# DETERMINANTS OF WEANING FAILURE AMONG ADULT PATIENTS ON INVASIVE MECHANICAL VENTILATION IN KENYATTA NATIONAL HOSPITAL INTENSIVE CARE UNIT.

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## DECLARATION

This thesis is my original work and has not been submitted for any academic award or published in any other university or any other institution of higher learning for the award of a degree.

**JANE OMUSULA**

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## SUPERVISOR APPROVAL

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To the Almighty God for His strength, mercy and grace.

## DEDICATION

I would like to dedicate this achievement to my mother Margret Nyawira. A strong and gentle soul, for being my first teacher.

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## LIST OF ABBREVIATIONS

**ARDS** - Acute Respiratory Distress Syndrome

**CCC** - Critical Care Center

**COPD** - Chronic Obstructive Pulmonary Disease

**ERC** - Ethics Review Committee

**ICU** - Intensive Care Unit

**IPPV** - Invasive Positive Pressure Ventilation

**KNH** - Kenyatta National Hospital

**MV** - Mechanical Ventilation

**NIV** - Non-Invasive Ventilation

**NPPV** - Noninvasive positive pressure ventilation

**PSV** - Pressure Support Ventilation

**SBT** - Spontaneous Breathing Trial

**UoN** - University of Nairobi

**WHO** - World Health Organization

## OPERATIONAL DEFINITIONS

**Extubation** is the removal of a tube previously inserted into a patient's body, especially which of an artificial ventilation tube from the trachea.

**Mechanical ventilation** is artificial ventilation where mechanical means are used to assist or replace spontaneous breathing.

**Prevalence** number of cases of weaning failure that present in a population of mechanically ventilated patients at a given time.

**Predictor** is a variable used in regression to predict another variable

**Weaning** process of decreasing the amount of support that the patient receives from the mechanical ventilator, to allow the patient to assume greater proportion of the ventilation effort.

**Weaning failure** is the failure to pass spontaneous weaning trial or the need for reintubation within 48 hours following extubation.

## ABSTRACT

**Background:** Weaning failure from mechanical ventilation has become a major challenge in management of patients in intensive care unit (ICU). Approximately 20% of patients on invasive mechanical ventilation fail to wean successfully in the first attempt. There are different factors that contribute to weaning failure which might be caused by patient characteristics as well as healthcare professionals' knowledge in weaning patients from mechanical ventilation. Thus, there is need to understand the current trends and determinants of weaning failure in mechanical ventilation.

**Objective of the study:** To establish the prevalence and determinants of weaning failure among critically ill adult patients on invasive ventilation at Kenyatta National Hospital intensive care unit.

**Methods:** This was a cross sectional study which incorporated a retrospective review of patients' files as well as assessing nursing practice in weaning. The study employed consecutive sampling where 246 patients' files from January 2019 to December 2019 were retrieved. Stratified sampling method were used to categorize nurses into their cadres followed by simple random sampling method which was be applied in the selection of 60 critical care nurses as participants from the strata. A data abstraction tool and questionnaire was used to collect data from patient's medical files and from the nurses respectively.

**Results:** The results showed that 163(66%) of patients were male. The average age was 43±15 years, the length of stay in the ICU was 33±24days, duration on MV was 9±6 days. Among nurses who participated in the study, 54(93%) had higher diploma as their highest level of education while 51(88%) asserted that they had attended a training in critical care nursing. The prevalence of weaning failure was 71(29%). The findings also showed that

There was a significant difference in weaning failure among different older age $x^2$ (2) = 6.779, p = 0.034. cigarette smokers, $x^2$ (1) = 4.746, p = 0.024, low HB level, $x^2$ (1) = 41.04, p = 0.00, CPAP mode of weaning, $x^2$ (1) = 53.5, p = 0.000 and longer duration on MV, $x^2$ (2) = 31.54, p = 0.000 were associated with weaning failure. Binary logistic regression showed that, Lower hemoglobin level, (OR =12.896, 95%CI, (4.2 -39.57, p = 0.000), CPAP mode of weaning, (OR =3.457, 95%CI, (2.029 – 5.891, p = 0.000), and longer duration on mechanical ventilation, (OR =2.92, 95%CI, (1.5 – 21.08, p = 0.000).

**Conclusion:** The results have shown that it is essential to control HB level, cigarette smoking, duration on MV as well as consider alternative for CPAP mode of weaning to increase the chances of weaning success among patients on Invasive mechanical ventilation. It is essential to consider alternative approaches to wean patients with these conditions to increase the chances of weaning success. Nurses in critical care have shown a moderate level of understanding on weaning practice for successful outcome.

# CHAPTER ONE: INTRODUCTION

## 1.1.Background of the Study

Mechanical ventilation is a lifesaving procedure in the critical care unit. Around 38.9% of critical care patients require a period of mechanical ventilation during their care in the critical care unit(1). The goal of mechanical ventilation is to deescalate the mechanical support in a process of weaning. Zein et al, states that an estimated 40% of the time a critically ill patient spent on mechanical ventilation is dedicated to the weaning process(2). This entails, the whole process from liberation from mechanical ventilator support to endotracheal extubation(3).

Weaning can be either abrupt or gradual depending on the patient condition and the level of nurse or healthcare provider expertise. Weaning from mechanical ventilation should be done safely and timely to achieve the desired outcomes. According to Ambrosino and Gabbrielli, Patients who underwent a process of prolonged weaning had significantly higher mortality rates(4). To minimize morbidity, mortality, to reduce patient ventilator days, minimize adverse events due to prolonged mechanical ventilation and to limit ICU stay and cost, weaning should be attempted as soon as clinically indicated. According to McConville and Kress, there is increased morbidity, mortality, ventilator days and hospital stay in patients who experience delayed discontinuation from ventilator support(5). Ghauri et al, states that with increased duration of ventilation, mortality increases(6). A group of patients with weaning duration of more than seven days identifies a subgroup at an increased risk of death(7). There is growing consensus that the use of systematic protocols for the weaning process as compared to usual care can significantly reduce duration of ventilation and improve weaning outcomes(8). Ventilator weaning is an important

process and a critical focus in critically ill patients on invasive ventilation. If weaning is not well done, it can lead to weaning failure.

Martin et al., categorized weaning into three groups. Simple weaning in which the patient tolerates extubation on the same day as the attempt to wean is initiated. Difficult weaning in which the patient requires up to seven days of ventilator weaning before extubation and Prolonged weaning where a patient will require more than seven days of ventilation weaning after the first weaning attempt is made(9). According to Meade et al., Prolonged mechanical ventilation and premature weaning which necessitates reintubation has been associated with significant higher mortality and morbidity(10).

Weaning determinants are parameters or variables that are intended to aid clinicians in prognosticating on the possible outcomes of weaning attempt. The ability to predict outcomes in weaning is important in reducing the rates of reintubation(2). The principal determinants of weaning outcomes are respiratory indices that project respiratory muscle strength, respiratory muscle load and the intensity of respiratory drive(11). Baptist Ella and Sarmento (2018) demonstrated that there was need for weaning and extubation outcomes to be guided by several other parameters and not only respiratory ones(12). Factors such as major organ failure, nutritional and psychological factors have been postulated as having a direct impact on weaning and extubation outcomes.

Use of better systems and process during weaning process help understand key processes that define a successful change development in patient health and ability to withstand spontaneous breathing trial (SBT). The weaning protocols include daily assessment of the patient wellbeing and ability to wean, interruption of sedation and

spontaneous breathing trial. A critical focus on these elements have led to improved weaning process from mechanical ventilator support(13). According to Blackwood and Tume, use of weaning protocols has been associated with reduced stay and faster weaning(14).

### 1.2.Problem Statement

Intensive care patients who need respiratory support benefit from mechanical ventilation. Patients are placed on mechanical ventilation with intention to stabilize their breathing(15). Patients on invasive mechanical ventilation comprise of a significant proportion of ICU admissions and this presents a critical focus for assessment of high-quality care. However, mechanical ventilation is associated with lung injury, complications of immobility, and lung infection. It is therefore imperative that the patients are weaned off the ventilator as soon as possible.

In a prospective study conducted by Tobi, Ekwere and Ochukpe in Nigeria found out that 20%of ventilated patients in intensive care unit demonstrated difficult weaning. Difficult weaning has been associated with increased ventilator days. Accordingto (Tobi et al., 2017) it was not clear whether weaning failure was associated to duration of ventilation or failure of judgement to wean. There is need to embrace a standardized approach to ventilatory weaning.

According to Heunks and Van Der Hoeven, 20% to 30% of patients in ICU are difficult to wean from invasive mechanical ventilation and pose a problem of prolonged mechanical ventilation(16). Patients who experience delay in ventilator weaning and those who need re intubation are associated with poor outcomes(8) .The reasons for ventilator weaning failure, are diverse. A structural approach into identifying determinants of weaning failure is relevant, (Leo et al., 2010). The

predictive parameters of weaning outcomes have been incorporated into the ventilator weaning protocols which has significantly improved the weaning outcome (Savi, Teixeira &Silva 2011).

According to Bouakl et al., the most effective method ventilator weaning follows a systematic approach. The use of weaning protocols has been associated with decreased weaning time and ventilator duration(17).Weaning process is effectively managed through protocols and guidelines which ensure that the process is systematic and successful. The purpose of weaning protocols is to allow the clinician to anticipate and predict the possible outcomes of the weaning process.

Despite evidence showing that structural approaches reduce weaning failure, these weaning protocols are underutilized in Kenyatta National Hospital critical care unit. The prevalence of ventilator weaning failure in Kenyatta National Hospital adult critical care unit is not known. There is no data on the determinants of weaning failure rates within KNH/ICU. The purpose of this study is therefore to assess the determinants of ventilator weaning failure and the prevalence of ventilator weaning failure in critically ill adult patients on invasive mechanical ventilation in KNH/ICU.

**Research Question**

i. What is the prevalence of weaning failure in critically ill adult patients on invasive ventilation in KNH/ICU?
ii. What is the patient characteristics in critically ill adult patients on invasive mechanical ventilation in KNH/ICU?
iii. What are the determinants of weaning failure in critically ill adult patients on invasive ventilation in KNH/ICU?

iv. What are the ventilator weaning practices among nurses taking care of the critically ill adult patients on invasive mechanical ventilation in KNH/ICU?

