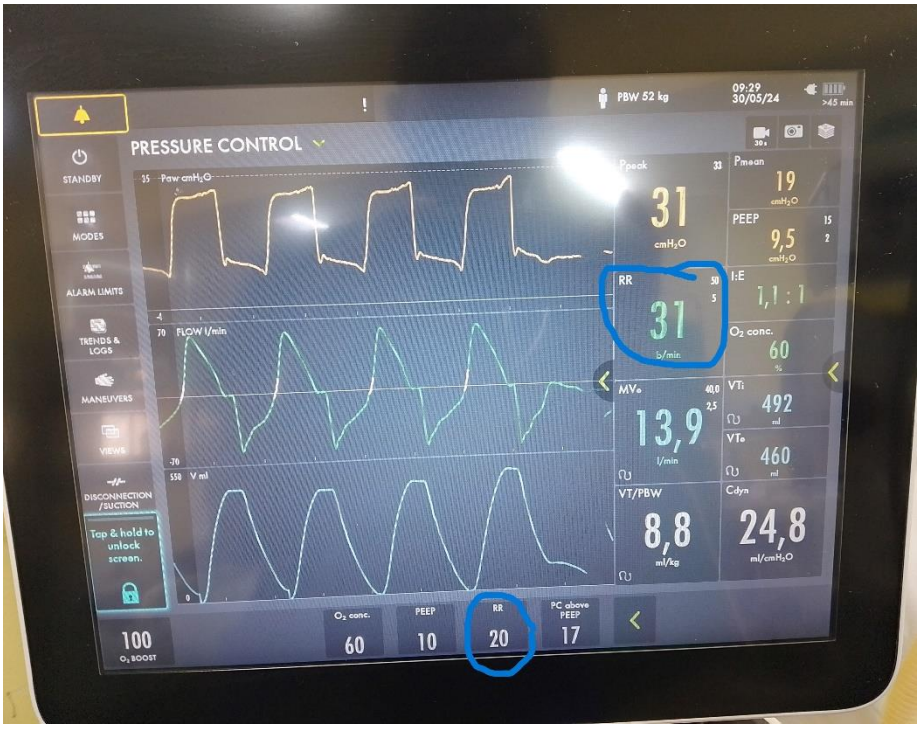
What is the abnormality in the ventilator graphics below, what are the possible causes and mitigations



What is the abnormality in ventilator graphic below, possible causes and solution



What is the abnormality in ventilator graphic below, possible causes and solution


PRESSURE CONTROL
PBW 52 kg
09:29
30/05/24
STANDBY
MODES
ALARM LIMITS
TRENDS & LOGS
MANEUVERS
VIEWS
DISCONNECTION /SUCTION
Tap & hold to unlock screen.
Paw cmH2O
FLOW l/min
V ml
Ppeak
31
cmH2O
Pmean
19
PEEP
9,5
RR
31
I:E
1,1 : 1
O2 conc.
60
MVe
13,9
l/min
VTi
492
VTe
460
VT/PBW
8,8
ml/kg
Cdyn
24,8
ml/cmH2O
100
O2 BOOST
O2 conc.
60
PEEP
10
RR
20
PC above PEEP
17

Appendix V: Ethical clearance letter

UNITED REPUBLIC OF TANZANIA

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES

OFFICE OF THE DIRECTOR – RESEARCH, INNOVATION AND PUBLICATIONS

In reply quote;
Ref. No.DA.282/298/01.C/1567 Date:07/03/2023

MUHAS-REC-03-2023-1567

Benedicto Obeth Mwampashi,
Department of Anesthesiology,
School of Medicine,
MUHAS.

RE: APPROVAL FOR ETHICAL CLEARANCE FOR A STUDY TITLED: ASSESSMENT OF MECHANICAL VENTILATION PRACTICE AND ITS ASSOCIATED FACTORS AMONG INTENSIVE CARE NURSES AT MUHIMBILI TERTIARY TEACHING HOSPITALS

Reference is made to the above heading.

I am pleased to inform you that the Chairman has on behalf of the University Senate, approved ethical clearance of the above-mentioned study, on recommendations of the Senate Research and Publications Committee meeting accordance with MUHAS research policy and Tanzania regulations governing human and animal subjects research.

APPROVAL DATE: 07/03/2023
EXPIRATION DATE OF APPROVAL: 06/03/2024

STUDY DESCRIPTION:
Purpose:
The purpose of this observational cross-sectional study is to assess mechanical ventilation practice and its associated factors among intensive care nurses at Muhimbili Tertiary Teaching Hospitals.

The approved protocol and procedures for this study is attached and stamped with this letter, and can be found in the link provided:
https://irb.muhas.ac.tz/storage/Certificates/Certificate%20-%2013692.pdf and in the MUHAS archives.

