RESEARCH PROJECT

COMPETENCE REGARDING MECHANICAL VENTILATION AMONG THE NURSES WORKING IN INTENSIVE CARE UNITS OF TWO UNIVERSITY TEACHING HOSPITALS IN RWANDA

By

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In the

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1. DECLARATION

I, MAHORO Jean de Dieu, declare that this proposal is my original work and has never been presented for a degree award or any other award in any University.

Signs…………………… Date…………………………

2. ABSTRACT

Background: More than fifty percent of critically patients admitted in intensive care units require respiratory supports with mechanical ventilation (MV).However the nurse's levels of competence on mechanical ventilation is reported to be quite low worldwide.A study done in South Africa regardless of nurses' training background, age, or experience showed a poor level of competence on mechanical ventilation with the following average score, 48% for ICU qualified nurses and 31% for non-ICU qualified nurses while the competence indicator was 75%.

Aim of the study: The purpose of the study was to determine the level of competence on mechanical ventilation among the intensive care unit nurses at University teaching hospitals in Rwanda.

Specific objectives: To determine the level of competence on mechanical ventilation and to identify the factors that are associated with the level of competence among nurses working in the intensive care units at university teaching hospitals in Rwanda.

Methodology: The cross-sectional descriptive design was used to achieve the research objectives. The study population was made by 62 nurses working in ICUs of University Teaching Hospitals in Rwanda. To get the sample size, census sampling method was used. The tool composed of demographic data and three clinical vignettes was adapted and used as data collection tool. Vignette one concerns the normal post-operative patient, Vignette two concerns the patient with ARDS and Vignette three concerns the patient with COPD. SPSS was used to capture and analyze data.

Results: The level of competence on mechanical ventilation was poor. Only 1.6% of participants achieved the competence indicator of 75% other 98.4% did not achieved. It was found that the competence level was associated with qualification, job position and age with p values ,P(0.000),P(0.000),P(0.038) respectively.

Conclusion: The overall competency level on mechanical ventilation among nurses working in selected ICUs was poor. This is likely to negatively affect the patient who is mechanically ventilated. Furthermore, associated factors were identified.

Keywords: Nurses, competence, mechanical ventilation, intensive care units.

3. DEDICATION

I most gratefully dedicate this work to the Almighty God who stayed alongside through my life.

I strongly dedicate this to my family for their encouragement and their sacrifice during my studies.

To my research supervisor, all my classmates for the best moments bonded together, finally to all my relatives and friends.

God bless you.

4. ACKNOWLEDGEMENT

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Thanks to the Almighty God, the creator who has made every accomplishment to happen, to Him the glory belongs forever and ever.

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7. LIST OF ACRONYMS AND ABBREVIATION

Cm/H20 - Centimeters of Water

CMV - Controlled Mandatory Ventilation

COPD - Chronic Obstructive Pulmonary Disease

CPAP –Continuous Positive Airways Pressure

ET tube - Endotracheal Tube

FIO2 - Fractional Index of Oxygen

FRC - Functional Residual Capacity

ICU - Intensive Care Unit

IE ratio - Inspiratory Expiratory Ratio

MCQs-Multiple Choice Questions

MSOF - Multi System Organ Failure

PEEP - Positive End Expiratory Pressure

SIMV - Synchronized Intermittent Mandatory Ventilation

Sp02 - Oxygen Saturation

Ti - Inspiratory Time

V_T- Tidal Volume

VILI - Ventilator Induced Lung Injury

WOB - Work of Breathing

CHAPTER ONE: INTRODUCTION

1.1 INTRODUCTION

Mechanical ventilation is a life sustaining therapy for the treatment of patients with acute respiratory failure. It is a very common modality in intensive care units (ICU), and indeed the advent of its use heralded the dawn of modern ICUs(Brochard, Slutsky and Pesenti, 2017, page 438-442).

Mechanical ventilation (MV) is usually considered to be a supportive therapy, and is often lifesaving. However, over the last15 years, there has been great emphasis placed on minimizing the risks associated with MV, especially an entity referred to as ventilator-induced lung injury (VILI).The delivery of so-called lung-protective ventilation has been shown to reduce this risk and improve outcomes in patients with the acute respiratory distress syndrome(ARDS)(Slutsky, 2015, page 1106-1115).

1.2. BACKGROUND

More than fifty percent of critically patients admitted in intensive care units require respiratory support with mechanical ventilation (MV). Therefore the nurses' competence on the use of mechanical ventilation is of paramount importance for nursing care of the ICU patients.However, the nurses' levels of competence on mechanical ventilation have been reported to be quite low (Metnitz *et al.*, 2015 page 816-824)

The study done in South Africa, regardless nurses' training background, age, or experience showed a poor level of competence on mechanical ventilation with the following average scores, 48% for ICU qualified nurses and 31% for non-ICU qualified nurses (Botha 2012)

A study done in Australia and New Zealand, has found that ICU nurses are actively involved in making decisions about ventilator management and frequent adjustment on ventilator settings independently, without input from physicians. However, many of them have limited competence on mechanical ventilation (Jubran, 2012).

Rose and colleagues conducted a multicenter self-administered survey of nurse managers of ICUs in eight European countries. About 63% to 88% of decisions regarding ventilator management were made by nurses in collaboration with physicians. Moreover, the ICU nurses performed 40% to 68% of ventilator adjustments independently. Therefore it should be better for ICU nurses to hold a high competence on mechanical ventilation (Jubran, 2012, page 1).

In developing countries, more than 85% of patients admitted in ICU require respiratory support by the use of mechanical ventilation. However, a study done by Guilhermino et al., (2014, page 126-132) has reported that more than 75% of nurses had low levels of competence on the use of mechanical ventilation. In Rwanda, about 85% of patients admitted in intensive care unit are under mechanical ventilation. Their mortality rate is 47.3%(Riviello et al., 2016)., and the likely contributing factor is the poor nursing competence regarding mechanical ventilation(DeenaM.Kelly, 2014)

The factors that hinder the nurse competence on mechanical ventilation were found to be low levels of education and limited training compounded by lack of CPD on management and monitoring of critically ill patients as well as settings of mechanical ventilator (Munyiginya et al., 2016).

1.3 PROBLEM STATEMENT

The ICU nurses competence on mechanical ventilation is globally poor. A study done in South Africa has reported that even in high income countries where the nursing education is advanced, the levels of competence on mechanical ventilation is not perfect(Botha,2012). This is likely to be even worse in Rwanda where nursing education is still growing.

About eighty five percent of patients admitted in intensive care unit are under mechanical ventilation. Their mortality rate is 47.3%(Riviello et al., 2016) and they are most likely to be cared for by general nurses who have limited training on management, monitoring of critically ill patients and settings of mechanical ventilator (Munyiginya et al., 2016).