## Objectives of the Study

### 1.4.1 General Objectives

To establish the prevalence and determinants of weaning failure and Weaning practices in critically ill adult patients on invasive ventilation in Kenyatta National Hospital intensive care unit.

### 1.4.2 Specific Objectives

i. To establish the prevalence of weaning failure among adult patients on invasive mechanical ventilation in Kenyatta National Hospital's Intensive Care Unit.

ii. To identify patient characteristics in critically ill adult patients on invasive mechanical ventilation in Kenyatta National Hospital's Intensive Care Unit.

iii. To establish patient related factors (ventilator days, hemoglobin level, age, patient diagnosis on admission) as determinants of weaning failure in critically ill adult patients on invasive ventilation in Kenyatta National Hospital's adult intensive care unit.

iv. To evaluate weaning practices among nurses managing critically ill adult patients on invasive ventilation in Kenyatta National Hospital's adult intensive care unit.

**Justification of the Study**

Most of these patients on invasive mechanical ventilation are vulnerable to weaning failure due to the fact that they are critically ill and most are on invasive mechanical ventilation. Weaning failure from mechanical ventilation has become a major challenge in management of intensive care unit patients. Given the magnitude and seriousness of this problem of weaning failure, it is important that critical care nurses involved in managing the weaning process of the patients on invasive mechanical ventilation have an understanding of the subject and developments in the field. The investigator is therefore in part, seeking to determine the weaning practices among nurses managing the critically ill patients on invasive mechanical ventilation.

In addition, over several years of nursing experience, I have observed increased mortality, increase in medical costs and prolonged hospitalization as a result of weaning failure among the critically ill patients. For weaning failure to occur, patients' inherent characteristics and the environment play a key role. The investigator would thus like to establish the determinants of weaning failure among these patients in terms of; patient related factors as well as nurse related factors that influence the occurrence of weaning failure.

There are several studies that have been done on mechanical ventilation weaning failure, but most of these studies have focused on clinical physiological parameters as determinants on weaning outcomes. The limitation to this has been that the study groups may have inherent differences such as underlying disease, comorbidities and age difference as other elements bound to influence the weaning outcomes. So far, there is no study done in KNH ICU on prevalence and determinants of ventilator weaning failure.

This study therefore presents a major focus on the determinants of weaning failure from mechanical ventilation and contributing factors which can be effectively assessed to improve patient care and overall commitment to improved weaning outcomes. Understanding of the prevalence, determinants of weaning failure and nursing practices that are employed will help define effective strategies and principles that can help streamline the management of critically ill patients on invasive mechanical ventilation in intensive care unit.

# CHAPTER TWO: LITERATURE REVIEW

## 2.1 Pathophysiology of Weaning Failure

Understanding the pathophysiology of weaning process is complex. The focus of studies published on weaning failure has mainly been on one aspect of weaning which makes it difficult to develop an overall specific platform that define improved outcomes (Ladeira et al., 2014;Boles, Bionc, & Et, 2007).

Weaning patients from mechanical ventilation comprises the major portion of workload in the ICU. Around 40% of total ventilator time is taken trying to wean patients (20) There are different pathophysiological mechanisms that can be assessed to help in describing weaning failure. However, the exact role of each mechanism has not been effectively defined. Patients who fail to wean are at increased risk of death. However the common outcome associated with weaning failure is hypercapnia which occurs as a result of decreased tidal volume rather than decrease in respiratory drive (21).

The performance of respiratory muscle is lessened due to the dynamic hyperinflation as well as paradoxical motion of the rib cage and abdomen. The deteriorating of pulmonary mechanics will cause a significant embarrassment of the respiratory muscles (Epstein, 2002). However, the clinical importance of the respiratory muscle fatigue has remained unclear making it difficult to understand the whole process and the development of muscles within the respiratory system. The afferent stimuli that arise from the lung parenchyma or impaired gas exchange is transmitted to the control centers due to the existing severe dyspnea in patients who are likely to fail the weaning trial (23).

## 2.2 Epidemiology of Mechanical Ventilation Weaning

Weaning from a ventilator is difficult. It requires a more specific approach with a clear understanding on common guidelines that are followed to ensure that the process is successful. Weaning is classified in three categories which include simple, difficult and prolonged weaning. Simple weaning is associated with better clinical outcomes compared to difficult and prolonged. Knowing when to wean a patient is the most challenging activity among healthcare providers resulting into failure.

The use of noninvasive ventilation presents a different approach in determining weaning failure among patients. Thus according to different authors, weaning success has been identified as the absence of mechanical ventilation for a minimum of 48 hours following extubation (Kirakli et al., 2011; Laghi et al., 2003). According to a randomized controlled study conducted by Esteban (1995), spontaneous breathing trials had faster liberation from ventilator support compared to weaning using pressure support ventilation or intermittent mandatory ventilation. Similar findings were also obtained by Meade et al., who found that gradual reduction from the ventilator support accelerates successful discontinuation(10).

A randomized prospective study conducted by Haas and Loik revealed that spontaneous breathing trials(SBT) resulted into a more rapid liberation than pressure support ventilation(PSV)although clinicians were also slow to wean(29). Weaning is a process that can be done as soon as possible as long there is a clear understanding of the underlying factors which might have a detrimental influence on the process (30).

There are guidelines that healthcare providers within intensive care units are expected to follow to ensure that they are successful in weaning process. The guidelines include specific information which help understand the existing situation while maintaining a

proper emphasis on better results(31). The guidelines that are adopted identify the need for screening of a patient before beginning the weaning trial. There are different approaches that are used to wean based on the need to ensure that it is successful. Gradual reduction is a major component in controlling pressure support while SBT allow the patient to spontaneously breath through the T-piece (10). In comparing weaning through pressure support and SBT. Heunks and Van Der Hoeven found that SBT resulted in an increased liberation compared to any other technique in weaning(16). However, different studies have attained different results regarding the need to prove the superiority of SBT in relation to pressure support as weaning methods (Heunks & Van Der Hoeven, 2010;Epstein, 2009). The variation in this case is explained based on the difference in study designs, duration of mechanical ventilation as well as patient characteristics which are essential to consider before in initiating weaning process (26).

### 2.3 Prevalence of Weaning Failure

Weaning failure has been more prevalent in recent times which presents the need to improve the level of ventilation management. Saiphoklang and Auttajaroon found that length of stay on Mechanical ventilation machine and malnutrition were major factors associated with weaning failure. The study further showed that the incidences of simple weaning was 46.6%, difficult weaning was 36.9% and prolonged weaning was 16.5% (24).

In a cohort prospective study conducted by Beduneau et al., from the initial 510 patients, 257 intubated patients started weaning. Simple weaning included 59%, difficult included 26% and 14% prolonged weaning. The findings also identified that there was an increase in mortality among patients with prolonged mechanical

ventilation(25). Around 30% of the patients in intensive care units are considered difficult to wean hence resulting into weaning failure (16).

The failure to pass a spontaneous breathing trial or necessity for re-intubation within 48 hours after extubation is considered as weaning failure (3). Being able to accurately predict the weaning success is essential in reducing the number of re-intubations which is associated with seven times increase in hospital mortality. Re-intubation is a common practice within Intensive care units at an estimated rate of between 10 to 15% (26). However, it is worth noting that such cases increase the risk of mortality. Determinants of weaning failure have been reported with excess secretions and duration of ventilation being the independent factors that influence weaning failure (10). The existing significant variation in weaning failure has been associated with different factors based on the definition of weaning failure especially the definition of weaning failure as a failed spontaneous breathing trial (Quinnell et al., 2006).

### 2.4 Patient Characteristics in patients on Invasive Mechanical Ventilation

Age and sex have not been significantly associated with mechanical ventilation weaning failure. According to Baptistella et al., patient's ventilator weaning outcomes could not be linked to contribute to weaning failure independent of patient's organ system dysfunction(33).

It is recommended that clinicians screen all medical critical care patients for alcohol use disorders(34). Screening for AUDs is strategy that can help detect when preventive measures are needed, and also help clinicians in tailoring patient care more appropriately.

Smoking of cigarettes has been associated with chronic lung disease. Schmidt et al., postulated that exposure to cigarette smoke aggravated injury to the alveolar epithelium and was a risk factor to respiratory distress syndrome(35).

In another study, Boles et al., the independent risk factors for weaning failure included age, duration on mechanical ventilation and anemia(36). Extubation failure has been associated with prolonged hospital stay which is a detrimental factor in the chances of survival among patients. In a randomized study conducted by Schonhofer, COPD, obesity and anemia were the major risk factors for weaning. Severe anemia was associated with increased risk for weaning failure (37).

### 2.4.1 Duration of Mechanical Ventilation

Duration of mechanical ventilation involves the time that a patient has spent on the ventilator. Difficult weaning has been associated with duration of ventilation. According to Boles et al., average duration of ventilation for the ICU patient ranged from 2.6 to 7.9 days(36). Significant differences in variation was associated with differences in patient characteristic. Prolonged mechanical ventilation has been associated with higher mortality and morbidity(6). Time period spent on ventilation correlates with increased cost of ICU care. Prolonged mechanical ventilation and difficult weaning is associated with 40% consumption of ICU resources. However patients who stay longer on ventilator support are likely to result in weaning failure (38).

A prospective study done by Ishaaya et al. (1995) established that the work of breathing was higher following extubation as compared to spontaneous breathing through the endotracheal tube. The findings showed that there was no significant correlation between the duration of intubation and the resistance of the tube.

According to Burns et al. (2013), the study showed that Noninvasive weaning had no impact on the duration of ventilation related to weaning (12).

### 2.4.2 Delirium and Depression in Weaning

Difficult to wean patients have been associated with brain dysfunction which is mainly linked to delirium. Cognitive dysfunction was associated with an increased risk of weaning failure among critical care patients (4). Weaning protocols identified different factors which present a specific approach in ensuring that there is a strong system for successful change. Physiotherapy is a crucial component of weaning protocol. Therefore, important elements that are evaluated include the complexity of patient situation as well as the underlying comorbidities. The expertise of healthcare providers is also an important factor that present a strong consideration on better elements which help attain improved outcomes (40).