9 United Nations Road; Upanga West; P.O. Box 65001, Dar Es Salaam: Tel. G/Line: +255-22-2150302/6; Ext. 1038; Direct Line:+255-22-2152489;Telefax:+255-22-2152489;E-mail:drp@muhas.ac.tz;Web:https://www.muhas.ac.tz

The PI is required to:

1. Submit bi-annual progress reports and final report upon completion of the study.
2. Report to the IRB any unanticipated problem involving risks to subjects or others including adverse events where applicable.
3. Apply for renewal of approval of ethical clearance one (1) month prior its expiration if the study is not completed at the end of this ethical approval. You may not continue with any research activity beyond the expiration date without the approval of the IRB. Failure to receive approval for continuation before the expiration date will result in automatic termination of the approval for this study on the expiration date.
4. Obtain IRB amendment (s) approval for any changes to any aspect of this study before they can be implemented.
5. Data security is ultimately the responsibility of the investigator.
6. Apply for and obtain data transfer agreement (DTA) from NIMR if data will be transferred to a foreign country.
7. Apply for and obtain material transfer agreement (MTA) from NIMR, if research materials (samples) will be shipped to a foreign country,
8. Any researcher, who contravenes or fail to comply with these conditions, shall be guilty of an offence and shall be liable on conviction to a fine as per NIMR Act No. 23 of 1979, PART III section 10 (2)
9. The PI is required to ensure that the findings of the study are disseminated to relevant stake holders.
10. PI is required to be versed with necessary laws and regulatory policies that govern research in Tanzania. Some guidance is available on our website https://drp.muhas.ac.tz/.

Dr Nahya Salim Masoud
Chairman, MUHAS Research and Ethics Committee

Muhimbili University of Health and Allied Sciences
DIRECTOR
Research & Publications
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cc; Director of Postgraduate Studies,
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Appendix VI: Authorization of research tool adaptation



Re: RESEARCH TOOL ADAPTATION

DB Dereje Bayissa <derebayu@gmail.com>
12/12/2022 4:50 PM

To: benedicto mwampashi

AnnexesQuestionaire.docx
549.82 KB

Dear Dr.
Use with citation and acknowledge
With regards!
Dereje Bayissa Demissie (BSc, MSc/MRH, PhD)
Associate Professor of Maternity and Reproductive health

QuEST Project Ethiopia researcher, Health System & Reproductive Health Research Directorate, Ethiopian Public Health Institute, Addis Ababa, Ethiopia

Tel. +251 912189560
Addis Ababa, Ethiopia.
https://orcid.org/0000-0003-1006-4318
https://www.researchgate.net/profile/Dereje_Demissie

Appendix VII: Approval for data collection at MNH

THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF HEALTH

MUHIMBILI NATIONAL HOSPITAL

In reply please quote:

Ref. No.: MNH/CRTCU/Perm/2023/382 Date: 02nd June, 2023

Block Manager,
ICU,
Muhimbili National Hospital

RE: PERMISSION TO COLLECT DATA AT MNH.

Name of student	**Benedicto Obeth Mwampashi**
Title	**"Assessment of Mechanical Ventilation Practice and its Associated Factors Among Intensive Care Nurses at MNH".**
Institution	Muhimbili University of Health and Allied Sciences
Supervisor	Dr. Edwin Lugazia (MUHAS)
Co - supervisor	**Dr. Lukansola Mabusi** (MNH)
Period	02nd June, 2023 to 30th August, 2023

Approval has been granted to the above principal investigators to collect data at MNH. Dissemination of study findings at MNH shall be overseen by **Dr. Lukansola Mabusi** (MNH) Co - supervisor.

Kindly ensure the named principal investigator abide to the ethical principles and other conditions of the research approval.

Sincerely,

TEACHING, RESEARCH & CONSULTANCY UNIT
P. O. Box 65000
DAR-ES-SALAAM

Dr. Charles K. Pallangyo
For: Head of Clinical Research, Training and Consultancy Unit

c.c DNS
c.c Benedicto Obeth Mwampashi

Upanga West, Kalenga Street, Plot No. 10480/3, P.O. BOX 65000, Dar es Salaam, Tanzania.
Telephone: +255-22-2151367-9, Telephone: +255-22-2151351-2
Email: info@mnh.or.tz, Website: www.mnh.or.tz

Appendix VIII: Approval for data collection at MOI

UNITED REPUBLIC OF TANZANIA
MINISTRY OF HEALTH

MUHIMBILI ORTHOPAEDIC INSTITUTE (MOI)

MOI
MUHIMBILI ORTHOPAEDIC INSTITUTE

Ref.PA. 382/401/01/54 **12th June 2023**

Muhimbili University of Health and Allied Sciences

Dar -es Salaam

Tanzania.

RE: APPROVAL FOR CONDUCTING RESEARCH STUDY

Reference is made to your letter with reference number HD/MUH/T.3/2021 dated on the 05th May, 2023 for conducting research study about. ''***Assessment of Mechanical Ventilation Practice and its Associated Factors among Intensive Care Nurses at Muhimbili Tertiary Hospital***''

On behalf of the Management I would like to officially inform you that, your permission has been granted for your student **Benedicto Obeth Mwampashi** to conduct study at Muhimbili Orthopaedic Institute (MOI).

It's my hope that your stay at MOI will be fruitful. For any clarification contact CRTM +255713764522.

Dr. Joel J Bwemelo, CRTM

For: MOI Executive Director

Cc: Director of Post Graduate studies

Cc: Supervisor

Muhimbili Orthopaedic Institute (MOI), Upanga West Plot No. 1048/2, Kalenga Street, P. O. Box 65474 - Dar es Salaam; Telephone Number +255 -022-2151298/2152937/2152938 Fax: +255 -022-2151744
Website: www.moi.ac.tz, info@moi.ac.tz,