Furthermore, the ICU doctors who are available every time are juniors on training (Residents) and rotate frequently. So they have no time for adequate experience. There are also limited CPD opportunities provided to the ICU nurses about mechanical ventilation.

In addition, there is a scarcity of data on the ICU nurses' levels of competence on mechanical ventilation in teaching hospitals, Rwanda. Therefore the present study is anticipated to be very important, as it is intended to find out more data regarding the levels of competence of the ICU nurses on mechanical ventilation.

1.4 THE AIM OF THE STUDY

The purpose of this study was to determine the levels of competence on mechanical ventilation among the intensive care unit nurses at University teaching hospitals in Rwanda.

1.5 RESEARCH OBJECTIVES

The objectives of this study were to:
1.5.1 Assess the level of competence on mechanical ventilation among the Intensive care unit nurses at University teaching hospitals in Rwanda.

1.5.2 Identify factors associated to the levels of competence on mechanical ventilation among the intensive care unit nurses at University teaching hospitals in Rwanda.

1.6 RESEARCH QUESTIONS

1.6.1 What is the level of competence on mechanical ventilation among the intensive care unit nurses at University teaching hospitals, Rwanda?

1.6.1 What are the factors associated to the level of competence on mechanical ventilation among the intensive care unit nurses at University teaching hospitals in Rwanda?

1.7. SIGNIFICANCE OF THE STUDY

This study hopes to be significant in three major areas

Nursing research: This study determined the levels of competence on mechanical ventilation among the intensive care unit nurses at University teaching hospitals in Rwanda. This study hopes to provide a basis for further research, for example, further intervention studies to improve the levels of competence of the ICU nurses in terms of mechanical ventilation to improve the quality of care and patient safety.

Nursing practice: Results of this study may inform national healthcare policy makers in referral hospitals, administration in particular, to recognize the levels of competence on mechanical ventilation and the contributing factors hence the basis to develop appropriate approaches to improve the ICU nurses' competences. This study will inform future improvement strategies in the nursing practice and patient safety.

Nursing education: The results of the study may be an added source of information to the existing literature on this subject as well as contribution to additional knowledge for caring of the carers and for the education of nurses especially those in management.

1.8. DEFINITION OF CONCEPTS OPERATIONAL MEANING

ICU Nurse:A nurse who has successfully completed specialist post-qualification education in critical care (or intensive care) nursing, which builds upon initial generalist nursing education(WHO, 2003).For the purpose of this study, "ICU nurse" is defined as a nurse who works in ICU irrespective of whether they have a speciality or just experience.

Competence: It is a cluster of elements, including knowledge, skills, attitudes, thinking ability and values that are prerequisite in certain contexts (Fukada, 2018,page 001-007).For the purpose of this study competence is the nurses' ability to understand the work of a mechanical ventilator, its settings and modes and to identify issues related to mechanical ventilation and start nursing interventions immediately. It was categorized into two levels being competent (≥75%) or incompetent (<75%) (Botha, 2012,p. 58).

Mechanical ventilator: A breathing machine is a medical device that provides a patient with oxygenation and ventilation when they are unable or have difficulty to breathe in and out on their own(Whitlock, 2018).In this study, the mechanical ventilator is defined as an electronic machine that is used to ventilate the critically ill patient in ICU(Whitlock, 2018).

An intensive care unit (ICU) is a nominated ward of a hospital which is specially staffed and prepared to provide intensive and specialized medical and nursing care, an enhanced capacity for monitoring, and multiple modalities of physiologic organ support for the critically ill patients. In this study ICU is the unit where the critically patients are cared for (Marshall et al., 2017, p. 270-276).

ICU qualified nurse: For the purpose of this study an ICU qualified nurse refers to a registered nurse who has an additional qualification like postgraduate diploma or masters' degree in intensive/critical care nursing.

Non-ICU qualified nurse: For the purpose of this study a non-ICU qualified nurse refers to a nurse registered or enrolled who does not hold an additional qualification in intensive/critical care nursing.

1.9. STRUCTURE/ORGANIZATION OF THE STUDY

This study report is organized into two main parts; the first part is made of title page, abstract, dedication, acknowledgements, table of contents, list of tables and list of acronyms and abbreviations. The second part is made of six chapters, chapter one that includes the introduction, background, problem statement, aims of the study, research objectives and questions, significance of the study, definition of concepts, structure/organization of the study and conclusion to chapter one.

Chapter two is the literature review that is made of theoretical literature, empirical literature, critical review, research gap identification and conceptual framework.

Chapter three is the methodology that includes, research design, research approach, research setting, population, sampling, data collection process, data analysis methods, ethical considerations, data management, data dissemination, limitations and challenges to the study and conclusion to chapter three.

Chapter four is made of introduction, demographic characteristics of respondents, presentation of results.

Chapter five is composed of discussions, while the sixth is made of the summary of the study, recommendations and conclusion.

CONCLUSION OF CHAPTER ONE

Chapter one has presented the background, problem statement, purpose of the study, research objectives and questions, definitions and significance of the study, the definitions of the key terms and the organization of the study.

CHAPITRE TWO: LITERATURE RIVIEW

2.1. INTRODUCTION

This chapter depicts the extensive literature on mechanical ventilation. It is made of theoretical and empirical literature review, the critical review and research gap identification including the conceptual framework.

The recent quantitative and qualitative research is explored to provide the current and consistent literature. Search engines used are Medline, Pub Med, Google Scholar, CINHAL, Ebco Host and HINARI

2.2. THEORETICAL LITERATURE REVIEW

This section will cover definition of mechanical ventilation, its indications and its complications, monitoring of ventilated patients, management of ventilated patients and weaning a patient from a mechanical ventilator.

2.2.1. Mechanical ventilation

2.2.1.1 Definition

Mechanical ventilation (MV) is the main intervention performed in the treatment of critically ill patients in intensive care units (ICUs) to support the respiration where a gas is pushed in and out from the lung via an external device connected straight to the patient (Marini, 2018, page xiii-xiv).

The ICU nurses must be knowledgeable about the function and limitations of ventilator modes and settings in order to provide high-quality patient-centered care to mechanically ventilated patients (Grossbach et al., 2011, page30-44).

2.2.1.2. Ventilator settings and patient's parameters

Fraction of inspired oxygen (FIO2): The concentration of oxygen in the inspired gas, it varies from 0.21 in air to 1.0 as pure oxygen. As soon as possible, clinicians should reduce the FiO2 to nontoxic levels (generally 0.6 or less), provided that an oxygen saturation (SpO2) of 94% or greater can be maintained (Peter Hou, 2018).

Tidal volume (VT): The tidal volume is the amount of air delivered with each breath, during volume-limited ventilation; the tidal volume is set by the clinician and remains constant (Mcsparron, 2018).