### 2.4.3 Anxiety and Depression

The patient stay in ICU is associated with significant different factors which influence their level of anxiety. Anxiety has also been associated to the process of weaning. The feeling of anxiety especially in critical care units makes it difficult to wean patients. According Azouly et al. (2013), the prevalence of anxiety among critically ill patients in ICU ranges between 30-75%. The contributing factors that are assessed include lack of ability to communicate, dyspnea and sleep and rest disruption(41).

Depression might occur as an independent factor or in association with ICU delirium. Different strategies have been developed with an intention to reduce anxiety among patients on ventilator support machines. The factors that were identified include increasing the inspiratory time and PEEP, use of relaxation techniques and nursing interventions based on the identified protocol (8).

Girard et al. (2008) conducted a randomized controlled study aimed at investigating the influence of sedation to weaning process in mechanical ventilation. The findings from the study showed that high level of sedation increases the number of days spent on ventilator machine as well as failure to wean. SBT have been associated with reduced hospital stay and quicker weaning which present a more stable focus on better changes that help improve the weaning process and success. The use of weaning protocols presents a clear guideline which help in maintaining a strong emphasize on improving the chances of weaning success or failure

According to Jubran et al. (2010), stress might have a negative influence on weaning process. A significant number of ventilated patients may develop emotional stress due to the overwhelming feeling of depending on a machine for their breathing. Stress and depression were also found to have a direct negative influence on weaning failure. Higher stress levels have negative influence on weaning success. (42). Roche-Campo et al. (2013) highlighted that improving patients sleep can be done through restricting noise and lighting during the sleeping hours (43).

## 2.5 Determinants of Weaning Failure in Critically Ill Patients on Invasive Mechanical Ventilation

Mechanical ventilation is an important therapy in stabilizing a patient in critical condition through assisted breathing (3). The artificial ventilation is employed as an alternative to spontaneous breathing. There exist two major types of ventilation which include invasive and noninvasive. Invasive ventilation involves the use of an instrument such as endotracheal tube which is inserted into the trachea with an intention to bypass the upper airway.

Decreasing the dependence of a patient on ventilator support is essential in improving the patient's health and preventing complications. The process is normally performed gradually while taking into consideration different factors such as the condition of the patient and existing comorbidities. Abrupt discontinuation of patients on ventilator can occur successfully in 75% of all patients. According to a study performed by Eskandar and Apostolakos (2007), it was found that around 20% of the patients fail to wean on the first attempt. Prolonged stay on ventilator support has also been associated with increased cost of care as well as mortality.

Studies have shown that daily trials of spontaneous breathing for appropriate patients based on the standing protocol and driven by respiratory care practitioners are essential in improving the weaning process and patient outcome (Eskandar & Apostolakos, 2007;Allen & McGrattan, 2013). In a randomized study conducted by Epstein (2009), it was identified that weaning is done with a specific emphasis on different levels which make it easier to maintain a stronger emphasis on important processes that help define improved level of management. The three levels based on duration include simple where there is ventilator discontinuation after the first assessment, difficult in which the ventilator is discontinued from 2–7 days after initial assessment. The third classification is prolonged where the ventilator was discontinued in >7d after initial assessment. Identification of determinants of weaning failure and adopting the various strategies to enhance and promote expeditious and successful weaning from mechanical ventilation is a research priority and quality improvement strategy(3).

### 2.5.1 Nutrition

Malnutrition is a common condition in the intensive care unit. Malnutrition has been associated with weakness, reduced muscle mass and inability to wean. A highly strong nutritional plan for ventilated patients present an improved commitment to better changes which can be integrated to help ensure there is a strong focus on the underlying level of engagement (46). Body mass index has been associated with length of ventilator stay which affects the weaning outcomes. Obesity has been described to pose a mechanical effect that decreases compliance and increases the burden of increased work of breathing. According to Malkoc et al. (2009) there was an increase in hospital stay among obese patients. Even though the prevalence of malnutrition among patients in critical care is around 40%, there is no significant research that has been conducted which identify the relationship with weaning failure. However patients who stay longer on ventilator support are likely to result in weaning failure (38).

Vitamin supplements have been used to increase the chances of weaning success among patients. In a study conducted by Hiesmyr (2012) on length of stay among patients using vitamin supplements. The results identified that there was significant difference in weaning success among patients using vitamin supplements and control group. Therefore, vitamin supplements were associated with increased chance of weaning success.

### 2.5.2 Anemia

Anemia has been greatly associated with weaning failure among ventilated patients. Increasing the hemoglobin(HB) level has been postulated to help with the increased demand for oxygen that occurs during the process of weaning(47) In a large

prospective randomized study, Herbert et al. (2001) sought to examine whether blood transfusions improve the outcomes that are related to mechanical ventilation. The findings from the study showed that maintaining HB level at 10-12g.dL did not cause a reduction in the duration of mechanical ventilation. This indicates that further investigation into the role of hemoglobin in ventilator weaning process is necessary.

### 2.5.3 Gas Exchange

During the weaning process, patients experience a disturbance in gas exchange. Patients may experience high or low levels of partial pressure of carbon dioxide or both during SBT. When the weaning process fails, the patient is not able to respond to a high partial pressure of carbon dioxide by raising their tidal volume as they experience weakness of the respiratory muscles. Incidences of pneumonia in critically ill patients as admission diagnosis or during the ventilator support are common. The incidence of ventilator acquired pneumonia is approximately between 9 and 67% and has a 50% risk for mortality among ventilated patients(48). Therefore shortening of the weaning process can go a long way in mitigating is and reducing the incidence and prevalence of ventilator caused pneumonia among patients (49). Powers et al. (2013) also states that re-intubation is associated with increased pneumonia among mechanically ventilated patients (50).Pneumonia and other comorbidities may also reduce pulmonary compliance and therefore reducing its incidences and optimizing cardiac function is indicated before the weaning process is initiated.

The process of aging is associated with various physiological changes such as a progressive decline in chest wall compliance and cumulative pulmonary function. Recommendations on weaning practices in this age group remain controversial(51).

### 2.5.4 Cardiac Function

The increased work of breathing that is associated with ventilator weaning, can cause significant stress to the patient's heart. Cardiac failure in itself is a factor that can compromise the weaning outcomes and cause failure to wean. Therefore it is important that this category of patients are identified and preemptive interventions instituted to mitigate adverse events in weaning(52). Chronic obstructive pulmonary disease (COPD) have also been associated with increased weaning failure. In patients with COPD, a reduction in the left ventricle ejection fraction which occurs as a result of afterload in the left ventricle has been linked to challenges faced during weaning.(53). According to Hunks and Van Der Hoeven (2010), Chronic obstructive pulmonary disease (COPD) has been identified as a significant independent predictor of weaning failure(16). In a similar study, Quinnel et al (2006) also found that there was a high prevalence of weaning failure in COPD patients attributing to up to 61% of weaning failure (23). Research has shown that patients who fail SBT should use non-invasive ventilation (NIV) to reduce the risk of mortality (15).

In another study conducted by Jubran et al. (1998) in failed weaning, increased afterloads were found in both of the right and the left ventricle (54). Patients with successful weaning had lower brain natriuretcic peptide (BNP) hormone (55).

## 2.6 Mechanical Ventilator Weaning Practices

Weaning is an important process in the development of care within critical units. A weaning approach that embraces team work and a multidisciplinary approach has been shown to improve patient outcomes (56) There are guidelines that inform the weaning protocol(56). However, Blackwood and Tume (2015) identified that weaning protocols are rarely used by healthcare providers which result into failure. The

weaning practices identify that there is need for daily assessment of the patient while also taking into focus the underlying factors influencing patient response(14)Studies on non-physician directed weaning have shown a reduction in weaning time, significant reduction in ventilator days and ICU days. Some studies reported reduced failed extubation and ventilator-associated pneumonia rates(29)

The Essential decision tools such as protocols ensure a stronger level of understanding of the process and also provide a standardized objective approach to the weaning process. A study done by (57) identified that mechanical ventilation weaning protocols can be utilized by non-physician clinicians.

## 2.7 Theoretical Framework

Humanistic nursing theory provide an understanding on improving the quality care through increased knowledge among healthcare providers. Increasing the chances of weaning success means that the nursing providers must understand the underlying predictors of weaning success and failure so that it would be possible to integrate favorable interventions to achieve successful theory development (58). The Humanistic theory identifies better concepts which help understand the level of care. The theory was developed by Josephine Paterson and Loretta Zderad based on key concepts which define quality healthcare and the role of nurses. Nursing education on weaning protocols is integral to having a successful understanding on better processes which help maintain a highly strong system for change.

Successful weaning is dependent on the ability of nursing care providers to understand the basic elements that can be considered in managing improved patient outcomes. This means that the level of knowledge among nurses is integral in having a successful weaning from mechanical ventilation. The nursing care provider must

effectively monitor the patient development before determining whether to begin the weaning process(59).Thus understanding the predictors of weaning present a highly integral understanding on important changes that help implement a successful commitment to management of patient development. Ventilated patients are sensitive and complex to handle. Weaning failure can easily lead to mortality if there is no enough knowledge on the weaning guidelines and protocols.