However during pressure-limited ventilation, the tidal volume is variable; it is directly related to the inspiratory pressure level and lung compliance, but indirectly related to the resistance of the ventilator tubing such that the clinician typically changes the tidal volume by adjusting the inspiratory pressure level (Mcsparron, 2018).

The tidal volume is commonly expressed in milliliters, and is calculated by 6-8ml/ kg of patient body weight (Mcsparron, 2018).

Respiratory rate (RR) or respiratory frequency: The number of breaths delivered by the ventilator or by the patient himself during one minute, for the adult patient. The respiratory rate varies between 10 and 20 breaths per minute. However, when the patient is making spontaneous breathing efforts during mechanical ventilation, the RR may be higher (Grossbach et al., 2011, p 30-44).

Minute ventilation (Me): The minute ventilation estimates the quantity of air/ oxygen, the patient breathes during one minute. It is the product of the tidal volume and respiratory rate. It is approximately 5 to 6 liters/minute in healthy individuals at rest, but increases among patients who are mechanically ventilated or have increased carbon dioxide production (e.g., fever, hypermetabolic states), metabolic acidosis, hypoxemia, increased dead space, and/or an increased central respiratory drive(Scott K Epstein, 2018).

Peak flow rate or peak inspiratory flow: The highest flow, or speed, that is set to deliver the tidal volume during inspiration, usually measured in liters per minute. When the flow rate is set higher, the speed of gas delivery is faster and inspiratory time is shorter, the normal values being 40-60L/per minute for the adult patient (General & Deaconess, 2017, p 1-33).

Inspiratory (I) and expiratory (E) time and I/E ratio: (I: E) ratio – Inspiratory time is equal to tidal volume divided by flow rate (I time =TV/FR). Decreasing the tidal volume or increasing the flow rate, decreases the inspiratory time, and decreases the inspiratory to expiratory (I: E) ratio.

The normal I: E ratio is 1:2 or 1:3, however the clinicians often reduce the I: E ratio to 1:4 or 1:5 in the presence of obstructive airway disease, which requires greater time for expiration. An inverse I: E ratio may be necessary in states of low lung compliance (Peter Hou, 2018).

Peak airway pressure (Paw): Represents the total pressure that is required to deliver the tidal volume and depends upon various factors, such as, airway resistance, lung compliance, and chest wall factors. It is expressed in centimeters of water (cm H_2O) (General & Deaconess, 2017, p 1-33).

Plateau pressure: The pressure that is needed to distend the lung, which can be measured by applying an end-inspiratory pause setting on the ventilator. It is expressed in centimeters of water (General& Deaconess, 2017, 1-33).

Sensitivity or trigger sensitivity: An assisted breath can be triggered by either pressure or flow; the former requires a demand valve, which senses a negative airway pressure deflection when the patient initiates a breath. A trigger sensitivity threshold of -1 to -3 cmH_2O is common and when the threshold is reached, the ventilator delivers a breath(Peter Hou, 2018).Triggering refers to the mechanism through which the ventilator senses inspiratory effort and delivers gas flow or a machine breath in concert with the patient's inspiratory effort. In modern ventilators, the demand valve is triggered by either a fall in pressure (pressure trigger) or a change in flow (flow trigger) (Khalil et al., 2019).

With pressure-triggered ventilation, a preset pressure sensitivity has to be achieved before the ventilator delivers fresh gas into the inspiratory circuit; with flow-triggered ventilation, preset flow sensitivity is used as the trigger mechanism (Khalil et al., 2019)

Positive end-expiratory pressure (PEEP): It is the alveolar pressure above atmospheric pressure that exists at the end of expiration. There are two types of PEEP:

Extrinsic PEEP: The PEEP that is provided by a mechanical ventilator, and is referred to as the applied PEEP.

Intrinsic PEEP: PEEP that is secondary to incomplete expiration is referred to as intrinsic PEEP or auto PEEP (Rommel t al., 2018).

Breath types: Mechanical ventilators can deliver different kinds of breaths, namely, a mandatory breath is started, controlled, and ended by the ventilator, which does all the work. The assisted breath is initiated by the patient, but controlled and ended by the ventilator (Peter, 2018).

A spontaneous breath is initiated, controlled, and ended by the patient. The volume of the breath delivered by the ventilator is determined by the patient’s effort and physiologic reserve (Peter Hou, 2018).

Functional residual capacity: Volume of gas present in the lungs at the end of passive expiration (General & Deaconess, 2017, p 1-33).

2.2.1.3. Modes of mechanical ventilation

Mode of ventilation refers to the method of inspiratory support provided by the mechanical ventilator. It is a specific combination of breathing pattern and control variables to deliver inspiration (Robert C Hyzy, 2018).

The selection of a mode is based on the clinician's familiarity with mechanical ventilation, experience and the institutional preferences. Some modes guarantee a constant volume (volume-targeted or volume controlled) with each machine breath, whereas other modes guarantee a constant pressure (pressure-targeted or pressure-controlled) (Robert C Hyzy, 2018).

An additional option on some ventilators is a dual controlled mode that combines the features of volume- and pressure targeted ventilation to ensure a minimum tidal volume (TV) or minute ventilation while limiting pressure(Robert C Hyzy, 2018).

A/C (Assist control): A type of positive pressure ventilator mode that delivers a preset volume of gas at a set rate. If the patient initiates a breath on their own, the ventilator will assist in delivering the preset volume.

The ventilator will deliver a breath every time the patient breathes so if the patient has a lot of spontaneous breaths this setting might not be indicated since the patient can hyperventilate resulting in a decreased CO_2 and respiratory alkalosis (General & Deaconess, 2017, p 1-33).

Synchronous Intermittent Mandatory Ventilation (SIMV): A type of positive pressure ventilator mode that provides a set respiratory rate and volume of gas for each breath; the ventilator delivers a breath when the patient has not initiated a breath spontaneously within a preset time and this allows the patient to breath spontaneously. This mode is often used during the weaning process (Gertler, 2018).

Pressure- regulated volume control (PRVC): The kind of dual-controlled ventilation in which the ventilator attempts to achieve the volume target using a pressure- control gas delivery format at the lowest possible airway pressure(Abou Shehata et al., 2012,p151-158).

Airway pressure release ventilation (APRV): During airway pressure release ventilation (APRV), a high continuous positive airway pressure (P high) is delivered for a long duration (T high) and then falls to a lower pressure (P low) for a shorter duration (T low)(Robert , 2018).

The transition from P high to P low deflates the lungs and eliminates carbon dioxide. Conversely, the transition from P low to P high inflates the lungs. The difference between P high and P low is the driving pressure (Robert, 2018).

Larger differences are associated with greater inflation and deflation, while smaller differences are associated with smaller inflation and deflation. The exact size of the tidal volume is related to both the driving pressure and the compliance high and T low determine the frequency of inflations and deflations (Robert, 2018).