## 2.8 Conceptual Framework

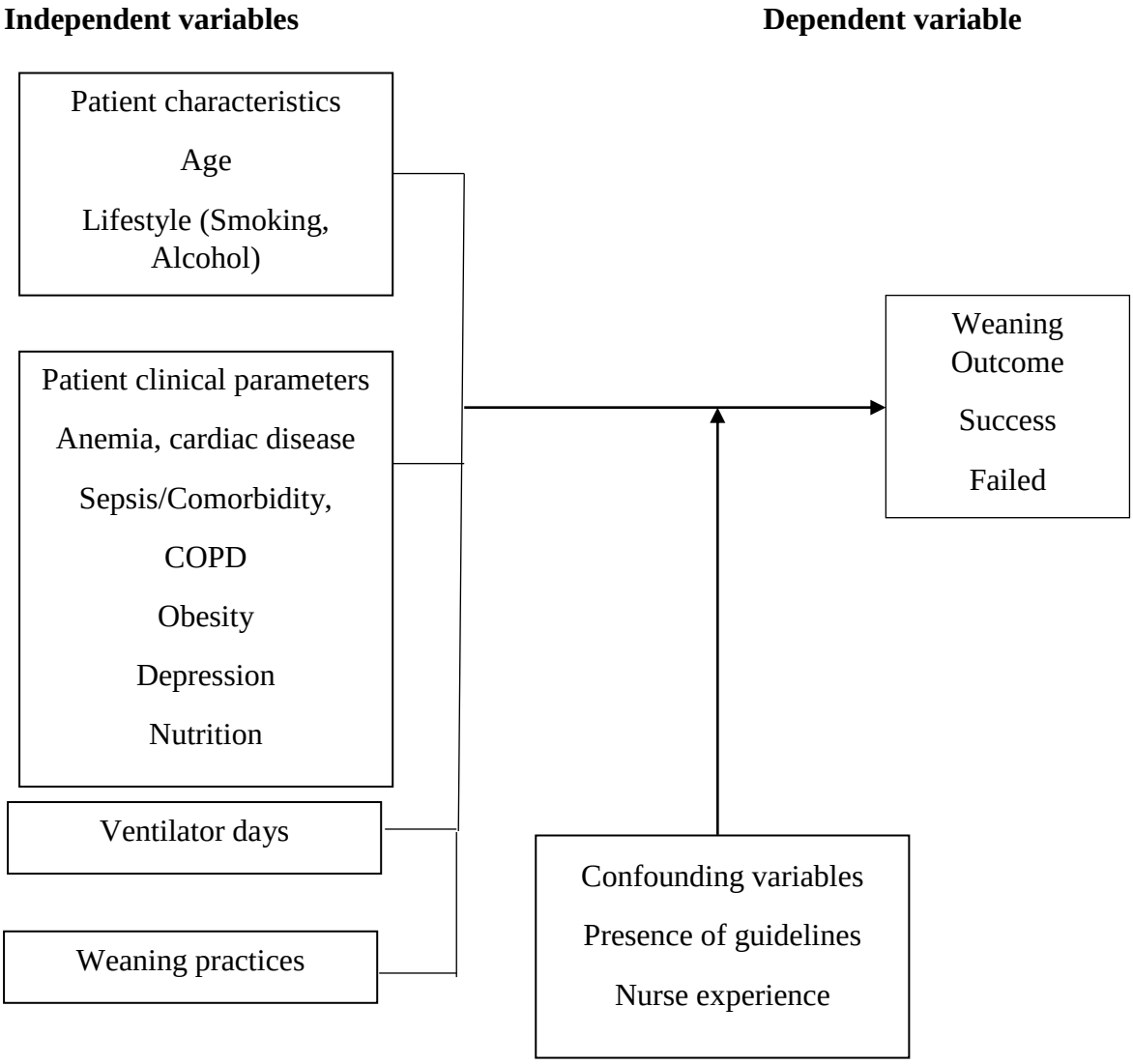


**Figure 2.1: Conceptual Framework**

# CHAPTER THREE: METHODOLOGY

## 3.1.Study Design

The study utilized a cross sectional study design. This design was adopted to determine the prevalence and determinants of weaning failure among adult patients on invasive mechanical ventilation at KNH, ICU. It incorporated a retrospective review of patients' records/ files for the period between January 2019 to December 2019. The retrospective design was selected because it provided an account of the prevalence of weaning failure as well as the patient related factors that predispose them to weaning failure. The cross-section design portrayed an accurate account of the knowledge and practice of nurses charged with implementation of the weaning process among the critically ill patients on invasive mechanical ventilation. This design is appropriate as it met the objectives of the study as it provided focus on the available data to assess weaning failure among patients on invasive mechanical ventilation and utilization of management guidelines by nurses.

## 3.2.Study Setting

The study was conducted at Kenyatta National Hospital Intensive Care Unit. Kenyatta National Hospital is the largest Teaching and Referral public health institution for the college of health sciences, University of Nairobi. It is located in Kenya's Capital city about 1.5 kilometers from central business district, in Upper hill area along hospital road, off-Ngong road. The hospital sits in a vast area of land covering about 5 hectares and has about 50 in-patient wards with hospital bed-capacity of 2000 (60). The hospital has the most advanced critical care unit available for general population hence provided a better basis for research. The main Intensive Care Unit consist has 21 beds and the medical ICU has 8beds.Admissionsin the two units is estimated to be around 100 patients per month [at 93% occupancy], with the average length of

hospital stay [ALOS] and the death rate of patients estimated to be 9.7 days and 41.7% respectively. While the length of hospital stay is at 9.7 days on average. Physicians, Critical care nurses, registrars, medical officers, nutritionists and physiotherapist tend to patients in these two ICU units. The study setting was also selected because of convenience.

### 3.3.Study Population

The study focused on adult patients who were on invasive mechanical ventilation between January2019 and December 2019. The focus on this population was able to provide accurate information regarding weaning from mechanical ventilation and associated determinants based on the available patient information.

The study also included nurses who are directly involved in management of patients on invasive mechanical ventilation. This population provided information regarding the utilized weaning guidelines within the hospital.

### 3.4.Eligibility Criteria

#### 3.4.1. Eligibility of Patient Files

**Inclusion**

- Files for Patients who were on invasive Mechanical Ventilation for more than 48hours between January 2019 and December 2019.
- Patients above 18 years
- Fully completed patient files that is files which include Age, gender, diagnosis, date of intubation and extubation, weaning process and outcome

**Exclusion Criteria**

- Patient's files without patient's gender, diagnosis, date of intubation and extubation, weaning process and outcome will be labeled incomplete and excluded.

- Patients with respiratory muscle dystrophies
- Patients who had been on ventilatory support at home before admission.
- Files for patients who were admitted before January 2019 and after December 2019.

### 3.4.2. Eligibility for Nurses

**Inclusion criteria**

- Nurses willing to participate in the study
- Nurses working in Critical care unit for past 2years
- Nurses who have weaned a patient from ventilator.
- Nurses on permanent employment.

**Exclusion Criteria**

- Nurses who have never weaned a patient from ventilator.
- Nurses who are off duty or on leave during the data collection period.
- Nurses who decline to consent to consent to participating in the study
- Student nurses, nurses on locum or work on part time basis

## 3.5.Sample Size Determination

### 3.5.1. The Sample Population for Patients

According to Saiphoklang and Auttajaroon (2018), approximately 20% of all patients fail in their first attempt to wean. Therefore the sample was calculated using Fischer's formulae (61).

$n = z^2pq/e2$

Where

n = sample population

Z = normal 95% confidence z score (1.96)

P= estimated population with the characteristic (0.2)

q is (1-p) = population without the characteristic (0.8)

e = margin of error (5%)

Therefore, the sample size will be

$n = Z^2Pq/e2$

$n = (1.96^2)\ (0.2*0.8)/0.05)$

= 0.614656/0.0025

= 246

**The sample size will be 246**

### 3.5.2. The Sample Population for Nurses

The sample size determination for nurses in the study will utilize Taro Yamane's formula

$$n = \frac{N}{1+N(e2)}$$

where N is the total population (153)

1 is the standard coefficient

e is the margin of error (0.1)

n is the sample population

Therefore,

$$n = \frac{153}{1+153(0.1)2)}$$

$$n = \frac{153}{1+N(e2)}$$

$$n = \frac{153}{1+1.53)}$$

n = 60

**The sample size is 60**

### 3.6.Sampling Technique

#### 3.6.1. Sampling of Patient Files

The Principal Investigator employed a purposive sampling technique in recruitment of patient files based on the inclusion criteria defined. The principal investigator with the help of the two research assistants consecutively extracted patient files within a one-year period between January 2019 and December 2019.

#### 3.6.2. Sampling of Nurses

Stratified sampling technique was utilized to sample nurses into the study. The principal investigator relied on the eligibility criteria outlined which helped in sampling the best suited respondents to help understand the research problem. Stratified sampling method was used to select the critical care nurses (CCN) participants in the study who met the specified inclusion criteria for the study after which simple random sampling method was used in each stratum. This is because the nursing profession is in cadres and this will avoid selection bias. The strata include; Senior nursing officer (SNO), Nursing officer 1(NO1), NO2 and NO3s. Sampling was done until the desired sample size of 60 CCNs was achieved.

### 3.7.Recruiting Research Assistants

The research assistants included two nurses with a minimum of diploma in Nursing qualification. The research assistants were individuals not working within the hospital

but had ICU experience. The researcher also prioritized individuals who had previously collected data from patient files to ensure smooth data collection process. The principal investigator undertook the training of the selected research assistants to ensure that they understood the research tool and any issues regarding the questionnaire to ensure that the processes was successful.

## 3.8.Recruitment and Consenting of Participants

### 3.8.1 Records Access and Selection

After the approval from UoN/KNH – ERC and KNH Administration, the data collection process began (Reference no. P94/02/2020). The Principal Investigator with the help of research assistants extracted patients' files for the year 2019 (January to December). The files that met the study inclusion criteria were selected consecutively. A data abstraction tool was used to extract data from patient files.

### 3.8.2 Recruitment and Consenting of Nurses

The recruitment of nurses into the study ran concurrently with collection of data from the files. The data collection process began after necessary approval from UoN/KNH – ERC and KNH Administration. The Principal Investigator with the help of two research assistants engaged nurses in the Critical Care unit to identify the nurses who work in the Intensive Care Unit. The eligibility of the nurses was assessed to determine whether they warrant inclusion into the study based on the inclusion criteria. Those who met the inclusion criteria were taken through the consent form where the research assistant explained, the purpose of the study, privacy and confidentiality measures that have been put in place. This was done during their change of shift after report or during their health break. A nurse who consented was included in the study as a respondent. The research assistant administered the questionnaire to each of the respondent and provided any clarification.