As an example, a patient whose T high is set to 5.4 seconds and whose T low is set to 0.6 seconds has an inflation-deflation cycle lasting 6 seconds; this allows 10 inflations and deflations to be completed each minute(Robert 2018).

APRV versus BIPAP: Both modes clearly have the same general pattern of airway pressures as intermittent mandatory ventilation, with time-triggered, pressure-targeted, and time-cycled mandatory breaths according to the preset values of T high and T low(Daoud et al., 2012,p 282-292).

Both modes allow unrestricted spontaneous breathing both during and between mandatory breaths, but there is more time for them to occur during mandatory breaths with APRV; The APRV typically uses extreme inverse I: E ratios, while BIPAP usually does not (Daoud et al., 2012, p 282-292).Also APRV usually keeps the duration of the T low at 1.5 seconds, while there is no restriction on the T low in BIPAP (Daoud et al., 2012, p 282-292).

Continuous Positive Airway Pressure (CPAP): It provides positive airway pressure throughout the spontaneous breathing cycle; it increases the functional residual capacity and is useful to correct hypoxemia due to intrapulmonary shunting (Robert, 2018).

Since CPAP does not provide mechanical ventilation, it is suitable only for patients who have adequate respiratory mechanics and can sustain prolonged spontaneous breathing (Robert, 2018).

2.2.2. Indications

Mechanical ventilation is indicated when the patient cannot maintain spontaneous ventilation to provide adequate oxygenation or carbon dioxide removal; the clinical conditions leading to mechanical ventilation can be grouped into four areas: acute ventilatory failure; impending ventilatory failure; severe hypoxemia; and prophylactic ventilatory support(Chang, 2013).

2.2.2.1. Acute Ventilatory Failure

The major indication for mechanical ventilation is the acute ventilatory failure. This is defined as an unexpected rise in the $PaCO_2$ to greater than 50 mmHg with an accompanying respiratory acidosis (pH <7.30) (David J Feller-Kopman, , Richard M Schwartzstein, 2018).

In the COPD patients, mechanical ventilatory support is indicated by an acute increase in the $PaCO_2$ above the patient's normal baseline. The PaCO2 goes together with a decompensating respiratory acidosis (David J Feller-Kopman, , Richard M Schwartzstein, 2018).

2.2.2.2. Impending Ventilatory Failure

The impending ventilatory failure happens when a patient can sustain only slightly normal blood gases at the expense of a significantly increased work of breathing (Chang, 2 013, p 215). Reliant on the pulmonary reserve and lung function of a patient, the $PaCO_2$ value may be normal or low at the beginning of impending ventilator failure. This is because of an increase in minute volume in an effort to compensate for the gas exchange deficiencies (Chang, 2 013, p 215).

Nevertheless, if the pathophysiological causes are not fixed in time muscle fatigue will occur as a result of elongated, extreme work of breathing, at this time, the $PaCO_2$ will rise and the pH will fall (Chang, 2013, p 215).

2.2.2.3. Severe Hypoxemia

Hypoxemia is a clinical feature observed in lung diseases, when hypoxemia is severe, mechanical ventilation may be obligatory, needed to support oxygenation deficit (Chang, 2013, p 217). ALI, ARDS, pulmonary edema, and carbon monoxide poisoning are conditions that often require ventilatory support for the primary purpose of oxygenation (Chang, 2013, p 217).

2.2.2.4. Prophylactic Ventilatory Support

Prophylactic ventilatory support is provided in clinical conditions in which the risk of pulmonary complications, ventilatory failure, or oxygenation failure is high. (Chang, 2013, p 218).You could give an example of post-surgical procedure normally affecting the chest cavity, for example.

2.2.3 Complications of mechanical ventilation

The complications of mechanical ventilation involve various systems but commonly affect the lungs.

2.2.3.1. Pulmonary Complications

Volutrauma and Barotraumas: Damage to the lung occurs as a result of repetitive distention (over-distention) of alveoli and excessive transpulmonary pressures to the level of rupture. Consequently, air leaks into the plural space resulting in conditions including pneumothorax, pneumomediastinum and subcutaneous emphysema (Beitler et al., 2016, p 633-646).

Bio trauma: Extensive alveolar damage may lead to an increase in inflammatory cytokines in the lungs, resulting in VILI (Beitler et al., 2016, p 633-646).

Atelectrauma: Recurrent re-opening and collapsing of the under-recruited alveoli during ventilation causes injury affecting surfactant functioning leading to collapse of the dependent portions of the lung and regional hypoxia (Beitler et al., 2016, p 633-646).

Oxygen Toxicity: Oxygen concentrations nearing 100% are known to cause oxidant injuries in the airways; increased reactive oxygen species (ROS) leading to inflammation, secondary tissue injury, depletion of cellular antioxidant defenses and cell death (Jacoby, 2016).

Ventilator-Associated Pneumonia (VAP) is a nosocomial pneumonia occurring in patients who are mechanically ventilated >48 hours caused by aspiration of microbes from oropharyngeal, gastric, or tracheal secretions around the cuffed endotracheal tube into the normally sterile lower respiratory tract (Jacoby, 2016).

2.2.3.2. Cardiovascular and Renal Complications: Positive-pressure ventilation raises intrathoracic pressure during inspiration, decreasing venous return. The depressed venous return means decreased right ventricular preload and right ventricular output. The low right-sided output results in lower left ventricular preload because of diminished left ventricular end-diastolic volume (Jacoby, 2016).As a result, the after load increases due to compensatory mechanisms for low cardiac output until a stage of decomposition is reached due to decreased filling time and reduced myocardial circulation from compensatory tachycardia including compensatory vasoconstriction from baroreceptor –renin-angiotensin compensatory mechanisms increasing afterload (Mutlu et al., 2001, p1222-1241).

2.2.3.3. Gastrointestinal and Nutritional Complications

Gastritis and ulcer formation caused by a decrease in perfusion to the GI tract as result of intrathoracic pressure which decline venous return and cardiac output and medications frequently used during mechanical ventilation, the gastric ulcer can develop from the stress response with increased corticosteroid and catecholamine release (Jacoby, 2016).

Morphine sulfate is a medication frequently used for patient ventilator synchrony. Its side effect includes constipation as a result of the decrease of peristaltic movement (Jacoby, 2016).

2.2.3.4. Neuromuscular and Psychological Complications

The neuromuscular dysfunction is attributed to the depressed central drive or central ventilatory command which leads to the failure of the neuromuscular respiratory system and the peripheral dysfunction which is considered as primary cause of neuromuscular weakness; critical illness neuromuscular abnormalities (Khalil et al., 2012, p 224).

Central drive may be impeded by metabolic alkalosis, mechanical ventilation itself or the use of sedative/hypnotic medications (Khalil et al., 2012, p 224).Mechanical ventilation is an immediate synonym of anxiety. With other psychological factors such as delirium can cause weaning failure up to 20%-30% by increasing oxygen consumption and carbon dioxide production (Khalil et al., 2012).

2.2.3.5. Complications related to endotracheal cuff

Laryngeal injury: It happens due to ischemic injury resulting from high pressures generated around the endotracheal tube by pressing on the pentagonal structure of the larynx, especially at the vocal processes of the arytenoids and the cricoid ring (Indian, 2005 p 308-318).

Tracheal stenosis: It occurs as a result of intra-cuff pressure transmitted laterally against the wall of the trachea; ischemia and eventual necrosis occur when the lateral tracheal wall pressure exceeds the capillary perfusion pressure of about 25 mmHg. When intra-cuff pressures continue to be high, it can lead to tracheoesophageal fistula (Indian, 2005, p 308-318).

Aspiration: Nevertheless, the cuffed tube is used to protect the lungs from aspiration of foreign material; if it is not cuffed properly aspiration may occur (Indian, 2005 p 308-318).

2.2.3.6. Electrolyte disturbance and electrolyte imbalance

This happens from the development of inappropriate anti-diuretic hormone ADH-like electrolyte abnormality in some patients. This is related to stimulation of the ADH through thoracic volume chemoreceptors by positive pressure breathing. It can also occur if ventilation causes acid base imbalances as a complication (Drašković & Rakić, 2011, p965-975).

2.3.4. Monitoring Ventilated Patient

There are four reasons for monitoring a patient on a continuous basis: (1) baseline measurements can be used to set up the initial treatment plan and serve as a reference point for future measurements; (2) a trend can be established to document the progress or regression of a patient's condition; (3) treatment plans can be added, altered, or discontinued according to the measurements obtained; and (4) high-limit and low-limit alarms can be set on most monitors to safeguard a patient's safety (Chang, 2013 p 242).

Patient monitoring includes: vital signs (heart rate, blood pressure, respiratory rate, and temperature); this can provide very useful information on the overall condition of a patient. Considering that a mechanical ventilator can affect the venous return and cardiac output changes in vital signs often indicate changes in the patient's cardiopulmonary status (Chang, 2013, p243).

Monitoring of patient ventilation and oxygenation is important through chest inspection, chest movement, arterial blood gas or venous blood gas, auscultation, chest radiograph, oxygen saturation, capnography (Chang, 2013 p 375; Tusman, Bohm and Suarez-sipmann, 2016&Zeserson et al., 2018**).**

2.4. EMPIRICAL LITERATURE REVIEW

The empirical literature will cover the different levels of competence on the use of mechanical ventilation and the contributing factors among the ICU nurses.

2.4.1 The levels of ICU nurse's competences

The competence on the use of mechanical ventilation refers to the expertise, knowledge base, complex decision making skills and clinical competencies in caring for and understanding the theoretical, practical, and technological aspects of mechanical ventilation (Botha, 2012).

The levels of competence are evaluated by using the clinical vignettes (questionnaire) from Botha, (2012)and classified as adequate or satisfying when the ICU nurse has the score from 50% to 75% while the poor competence is reported when the participant has the score below 50% , scores of 75% or more indicate competence(Botha, 2012).

Different research has been done to determine the ICU nurses' levels of competence on mechanical ventilation, e.g. a study done by Pradhan & Shrestha, (2017) has found that among the ICU nurses, 45.6% exhibited the required competence to use the mechanical ventilation while 54.4% of ICU nurses were incompetent in this domain.

A cross–sectional survey on education of ICU nurses regarding invasive mechanical ventilation, reported that the majority of ICU nurses (63%) reported not receiving education about mechanical ventilation prior to the allocation in ICU (Guilhermino et al., 2014, p 222-229).In that study, only 35% of ICU nurses reported to be equipped with adequate skills and competence to manipulate and handle the mechanical ventilators (Guilhermino et al., 2014, p 222-229).

During the study to determine Critical care nurses' knowledge of ventilator bundle the researcher found that the level of knowledge of VAP prevention among critical care nurses is inadequate, especially among non-ICU-licensed nurses and nurses with a low RN rank. This may be due to lack of specialty training in critical care which is often provided at masters' levels (Sigler, 2015, p73).

The study conducted in South Africa (Johannesburg) by Lynn Botha in 2012 reported the competence level on mechanical ventilation for ICU qualified nurses to be48%and 31% among the unqualified nurses while the indicator for adequate level of competence should be 75%(Botha, 2012,page 91).

2.4.1.1. Factors that promote the ICU nurse's competence on MV

Nursing qualifications

Nursing specialization in critical care (intensive care) was found to be associated with improved levels of competence on mechanical ventilation. This is justified by Botha, (2012) in her study where ICU qualified nurses had average of 48% on his evaluation while non ICU qualified nurses had average of 31%. Therefore the nursing qualification influences the nurses competence more on mechanical ventilation (Botha, 2012).

2.4.1.2. Factors that hinder ICU nurse's competence on MV

Lack of qualification in critical care

Most undergraduate curricula for nursing like in Australia, Rwanda, etc. integrate basic care of the patient with breathing difficulties. Nevertheless, the principles of invasive MV are not provided in detail, and registered nurses (RNs) new to ICU, are not appropriately prepared autonomously to care for the patients on mechanical ventilation. Therefore the unqualified nurses on specialization are likely to have poor competence on mechanical ventilation (Botha, 2012).

The majority of RNs start working in the ICU before enrolling in a postgraduate course; therefore it is necessary that the work-place offers high quality of in service training or other special education to bridge the gap between new knowledge acquired and competent practice (Copede, et al., 2013).

2.5. CRITICAL REVIEW AND RESEARCH GAP IDENTIFICATION

The study of Lynn Botha conducted in South Africa did not identify factors associated with the identified low level of competence.

Through exploration of recent research and different search engines the researcher found limited literature related to competence regarding mechanical ventilation among the nurses in intensive care units of two university teaching hospitals in Rwanda.

This study therefore aims to determine the levels of competence on mechanical ventilation among the intensive care unit nurses at University Teaching Hospitals in Rwanda and to identify factors that promote or hinder the adequate level of competence. The prospective researchers can then set the strategies to tackle the problems identified by this study.