### 3.9. Data Collection Tools

Data abstraction tool and a questionnaire were used to collect data. Data abstraction tool was used to collect patient data from the patient's files. A questionnaire was used to collect information from nurses who participated in the study. The questionnaire was interviewee-administered. The questionnaire included questions related to the study outcomes.

### 3.10. Validity and Reliability of Study

The data tool was reviewed by a qualified and experienced nurse in critical care unit to ensure that it captured correct information. Participants into the study were randomly recruited hence limiting bias. There was limited room for error considering that the data was documented in patient files. The principal investigator explained the purpose of the study to nurses and answered questions relating to the study to ensure they understood before consenting. The data abstraction tool was also informed by past literature which presented an improved understanding on the study problem and structure of the data collection instruments.

Validity is the extent to which a given measurement is able to provide accurate results that correspond to real world (62). A tool is assessed to determine whether it will produce the results intended based on the methodology adopted. Heale and Twycross (2015) identified that the degree of accuracy in evaluation varies significantly and thus provide a strong focus on essential concepts which help in determining whether a given treatment method that has been suggested can achieve the desired outcomes. Internal validity of the study was achieved through review of the data abstraction tool and questionnaire by an expert statistician and professionals in the Critical Care Health management.

### 3.11. Pre-test

The questionnaire was pretested in the KNH neurological ICU. The pretest was done on 6 CCNs who met the set inclusion criteria. The purpose of the pretest was to determine whether the questions were clear and correct and whether the nurses understood what was required from them. The data collection tools were then reviewed to incorporate findings from the pretesting exercise. A review of 10% of patient files of patients on invasive mechanical ventilation was done to assess the effectiveness of the developed data abstraction tool. No changes were implemented to the data abstraction tool and the questionnaire. The data collection tools were found to capture accurate information relating to the study hence there were no major changes that were done.

### 3.12. Data Management

The data collected using questionnaires and checklist was checked daily for completeness by the principal investigator. Collected data was entered in Epi-Data 3.1 database then analyzed using SPSS computer package, version 25.

The consent forms, questionnaires and checklists had codes and respondents did not have to include their names on them. Once they were filled, they were locked up in a safe cupboard and will be stored for a period of three years. The data was managed by a qualified statistician. The analyzed data was stored in a password protected laptop and accessible by the principal investigator.

### 3.13. Data Analysis and Presentation

The researcher used descriptive statistics to describe the socio-demographic characteristics of the sample population. Among the variables used for this included but not limited to; Gender, age, level of education and marital status and other variables included in the research. Categorical data such as gender, smoking and

alcohol use presented as proportions (%). Continuous data such as age, number of ventilator days presented as means ± SD or Median ± IQR.

A binary logistic regression analysis was conducted to establish determinants of weaning failure among patients on mechanical ventilation system. The determinants assed in this case included duration of mechanical ventilation, hemoglobin level, patient diagnosis on admission and comorbidities and mode of weaning.

The analysis was done using Statistical Package for Social Sciences (SPSS) Version 26. The null hypothesis will be rejected at $p<0.05$.

### 3.14. Ethical Consideration

The nature of the study limited the underlying ethical issues which needed to be exhaustively developed. Approval to carry out the study was sought from KNH-UoN ERC (Reference no. P94/02/2020) on 26$^{th}$ August 2020. Permission to carry out the study was also obtained from KNH administration. KNH administration provided approval to access patient files and to recruit nurses to participate in the study. Confidentiality, anonymity and privacy was fully guaranteed throughout the study.

In ensuring that there were no healthcare risks especially in relation to COVID-19, the Principal investigator provided face masks to the two research assistants and respondents who were recruited into the study. When engaging nurses, the principal investigator trained the research assistants on maintaining 1.5m social distance as well as provided hand sanitizers which were used by research assistants and study respondents.

# CHAPTER FOUR: RESULTS

## 4.1.Introduction

The purpose of the study was to establish the prevalence and determinants of weaning failure among critically ill adult patients on invasive ventilation at Kenyatta National Hospital intensive care unit. The target population included both nurses and patients on invasive mechanical ventilation.246 patient's files were retrieved and included in the analysis. The study included 60 nurses who were targeted in this study. Among the 60nurses, 58 completed their questionnaires successfully and returned the questionnaires for analysis representing a 97% response rate. There were no changes that were made to the data collection tools after pretest.

## 4.2 Demographic Characteristics

### 4.2.1 Patient Demographic Characteristics

The analysis investigated demographic characteristics among patients who were included in the study and were assessed as shown in Table 1.

**Table 1: Demographic characteristics among patients included in the study**

| Variable | | Frequencies | Percentages |
|---|---|---|---|
| **Age** | Mean ±SD | 43±15 | |
| | Median (IQR) | 42 (32 – 52 years) | |
| | ≤30 Years | 56 | 22.8 |
| | 31 - 50 Years | 119 | 48.4 |
| | Above 50 Years | 71 | 28.9 |
| **Gender** | Male | 163 | 66.3 |
| | Female | 83 | 33.7 |
| **Level of education** | No formal education | 19 | 7.7 |
| | Primary education | 26 | 10.6 |
| | Secondary | 111 | 45.1 |
| | Tertiary | 90 | 36.6 |
| **Occupation** | Formal employment | 94 | 38.5 |
| | Self | 77 | 31.6 |
| | Unemployed | 55 | 22.5 |
| | Student | 18 | 7.4 |
| **Religion** | Christian | 214 | 86.9 |
| | Muslim | 31 | 12.7 |
| | Hindu | 1 | .4 |
| **Department of admission** | Main ICU | 130 | 52.4 |
| | Medical ICU | 116 | 47.2 |
| **Presence of comorbidities** | Yes | 130 | 52.4 |
| | No | 116 | 47.2 |
| **Types of Comorbidities** | Psychological | 5 | 2.0 |
| | Sepsis | 37 | 15.0 |
| | Cardiac Disease | 33 | 13.4 |
| | Respiratory | 14 | 5.7 |
| | disease | 11 | 4.5 |
| | Endocrine | 13 | 5.3 |
| | Trauma | 17 | 6.9 |
| | CKD | | |
| **Length of stay in ICU** | Mean± SD | 33±24 | |
| | Median (IQR) | 31 (14 – 43 days) | |
| | <30 days | 120 | 48.8 |
| | 31 - 60 days | 89 | 36.2 |
| | Above 60 days | 37 | 15.0 |
| **Duration of invasive MV days** | Mean± SD | 9±6.3 | |
| | Median (IQR) | 7(5 – 12 days) | |
| | Less than 7 days | 130 | 52.8 |
| | 8 - 14 days | 74 | 30.1 |
| | More than 14 days | 42 | 17.1 |

ICU – Intensive care unit, MV – Mechanical ventilation, CKD – Chronic kidney disease, SD - Standard deviation, IQR – Interquartile Range

### 4.3 Nurses Demographic Characteristics

Among nurses included in the study, the average age was 37 years with a standard deviation of 5. Most of the nurses recruited, 47(81%) were aged between 31 and 50 years, 51(88%) had training in critical care nursing, 54 (93%) had higher diploma as their highest level of education while 36 (62.1%) were stationed in medical ICU as shown in Table 2.

**Table 2: Nurses Demographic Characteristics**

| Variable | | Percentage | Percentage |
|---|---|---|---|
| **Age** | Mean ±SD | 37±5 | |
| | Median (IQR) | 37(33 – 40 years) | |
| | ≤30 Years | 11 | 19 |
| | 31 - 50 Years | 47 | 81 |
| **Training in Critical Care Nursing** | Yes | 51 | 88 |
| | No | 7 | 12 |
| **Level of education** | Higher diploma | 54 | 93.0 |
| | Masters | 4 | 7.0 |
| **Unit stationed** | Main ICU | 22 | 37.9 |
| | Medical ICU | 36 | 62.1 |

### The Prevalence of Weaning Failure among Adult Patients on Invasive Mechanical Ventilation

The researcher sought to investigate the prevalence of weaning failure among patients on invasive mechanical ventilation at Kenyatta National Hospital. Weaning failure was considered as the failure to pass spontaneous breathing trial or the need for re intubation within 48 hours following extubation. The results showed that the prevalence of weaning failure was 71(29%) among all patients on invasive mechanical ventilation.

$$\text{Prevalence} = \frac{Numberofpatientswho\ hadweaningfailure}{numberofsamplepopulation\ (n)} * 100$$

Thus, number of sample population = 246

Number of patients who had weaning failure = 71

Prevalence (%) = $\frac{71}{246} * 100$

= 29%

Thus, the prevalence of weaning failure is 29%

**Association between Patient Characteristics and Weaning Outcome in in Critically Ill Adult Patients on Invasive Mechanical Ventilation**

A chi-square test was conducted to investigate the association between patient characteristics and weaning outcome among patients on invasive mechanical ventilation as shown in Table 3. The findings showed that, there was relatively same level of weaning failure, among male and female patients included in the study. There was a significant difference in weaning failure among different age groups $x^2$ (2) = 6.779, p = 0.034, cigarette smokers, $x^2$ (1) = 4.746, p = 0.024, lower HB level, $x^2$ (1) = 41.04, p = 0.001, longer duration on ventilator machine, $x^2$ (2) = 31.54, p = 0.000 and CPAP mode of weaning$x^2$ (1) = 53.5, p = 0.000 were associated with weaning failure.