2.6. CONCEPTUAL FRAMEWORK

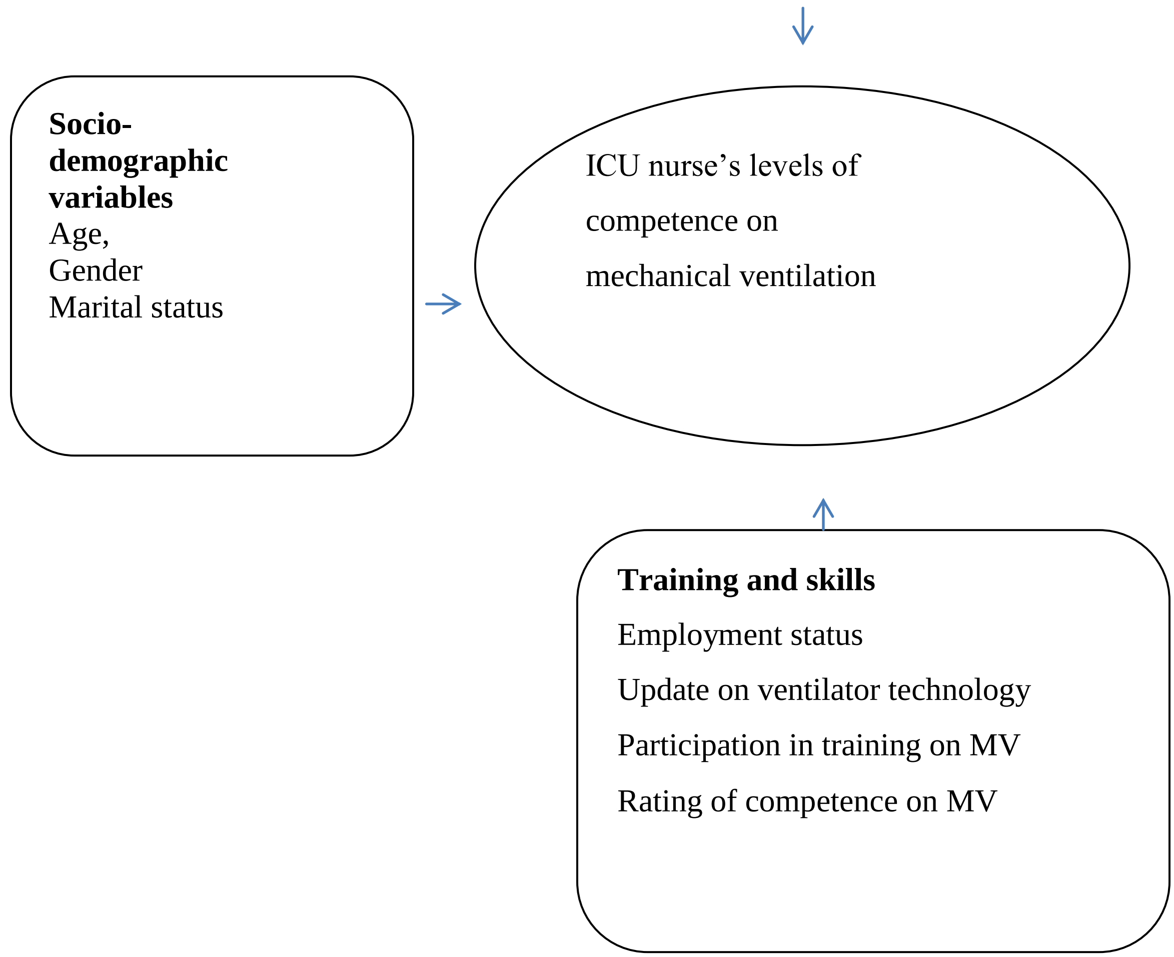
The conceptual framework in this study is comprised of several concepts, namely, socio-demographic data; data on qualifications, data on training and skills of the ICU nurses on mechanical ventilation that affect the nurses' levels of competence on mechanical ventilation, these concepts make the variables of this study. These concepts will be defined and their relationships spelt out hereunder.

The socio-demographic variables affect the ICU nurses' competence on mechanical ventilation. For example the highly qualified nurses (critical care nurse specialists) and having the postgraduate diploma in critical care (intensive care) were reported by Botha, (2012) to possess adequate levels of competence on mechanical ventilation.

In addition the participation in on the job training and in different conferences on mechanical ventilation and airway management were reported to play a role in improving the levels of competence on mechanical ventilation (Botha, 2012).

Levels of competence on mechanical ventilation: The different levels of competence on mechanical ventilation were evaluated by the clinical vignettes (questionnaire) to rank their marks adequate (more or equal to 75%) and inadequate (less than 75%).This was reported to be affected by the above mentioned variables (Botha, 2012).

Figure2.1: Conceptual Framework indicating the levels of competence on mechanical ventilation and the contributing factors



CONCLUSION TO CHAPTER TWO

Chapter two presented extensive literature on mechanical ventilation. It was made of theoretical and empirical literature review, the critical review and research gap identification and the conceptual framework.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1. INTRODUCTION

Chapter three is the research methodology. It presents the process and methods that were used to conduct this research. It includes a study design, research approach, study population, sample size and sampling methods, data collection instruments, methods and procedures, data analysis, study limitation and problems, and ethical consideration.

3.2. STUDY DESIGN

The descriptive cross-sectional design was used to conduct this research. Across-sectional design is a type of descriptive epidemiological study in which the health related event of the study population is determined at a given point of time.

3. 3. RESEARCH APPROACH

Quantitative approach was applied to the present research. A quantitative approach is the study that involves statistical measurement (numbers) or numerical analysis of data.

3.4. STUDY SETTING

This study was conducted at University Teaching Hospitals in Rwanda, namely, Kigali University Teaching Hospital (CHUK) and Butare University Teaching Hospital (CHUB).

3.4.1 Description of study setting

Kigali University Teaching Hospital is one of Rwanda University teaching hospitals located in Kigali City within Nyarugenge district, nearby SERENA Hotel, National laboratory and national blood transfusion Centre.

CHUK was built in 1918 by a group of Missionaries referred to as Pennies through the initiative of the official Authorities of Belgium. The hospital began with four rooms for hospitalization and a dispensary.

CHUK was awarded the status of a referral and teaching hospital on 7/12/2000 by the law N^{o}41/2000 and then expanded.

Currently CHUK has a capacity of admitting 509 patients and employs 434 nurses. Its mission is to provide education and clinical training for a medical profession, to deliver high-quality medical care for all categories of people and to develop research.

The intensive care unit at CHUK is made of seven beds and other three bed of PICU; the nurses allocated in ICU and PICU are forty eight in number.

Butare University Teaching Hospital is situated in HUYE district, Southern province. It is a university teaching hospital with 251nurses and 206 beds.

CHUB started its health services from 1928.By the time, it was the Butare Hospital. It was built by Belgian colonies. Butare Hospital became a University Teaching Hospital in 1966.

The intensive care unit at CHUB is made of five beds; the nurses working in ICU are eighteen in number.

3.5. STUDY POPULATION

The study population was made by the nurses working in intensive care units (ICUs) at two University Teaching Hospitals, namely, Kigali University Teaching (CHUK), and Butare University Teaching Hospitals (CHUB).

The study population includes 48 nurses from CHUK and 17 from CHUB which make the total of 65 nurses working in these ICUs.

3.6. SAMPLING

3.6.1. Sampling strategy

A census sampling method (complete enumeration) was applied in this study. Census sampling is a sampling strategy during which every unit or everyone in the study population is included in the sample. The whole study population constitutes the study sample.

The rationale for choosing this method is because the ICU nurses are too few to random selection therefore the census was applied in order to support generalization

3.6.1.1. Inclusion criteria

The inclusion criteria were all nurses working in intensive care unit in University Teaching Hospitals (CHUK and CHUB) in Rwanda, who consented to participate in the study.

3.6.1.2. Exclusion criteria

The exclusion criteria were all nurses working in other units than intensive care unit, the ICU nurses who did not consent to participate in the study and those who were on leave for various reasons at the time of data collection.

3.6.2. SAMPLE SIZE

In this study, the target sample size was made by all ICU nurses fulfilling the inclusion criteria. Thus the sample was 45 nurses from CHUK and 17 nurses from CHUB, totaling 62 ICU nurses

3.7. DATA COLLECTION

3.7. 1. Data collection instrument

To achieve the study's objectives, the clinical vignettes were used as data collection tools to determine the levels of competence regarding mechanical ventilation and the associated factors among ICU nurses at University teaching hospitals, Rwanda.

The tool was simplified, compiled and adapted to this study, because the original version of the tool was in English.

The researcher in collaboration with a language expert translated the adapted data collection tool into French to ensure most accuracy and observe informed consent.

The final data collection tool was composed of two sections; the first was made of socio-demographic data that may affect the levels of competence on mechanical ventilation among the ICU nurses at University Teaching Hospitals.

The second section was made of three clinical vignettes to evaluate the levels of competence on mechanical ventilation among the ICU nurses at University Teaching Hospitals.

The clinical vignette (questionnaire) is made of three clinical cases regarding three categories of pathological conditions and the questions to ask to the participants (ICU nurses) to evaluate their levels of competence on mechanical ventilation.

Vignette one concerns the normal post-operative patient, who becomes agitated and restlessness and requires mechanical ventilation. The evaluation is made of ten MCQs with one mark for each.

Vignette two concerns the patient with ARDS, who requires mechanical ventilation. The evaluation is made of six MCQs with one mark for each.

Vignette three concerns the patient with COPD, who requires mechanical ventilation. The evaluation is made of six MCQs with one mark for each.

All marks are summed up and calculated on percent and interpreted as follows, the score greater or equal to 75% indicates adequate level of competence while a score of less than 75% indicates inadequate level of competence on mechanical ventilation (Botha, 2012).

Reliability

The study by Botha (2015) has reported the reliable internal consistency of the clinical vignette with Cronbach’s alpha of 0.88 and the composite reliability of 0.90.Therefore the clinical vignette has been reported to be reliable to describe the ICU nurses’ levels of competence on mechanical ventilation(Botha, 2012).

Validity

Content validity of the clinical vignette was undertaken using the item validity index (I-CVI) and scale content validity index (S-CVI), therefore a S-CVI/Ave of 90% was found while the I-CVI were 83% (Botha, 2012).

Table: 3.1: Matching of objective, Tools and conceptual framework

Objectives	Questionnaire	Conceptual framework
To assess the levels of competence on mechanical ventilation among the ICU nurses at University teaching hospitals, Rwanda.	Vignette one Vignette two Vignette three	Levels of competence on mechanical ventilation among the ICU nurses
To identify the factors affecting the levels of competence on mechanical ventilation among the ICU nurses at University Teaching Hospitals, Rwanda	Socio-demographic variables Nurses' qualification Training and skills of the ICU nurse,	Socio-demographic variables Nurse's qualification Training

3.7.2. Data collection procedure

After getting clearance from IRB/CMHS, the researcher applied for permission to conduct research from CHUB and CHUK ethics committees. Once permission was obtained, the researcher met the unit managers of ICUs to introduce himself and explain the study purpose and ask permission and appointments to meet the ICU nurses.

After explanation of the study purpose and permission from the ICU nurses to participate in the study, the consent forms were signed by each participant. There after the researcher distributed the questionnaires to the participants and supervised them to prevent working in collaboration or other kind of cheating.

3.8. DATA ANALYSIS

Data was captured and analyzed using SPSS version 23. Descriptive statistics (frequency, percentages,) were computed and summarized in the form of tables to describe demographic characteristic of participants. Then inferential statistics (chi-square and Pearson correlation coefficient, and cross tabulation) were used to determine the associations between variables.

3.9. ETHICAL CONSIDERATIONS

The researcher received ethical clearance from IRB/CMHS and then requested permission to conduct research from CHUB and CHUK ethics committees. To ensure anonymity and confidentiality of participants, codes were used on questionnaires and kept in locked box. Softcopies were kept in computer locked with a password known to the researcher only.

The participants were guaranteed the right to refuse participation and to withdraw from the study at any stage without negative consequences, therefore participation was totally voluntary.

The researcher approached and informed the participants about research purpose and objectives, procedures involved, their rights regarding study participation or withdrawal including potential risks and how they would be mitigated. For example, this study involves minimal risk of interruption of ward routine. However, the researcher approached the participants between routine daily activities.

Of course the comfort of their leisure time was disrupted but the benefit of the information that was produced by this study may balance or even outweigh the sacrifice. Then the participants were requested to sign an informed consent.

Permissions to use the data collection tool developed by Lynn Botha was obtained through her contact details as follows +27722204134 and lynnbotha76@gmail.com.

3.10. DATA MANAGEMENT

All data was collected, coded, entered in Excel, analyzed by SPSS, and stored safely and confidentially on the researcher's personal password controlled computer, online driver with the research purpose only. Hard data was locked in a cupboard with a key handled by the researcher only and will be kept for five years after which they will be destroyed by shredding and incineration.

The soft copies are stored on external disk, kept confidential and will be used for the purpose of research. These will also be deleted permanently after five years.

3.11. DATA DISSEMINATION

The results of this study will be published in order to be accessible to the academic and research community as needed. The researcher will also provide feedback to the study settings in order to facilitate them to set strategies to improve the levels of competence on mechanical ventilation among the ICU nurses.

3. 12. PROBLEMS AND LIMITATIONS OF THE STUDY

In this study some problems were anticipated, for instance, delay to get permission to collect data from study settings. This was anticipated by finishing the research proposal as early as possible and to get enough time to wait for permission. Some few participants were not willing to participate in this research due to time constraint.

CONCLUSION OF CHAPTER THREE

Chapter three has described the procedure and instruments that were applied by researcher to answer the research questions including the ethics principles that were upheld.