**Table 3: Association between Patient Characteristics and Weaning Outcome**

| | | Weaning outcome | | | | |
|---|---|---|---|---|---|---|
| | | Success | Failure | Df | chi square | p-value |
| Gender | Male | 116(71.2%) | 47(28.8%) | 1 | 1.03 | 0.551 |
| | Female | 59(71.1%) | 24(28.9%) | | | |
| Age group | >30 Years | 39(69.6%) | 17(30.4%) | 2 | 6.779 | 0.034 |
| | 31 - 50 Years | 93(78.2%) | 26(21.8%) | | | |
| | Above 50 Years | 43(60.6%) | 28(39.4%) | | | |
| Cigarette Smoking | Yes | 31(58.5%) | 22(41.5%) | 1 | 4.746 | 0.024 |
| | No | 139(73.9%) | 49(26.1%) | | | |
| Alcohol consumption | Yes | 44(64.7%) | 24(35.3%) | 1 | 1.91 | 0.111 |
| | No | 126(73.7%) | 45(26.3%) | | | |
| Presence of comorbidities | Yes | 109(66.9%) | 54(33.1%) | 1 | 2.647 | 0.069 |
| | No | 55(77.5%) | 16(22.5%) | | | |
| Types of comorbidities | Psychological | 2(40%) | 3(60%) | 6 | 12.146 | 0.059 |
| | Sepsis | 31(83.8%) | 6(16.2%) | | | |
| | Cardiac Disease | 17(51.5%) | 16(48.5%) | | | |
| | Respiratory disease | 10(71.4%) | 4(28.6%) | | | |
| | Endocrine | 7(63.6%) | 4(36.4%) | | | |
| | CKD | 11(64.7%) | 6(35.3%) | | | |
| Length of stay in ICU | ≤30 days | 89(74.2%) | 31(25.8%) | 1 | 1.047 | 0.189 |
| | Above 30 days | 86(65.2%) | 40(31.7%) | | | |
| HB level | ≤10 mgdl | 9(24.3%) | 28(75.7%) | 1 | 41.04 | 0.001 |
| | ≥10mgdl | 115(79.3%) | 30(20.7%) | | | |
| Sedation | Yes | 126(71.6%) | 50(28.4%) | 1 | 0.037 | 0.483 |
| | No | 45(70.3%) | 19(29.7%) | | | |
| Duration on MV | Less than 7 days | 108(83.1%) | 22(16.9%) | 2 | 31.54 | 0.001 |
| | 8 - 14 days | 51(68.9%) | 23(31.1%) | | | |
| | More than 14 days | 16(38.1%) | 26(61.9%) | | | |
| Mode of weaning | SBT | 114(91.9%) | 10(8.1%) | 2 | 53.5 | 0.001 |
| | PSV | 6(54.5%) | 5(45.5%) | | | |
| | CPAP | 54(49.1%) | 56(50.9%) | | | |

CPAP- Continuous Positive Airway pressure; PSV Pressure Support Ventilation; SBT Spontaneous Breathing Trial; MV – Mechanical Ventilation; CKD- Chronic Kidney Disease

**Determinants of weaning failure in critically ill adult patients on invasive ventilation**

The researcher also sought to assess determinants of weaning failure. A binary logistic regression analysis was performed to identify the determinants. Lower hemoglobin level, (OR =12.896, 95%CI, (4.2 -39.57, p = 0.000), CPAP mode of weaning, (OR =3.457, 95%CI, (2.029 – 5.891, p = 0.000), and longer duration on mechanical ventilation, (OR =2.92, 95%CI, (1.5 – 21.08, p = 0.000) as shown in Table 4.

**Table 4:Binary Logistic Regression**

| **Variables** | **Odds Ratio** | **Std. Err.** | **Z** | **P-value** | **[95% Conf. Interval]** | |
|---|---|---|---|---|---|---|
| | | | | | Lower | Upper |
| **Gender** | 0.944 | 0.508 | 0.013 | 0.909 | 0.349 | 2.552 |
| **Age** | 0.973 | 0.017 | 2.738 | 0.098 | 0.972 | 1.005 |
| **Smoking** | 0.315 | 0.680 | 2.887 | 0.089 | 0.083 | 1.194 |
| **Alcohol consumption** | 1.128 | 0.626 | 0.037 | 0.847 | 0.331 | 3.849 |
| **Presence of comorbidities** | 0.573 | 0.525 | 1.122 | 0.290 | 0.205 | 1.605 |
| **HB Level** | 12.896 | 0.572 | 19.985 | **0.000** | 4.204 | 39.566 |
| **Length of stay in ICU** | 1.013 | 0.009 | 1.946 | 0.163 | 0.995 | 1.031 |
| **Sedation** | 0.698 | 0.494 | 0.531 | 0.466 | 0.265 | 1.837 |
| **Duration on MV** | 2.920 | 0.282 | 14.441 | **0.000** | 1.501 | 21.081 |
| **Mode of weaning** | 3.457 | 0.272 | 20.811 | **0.000** | 2.029 | 5.891 |
| **Constant **** | | | | | | |

MV – Mechanical ventilation, ICU – Intensive care unit, HB - Haemoglobin

**Weaning practices among nurses in management of critically ill adult patients on invasive ventilation**

Weaning practices among nurses was assessed using frequencies and percentages. The findings are as shown in Table 5.

**Table 5: Weaning Practices Among Nurses**

| | | Frequency | Percentage |
|---|---|---|---|
| Presence of weaning guidelines in the ICU | Yes | 35 | 62.5 |
| | No | 10 | 17.9 |
| | Not sure | 11 | 19.6 |
| Who is in-charge of ventilation weaning practice | Physician directed | 25 | 43 |
| | Both Physician and Nurses | 20 | 34 |
| | Critical care nurse directed | 7 | 12 |
| | Not sure | 6 | 11 |
| Specification of weaning frequency in the weaning guidelines | Yes | 17 | 31.5 |
| | No | 15 | 27.8 |
| | Not sure | 22 | 40.7 |
| Frequency in evaluating patient for weaning from MV | Never | 2 | 3.5 |
| | Rarely | 9 | 15.8 |
| | Frequently | 24 | 42.1 |
| | Always | 22 | 38.6 |
| Means of receiving education regarding weaning | Never received | 13 | 25.5 |
| | In hospital CME | 27 | 52.9 |
| | Out of hospital CME | 11 | 21.6 |
| Aware of different types of ventilator weaning | Yes | 30 | 55.6 |
| | No | 24 | 44.4 |
| Aware of early ventilator weaning benefits | Yes | 49 | 84.5 |
| | No | 9 | 15.5 |
| Weaning require multi-disciplinary team | Yes | 55 | 94.8 |
| | No | 3 | 5.2 |

CME – Continuing Medical Education

**Parameters observed that indicate an adult patient readiness for weaning**

The nurses were asked on essential parameters that indicate patient readiness to weaning. Nurses were required to affirm yes on the parameter they thought was essential in indicating patient readiness to wean. The findings showed that 51(89.5%) of nurses said $SPO_2$ of 96%, while 43(75%) stated adequate nutritional status as shown in Table6.

**Table 6: Parameters Observed That Indicate an Adult Patient Readiness for Weaning**

| Parameter | Yes<br>n (%) | No<br>n (%) |
|---|---|---|
| $SPO_2$ of 96% | 51 (89.5) | 7(10.5) |
| Adequate nutritional status | 43(75.4) | 14(24.6) |
| Mode of Ventilation CPAP/PSV | 51(89.5) | 7(10.5) |
| Patient tidal volume of >200 | 18(31.6) | 40(68.4) |
| ABGs – Normal acid base balance | 47 (82.5) | 10(17.5) |
| GCS of >8 | 17(29.8) | 40 (70.2) |

CPAP- Continuous Positive Airway pressure; PSV Pressure Support Ventilation; SBT Spontaneous Breathing Trial; MV – Mechanical Ventilation; PSV–Pressure support ventilation; GCS-Glasgow coma scale; ABGS-Arterial Blood Gas;PF-PO2/FIO2 ratio; PAO2-Partial pressure of oxygen; FIO2-Fraction of Inspired Oxygen; SPO2-Oxygen Saturation

# CHAPTER FIVE: DISCUSSION, CONCLUSION AND RECCOMMENDATION

## 5.1.Discussion

The study researcher sought to investigate the prevalence and determinants of weaning failure and weaning practices in critically ill adult patients on invasive mechanical ventilation in Kenyatta National Hospital intensive care unit. The results revealed that most of the respondents were ranging between the age of 32 to 52 years. Most of the patients were male with secondary level of education. These findings are similar to Khalil et al., who found that over a half of the respondents were male although the mean age was slightly higher (63). Most of the patients were admitted to the ICU as a result of head injury. The common comorbidities that were found among patients on mechanical ventilator were sepsis, cardiac disease, respiratory disease, trauma related as well as chronic kidney disease. Yucel et al., in a study conducted in Turkey found that most of patients in ICU had trauma related complications mainly from accidents. Sepsis was also identified as a major complication among patients in ICU (65). Additionally, Luetz et al., also found that cervical trauma cases were common among patient on mechanical ventilation with chest and cervical spine injuries as the leading diagnosis (7).

The researcher also sought to investigate the prevalence of weaning failure. The prevalence of weaning failure was assessed in the study where it was determined that there was a 29% failure from invasive mechanical ventilators. Saiphoklang and Auttajaroon in a study conducted using a smaller sample found 36% prevalence of weaning failure (24). In a larger sample size of 2,729, the prevalence of weaning failure was 30% (n = 819) (6). This was as a result of lack of clear guidelines on weaning. The findings in this study suggested that despite more than half of ICU

nurses that were included in the study knowing about the existence of weaning guidelines there was a lower percentage of these who followed these guidelines. Funk et al in a study conducted in Thailand identified that patients who failed to wean on the first attempt were 36% with most of the patients failing to wean even after three attempts (66). This was associated with lack of clear guidelines among nurses to understand when and how to wean successfully.

The findings from the study revealed that patient characteristics that were associated with weaning failure were older age, cigarette smoking, lower HB level, duration of stay on ventilator and the mode of weaning. The findings showed that patients who were aged above 50 years were more likely to fail in weaning trial on first attempt. These findings arecomparably to Boles et al. (19) who found that age was a major independent risk factor for weaning failure. The results from this study identified that cigarette smokers were more likely to fail in first weaning attempt. These findings are comparable to Schmidt et al. who found that majority of cigarette smokers could not sustain as successful weaning outcome because it is associated with development of other health challenges such as respiratory distress syndrome which reduces the ability to wean successfully (35). Longer duration of stay on the MV was also associated with weaning failure. Most of these past researchers have shown that longer stay is associated with increased risk of failure (24, 35, 37). Extubation failure has been associated with prolonged stay on the mechanical ventilator which is a detrimental factor in the chances of survival among patients. Patients who stay longer on the mechanical ventilation machine are highly likely to fail weaning attempt.

Multivariate analysis found that HB level, duration on mechanical ventilation and the mode of weaning were independent predictors of weaning failure among patients. This could be as a result of factors such as ventilator associated pneumonia and other ICU based infections which reduces patient's stability and ability to wean successfully. These findings are comparable to Boles et al. found that longer duration of stay on mechanical ventilation was associated with weaning failure (36). The severity of the patient wellbeing and the level of consciousness significantly contributed to longer patient stay on mechanical ventilation.

However, these findings are different from Ishaaya (2015) who found that work of breathing was higher after extubation compared to spontaneous breathing through the endotracheal tube. The findings showed that there was no significant correlation between the duration of intubation and the resistance to wean. The difference could be as a result of weaning guidelines efficiency, condition of the patients as well as patient diagnosis at admission.

The findings from the study revealed that there was moderate knowledge and practice of weaning guidelines among nurses in ICU. Almost half of nurses were not sure of the specification of weaning frequency as documented in the weaning guidelines. This could be explained by lower knowledge level among nurses in critical care units These findings are similar to Blackwood and Tume who found that weaning protocols are rarely used by healthcare providers which in most cases result in failure to wean (14).

The weaning practices identify that there is need for daily assessment of the patient while also taking into focus the underlying factors influencing patient response(14). Nurses working in the ICU are expected to have higher knowledge on weaning to

allow for a successful weaning process. Knowledge on when to wean and how to wean is essential in improving the chances of survival among patients on the mechanical ventilation. Majority of nurses agreed that weaning is a multidisciplinary team hence requires a collaborative environment. These findings conquer with Rose et al in a study conducted in Australia which found that embracing team work and a multidisciplinary approach has been shown to improve patient outcomes (56).

### 5.2 Conclusion

The results showed that the prevalence of weaning failure was 29%. The average age was 42 years ranging from 32 to 52 years. Most of the patients 163 (66%) were male. The most common diagnosis among the patients included, head injury, blunt chest injury, blunt abdominal injury, airway obstruction and cardiac arrest, other diagnosis at admission included, Septic shock, HELLP syndrome, diabetic acidosis (DKA), stroke, convulsive disorder and acute subdural hematoma. Patient factors that were associated with weaning failure included older age, cigarette smoking, lower HB level, longer duration on mechanical ventilation and use of CPAP as mode of weaning. Binary logistic regression found that lower HB level, duration of mechanical ventilation and the mode of weaning were independent predictors of weaning failure. Intensive care nurses that were enrolled in the study had moderate practice of weaning.

### 5.3 Recommendation

- To encourage use of assessment tools to determine patient readiness to wean.
- Further studies needed to explore the optimal hemoglobin levels for critically ill patients during the weaning process because lower hemoglobin levels had a higher influence on weaning failure.
- Increase nurse trainings and workshops on specialized ICU care on weaning from mechanical ventilation.
- To encourage more teamwork among nurses to increase their efficiency in weaning practice

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## Appendices

### Appendix I: Consent Form for Nurses

**Title of the study: Determinants of Weaning Failure Among Adult Patients On Invasive Mechanical Ventilation in Kenyatta National Hospital Intensive Care Unit.**

**Researcher:** Jane Omusula

**Introduction to the study:** You are asked to participate in the study which is voluntary and will be conducted in the department of critical care at Kenyatta National Hospital.

**The Purpose of the study:** To establish the determinants of ventilator weaning failure among adult patients on invasive mechanical ventilation in KNH/ICU.

**Time:** The questionnaire has simplified multiple choice questions expected to guide the researcher. Completing the questionnaire will take approximately 10 minutes.

**Benefit of the study:** The study will help in identifying training areas.

**Risks, stress and discomfort:** There are no direct foreseen risks in you participating in this study. However, the study will require you to spare at most 10 minutes of your time and fill the questionnaire. If there are any questions you do not want to answer, you are obliged to skip. In addition, you have the right to decline giving information.

**Cost and risk of loss of Confidentiality:** There will be no direct cost incurred by you neither will you receive any money for participating in this study. Data including questionnaires and file from the study will be kept locked in a cabinet during the study period. Your data will be labelled with your unique identity and your name concealed to maintain confidentiality when taking part in the study. Furthermore, your name will not appear in any report or publication of the research and all your personal information will be handled with a high level of confidentiality.

**Voluntary Participation and withdrawal:** Remember, your participation is entirely voluntarily. Should you consider changing your mind midway, you have the right to do so and you shall not suffer any consequence whatsoever.

**Sharing of results:** The results of this study may be presented during scientific and academic forums and may be published in scientific medical journals and academic papers.

**Participants consent**

I confirm that the researcher has explained fully the nature of the study and the extent of activities which I will be asked to undertake. I confirm that I have had adequate opportunity to evaluate and ask questions about this study. I understand that my participation is voluntary and that I may withdraw at any time during the study, without having to give a reason. I agree to take part in this study by filling in the questionnaire.

Signed by participant……Date…….

In case of any issues or challenges related to this study, please contact me on **0726290973or Dorcas Maina(Supervisor) on 0724440843 or** the Ethical Review Committee Secretariat, KNH/UON ERC Secretariat on Tel.2726300 ext. 44102, uonknherc@uonbi.ac.ke.write to the KNH-ERC through:

The chairperson,
KNH/UON Ethics and Research Committee
P.O. Box 20723-00202, Nairobi.
Telephone number: (254-020) 2726300-9 Ext 44355
Email: uonknh_erc@uonbi.ac.ke

Thank you for sparing your precious time dedicated to participating in this study exercise.

**Researcher's statement**

**Respondent**: I certify that the purpose, potential benefits and possible risks associated with participating in this research have been explained to the above participant and the individual has consented to participate.

Signature_____ Date_____

**Appendix II: Data abstraction tool**

**DETERMINANTS OF WEANING FAILURE AMONG ADULT PATIENTS ON INVASIVE MECHANICAL VENTILATION IN KENYATTA NATIONAL HOSPITAL INTENSIVE CARE UNIT.**

**Date: _____ Enumerator's initials: _____ Code: _____**

**Section 1: Patient characteristics.**

1. Age in years…….
2. Gender (Tick one)

   Male [] Female [ ]

3. Highest level of education

   No formal education [ ]

   Primary [ ]

   Secondary [ ]

   Tertiary [ ]

4. Occupation

   Formal employment [ ] Self-employment [ ] Unemployed [ ] Student [ ]

5. Religion

   Christian [ ] Muslim [ ] Others……..

6. Department

   Main ICU [ ] Medical ICU [ ]

**Section 2: Determinants of weaning failure from mechanical ventilation**

1. Date of admission…….
2. Smoking

   Yes [ ] No [ ]

3. Alcohol intake

   Yes [ ] No [ ]

4. Date of discharge/death……
5. Admitted to ICU from (Tick one)

   Ward in KNH [ ]  A&E  [ ]  Referral from another facility [ ]

6. Diagnosis on admission

   …….

7. Are Comorbidities present?

   Yes [ ] No [ ]

8. If yes, Which one

   Psychological [ ]  Sepsis [ ] Cardiac disease [ ] Respiratory disease [ ]

   Endocrine/metabolic dysfunction [ ]  Trauma [ ] CKD [ ]

   Other(specify)……..

9. Patients Hemoglobin levels at onset of weaning: a>) 10mgdl b)<10g/dl
10. Length of stay in ICU in days……
11. Was the patient sedated

    Yes [ ]  No [ ]

12. Type of mechanical ventilation

    Invasive [ ] Non invasive [ ]

13. Duration of invasive mechanical ventilation in days

    ……

14. What was the mode of weaning?

15. SBT [ ]  PSV [ ] CPAP  [ ]
16. What was the weaning outcome?

    Successful weaning [ ]  Failed weaning  [ ]

17. Clinical outcome (tick one)
    a. Death [ ]  Referral [ ]  Discharged [ ]
18. Conclusion:

    a) weaning failure present  b) weaning failure absent

**Appendix III: Questionnaire for CRITICAL CARE NURSES**

DETERMINANTS OF WEANING FAILURE AMONG ADULT PATIENTS ON INVASIVE MECHANICAL VENTILATION AT KENYATTA NATIONAL HOSPITAL INTENSIVE CARE UNIT.

Serial Number……. Date: _____

**INSTRUCTIONS**

1. **Do not write your name on this form**
2. **Answer all questions.**
3. **Do not leave any blanks**
4. **Tick ALL appropriate responses in the box**

**Part 1: Nurses Demographic factors**

1. What is your age in years…….?
2. Do you have training in critical care nursing?

   a) Yes [ ] No [ ]

   b). If yes, What is the level of training

   Higher diploma [ ] Masters [ ]
3. Unit stationed in

   Main ICU [ ] Medical ICU [ ]
4. How long have you worked in ICU?.....

**SECTION B:Nurse related factors that influence weaning failure among critically ill patients.**

5. Does your ICU have ventilation weaning guidelines?

   a) Yes [ ] No [ ] Not sure [ ]

   b). If yes, how is it directed

   Physician directed [ ]

   Critical care nurse directed [ ]

   Not sure [ ]

   Other(specify)……..
6. Does your ICU ventilator weaning guidelines specify frequency by which weaning readiness should be assessed?

   Yes [ ] No [ ] Not sure [ ]

7. What entails assessment of the patient on readiness to wean?

   _____

   _____

8. What is the criteria for weaning the patient from mechanical ventilation?

   _____

   _____

   _____

9. How often do you evaluate your patient for weaning from the mechanical ventilator?

   Never [ ]

   Rarely [ ]

   Frequently [ ]

   Always [ ]

10. Indicate the means through which you received education regarding ventilator weaning (tick one)

    Never received [ ]

    In hospital CME [ ]

    Out of hospital CME [ ]

    Others……

11. Are you aware of different types of ventilator weaning?

    Yes [ ] No [ ]

    9a. If yes, specify the types……

12. A What are the causes of weaning failure among patients on invasive mechanical ventilation?

    _____

    _____

    _____

    _____

    _____

13. The critical care nurse observes the following parameters that indicate an adult patient readiness for weaning. Place a tick (√) against all correct responses

    Tachypnoea [ ]

    PF ratio (PaO2:FiO2 > 150 [ ]

    SPO2 of 96% [ ]

    Adequate nutritional status [ ]

    Mode of ventilation CPAP/PSV [ ]

High level of inotropic support [ ]

Patient tidal volume of 200 [ ]

ABGs – normal acid base balance [ ]

GCS of 8 [ ]

Patient on sedation [ ]

Initial reason why on ventilator not resolved [ ]

14. Are you aware about benefits of early ventilator weaning?

    Yes [ ] No [ ]

    10a. If yes, specify ……..……..

15. Does mechanical ventilation weaning require a collaborative /multidisciplinary team?

    Yes [ ] No [ ]

    11a. If yes, specify.

**Thank you**

**Appendix IV: Budget**

| Components | Unit of Measure | Duration/ Number | Cost (Kshs) | Total (Kshs) |
|---|---|---|---|---|
| **Personnel** | | | | |
| Research Assistant | 3 | 15 | 2,000 | 50,000 |
| Statistician | 1 | 1 | 20,000 | 20,000 |
| Participants | 300 | | | |
| **Printing** | | | | |
| Consent Form | 1 | 2 | 10 | 20 |
| Assent Form | 1 | 2 | 20 | 40 |
| Questionnaires | 5 | 1 | 50 | 50 |
| Final Report | 10 | 1 | 10 | 100 |
| Binding | 6 | - | 500 | 3000 |
| **Photocopying** | | | | |
| Consent Form | 2 | 300 | 5 | 1800 |
| Assent Form | 2 | 300 | 5 | 1800 |
| Questionnaires | 5 | 300 | 5 | 4500 |
| Final Report | 10 | 50 | 5 | 1500 |
| Final Report Binding | 10 | 10 | 70 | 7000 |
| **Other costs** | | | | |
| Records Access Fee | | | | |
| Pens | 30 | 2 | 50 | 1500 |
| Notebooks | 12 | 2 | 100 | 2400 |
| Research assistants training + costs | 3 | 2 | | 15,000 |
| Final project Binding | **8** | **-** | **500** | **4000** |
| Final project printing | **8** | **40** | **10** | **3200** |
| Miscellaneous | **-** | **-** | **-** | **40,000** |
| **Total** | | | | **120,000** |

**Appendix V: Work plan**

| Action | Oct2019-Feb: 2020 | | March - April 2020 | May-June2020 | July 2020 |
|---|---|---|---|---|---|
| Topic identification and Proposal development | | | | | |
| Ethics Review and Approval | | | | | |
| Data collection | | | | | |
| Data analysis and Results interpretation | | | | | |
| Submission | | | | | |

## Appendix VI: letter of approval from ERC

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

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

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

Ref: KNH-ERC/A/276

26th August 2020

Jane Omusula
Reg. No. H56/11027/2018
School of Nursing Sciences
College of Health Sciences
University of Nairobi

Dear Jane

**RESEARCH PROPOSAL – DETERMINANTS OF WEANING FAILURE AMONG ADULT PATIENTS ON INVASIVE MECHANICAL VENTILATION IN KENYATTA NATIONAL HOSPITAL INTENSIVE CARE UNIT (P94/02/2020)**

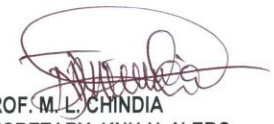
This is to inform you that the KNH- UoN Ethics & Research Committee (KNH- UoN ERC) has reviewed and **approved** your above research proposal. The approval period is 26th August 2020 – 25th August 2021.

This approval is subject to compliance with the following requirements:

a. Only approved documents (informed consents, study instruments, advertising materials etc) will be used.
b. All changes (amendments, deviations, violations etc.) are submitted for review and approval by KNH-UoN ERC before implementation.
c. Death and life threatening problems and serious adverse events (SAEs) or unexpected adverse events whether related or unrelated to the study must be reported to the KNH-UoN ERC within 72 hours of notification.
d. Any changes, anticipated or otherwise that may increase the risks or affect 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.
e. Clearance for export of biological specimens must be obtained from KNH- UoN ERC for each batch of shipment.
f. 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*).
g. Submission of an *executive summary* report within 90 days upon completion of the study. This information will form part of the data base that will be consulted in future when processing related research studies so as to minimize chances of study duplication and/ or plagiarism.

For more details consult the KNH- UoN ERC website**http://www.erc.uonbi.ac.ke**

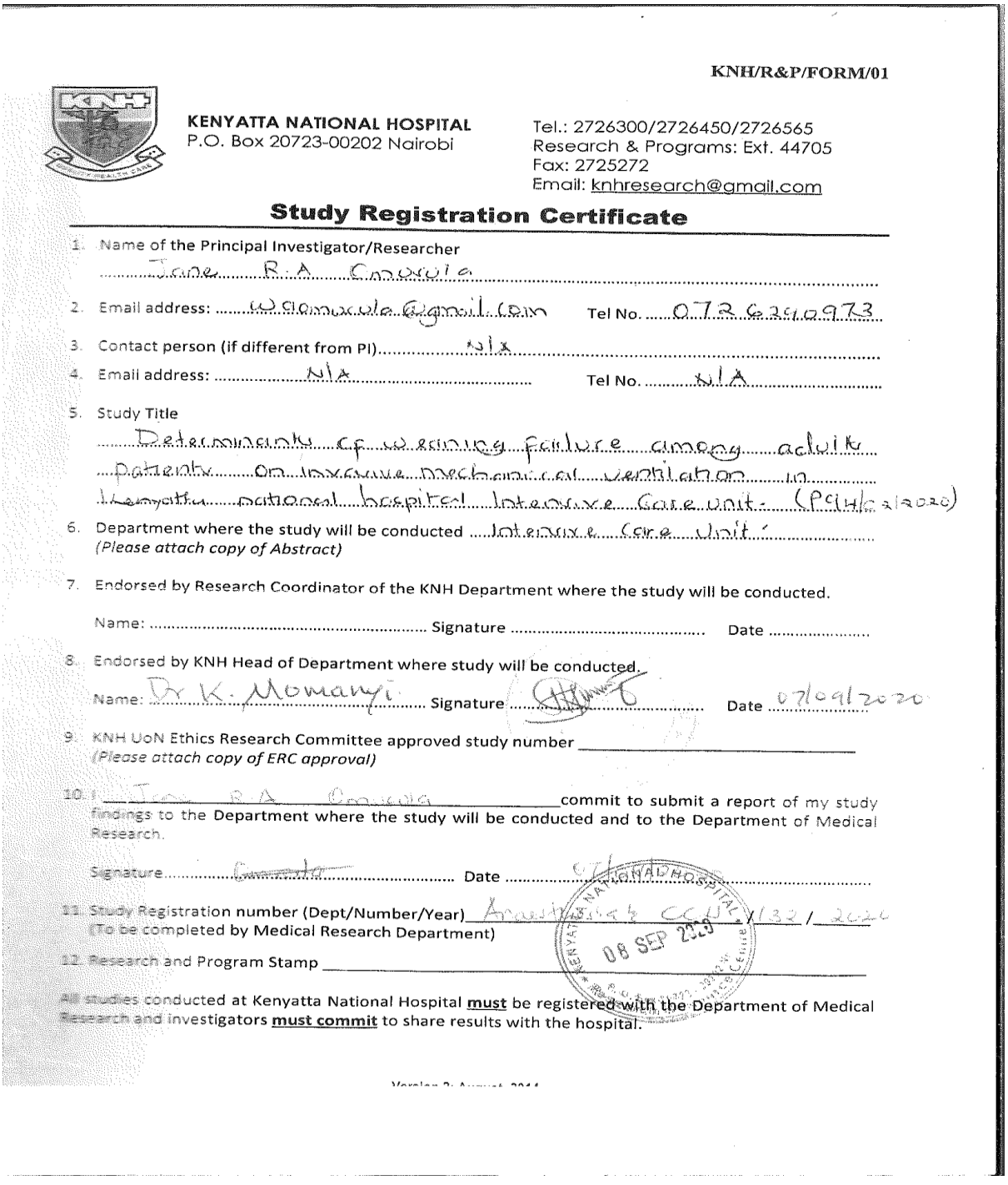
Yours sincerely,



**PROF. M. L. CHINDIA**
**SECRETARY, KNH-UoN ERC**

c.c. The Principal, College of Health Sciences, UoN
The Director, CS, KNH
The Chairperson, KNH- UoN ERC
The Assistant Director, Health Information, KNH
The Director, School of Nursing Sciences, UoN
Supervisors: Dr. Dorcas Maina, School of Nursing Sciences, UoN
Dr. Angeline C. Kirui, School of Nursing Sciences, UoN
Ms. Hanna Inyama, School of Nursing Sciences, UoN

## 12. Appendix VII: Study registration certificate



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
   Tone R.A Cmwula
2. Email address: wcmwula@gmail.com Tel No. 0726291973
3. Contact person (if different from PI) N/A
4. Email address: N/A Tel No. N/A
5. Study Title
   Determinants of weaning failure among adult patients on invasive mechanical ventilation in Kenyatta national hospital Intensive Care unit. (PCH/c 2/2020)
6. Department where the study will be conducted Intensive Care Unit
   *(Please attach copy of Abstract)*
7. Endorsed by Research Coordinator of the KNH Department where the study will be conducted.
   Name: ..... Signature ..... Date .....
8. Endorsed by KNH Head of Department where study will be conducted.
   Name: Dr K. Momanyi Signature ..... Date 07/09/2020
9. KNH UoN Ethics Research Committee approved study number _____
   *(Please attach copy of ERC approval)*
10. I Tone R.A Cmwula 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 .....
11. Study Registration number (Dept/Number/Year) Anesthesia & CCU / 132 / 2020
    (To be completed by Medical Research Department)
12. Research and Program Stamp _____

KENYATTA NATIONAL HOSPITAL 08 SEP 2020

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.

Version 2: August 2014