CHAPTER FOUR: RESULTS

4.1. INTRODUCTION

This chapter presents the findings of this study according to the research objectives. The results are presented in tables which are preceded by a short summary of the contents within the table.

The study was intended to determine the level of competence regarding mechanical ventilation among the nurses working in intensive care units of two university teaching Hospitals in Rwanda and to identify factors which influence the level of competence of these ICU nurses.

4.2. DEMOGRAPHIC CHARACTERISTICS OF PARTICIPANTS

A total of 62 participants were involved in this study. The main characteristics of the participants as shown in Table 4.1.most were between 20 to 35 years (59.7%).

The results also show that the majority of participants (88.7%) were married. Most (93.5%) of the respondents were non ICU qualified, and 62.9% had received training while 59.7% reported that they had less than five sessions of training.

Finally, the majority of respondents (38.7%), on the type of training gained on mechanical ventilation, got on the job training, and only 24.2% got formal training.

Table 4. 1. Socio-demographic characteristics of participants

Background characteristics		*Frequency*	*Percent, %*
Total		**62**	**100**
Gender	Female	23	37.1
	Male	39	62.9
Age category	20-35	36	58.1
	36-50	25	40.3
Marital status	Married	55	88.7
	Single	7	11.3
Qualification	Non ICU qualified	58	93.5
	ICU qualified	4	6.5
Experience	inferior or equal to 5years	42	67.7
	superior to 5years	20	32.3
Job position	ward nurse	59	95.2
	Nurse administrator	3	4.8
Competence	inferior to 75	26	41.9
	superior to 75	36	58.1
Training	Trained	39	62.9
	Not trained	21	33.9
Number of training	Inferior to 5	37	59.7
	Superior to 5	2	3.2
Duration of training	Inferior to one week	33	53.2
	Superior to one week	6	9.7
Type of Education	Formal education	15	24.2
	On job training	24	38.7

4.3. PRESENTATION OF FINDINGS

4.3.1. Level of competence on managing ventilation on patient with normal lung (Post-operative patient)

Competence on a normal post-operative patient who becomes restless and agitated with a normal gas showed that most participants 50(80.6%) responded correctly. On the description of SIMV as a mode that the patient was on, 75.8% gave correct responses.

Secondly, Table 4.2. shows that almost a three quarter 46(74.2%) of participants answered incorrectly on diagnostic data to reflect good oxygenation and ventilation. Almost the same percentage of participants (71.0%) responded incorrectly to the question on expected tidal volume monitored.

The results also show that questions on differences between modes with respect to settings of volume, pressure, flow rate and inspiratory time (question 6.1, 6.2, 6.3 & 6.4) were done poorly at the rates of54.8%, 58.1%, 54.8%, and 54.8% respectively. On the question on the acceptable trigger sensitivity setting (question 7) a large majority (80.6%) responded incorrectly. The rate of responses on questions asking on the weaning process (questions 8 and 9) indicated that correct responses had a high percentage (72.6% and 54.8% respectively), compared to those who gave wrong responses. Finally over half of responses (59.77%) to the question on preventing aspiration on extubation were correct.

Table 4.2: The level of competence on managing ventilation on a patient with normal lung (Post-operative patient)

Variable		***Frequency***	***Percent, %***
1. Normal post op patient getting restless and agitated	Incorrect	12	19.4
	Correct	50	80.6
2.Pressure Control SIMV	Incorrect	15	24.2
	Correct	47	75.8
3.Pressure Support Ventilation	Incorrect	57	91.9
	Correct	5	8.1
4. Diagnostic data that would best reflect oxygenation and ventilation	Incorrect	46	74.2
	Correct	16	25.8
5.Exhaled tidal volume	Incorrect	44	71.0
	Correct	18	29.0
6.1 Differences between volume control and pressure control ventilation	Incorrect	34	54.8
	Correct	28	45.2
6.2. Differences between volume control and pressure control ventilation	Incorrect	36	58.1
	Correct	26	41.9
6.3.Differences between volume control and pressure control ventilation	Incorrect	34	54.8
	Correct	28	45.2
6.4. Differences between volume control and pressure control ventilation	Incorrect	34	54.8
	Correct	28	45.2
7. Trigger sensitivity	Incorrect	50	80.6
	Correct	12	19.4
8. Signs and symptoms indicating who is not ready to be weaned	Incorrect	17	27.4
	correct	45	72.6
9.Correct sequence of weaning	Incorrect	28	45.2
	Correct	34	54.8
10.Extubation a patient	Incorrect	25	40.3
	Correct	37	59.77

4.3.2. Level of competence on managing ventilation on patient with lung pathology (ARDS)

Table 4.3 shows the participants' responses about competency on managing ventilation in a patient with ARDS. The results show that responses on the rationale for high PEEP in ARDS were incorrect by a large majority (83.9%) (Question1). The interpretation of the arterial blood gas reveals that the respondents coped with interpreting the pH (61.3%), $PaCO_2$ (64.5%) and PaO_2(59.7%)but got the metabolic parameters (Base Excess and Bicarbonate) incorrectly at a rate of 61.3% and 58.1% respondents respectively with their incorrect responses at 83.9%, 61.3%, 58.1%, 87.1% and 83.9% respectively.

A large majority (87.1%) of respondents responded to the presented arterial blood gas incorrectly. In response to a deteriorating patient on mechanical ventilation with high PEEP, and FiO_2, another large majority (83.9%) responded incorrectly. Over two thirds (67.7%) of the respondents got the rationale for PEEP correct.

Table 4.3: The level of competence on managing ventilation patient with lung pathology (ARDS)

Variable		***Frequency***	***Percent, %***
1. Mechanically ventilating the patient with ARDS	Incorrect	52	83.9
	Correct	10	16.1
2.1.Interpret ABG (Ph)	Incorrect	24	38.7
	Correct	38	61.3
2.2. Interpret ABG (PCO_2)	Incorrect	22	35.5
	Correct	40	64.5
2.3. Interpret ABG (PaO_2)	Incorrect	25	40.3
	Correct	37	59.7
2.4 Interpret ABG(BE)	Incorrect	38	61.3
	Correct	24	38.7
2.5. Interpret ABG (SBC)	Incorrect	36	58.1
	Correct	26	41.9
3. Having interpreted the above ABG which ONE of the ventilator settings choices	Incorrect	54	87.1
	Correct	8	12.9
4. Intervention at this stage	Incorrect	52	83.9
	Correct	10	16.1
5.Effect of optimal PEEP at alveolar level of the lungs	Incorrect	30	48.4
	Correct	32	51.6
6. Graphic depicted on the screen.	Inferior	20	32.3
	superior	42	67.7

4.3.3. Level of competence in managing ventilation on patient with airway obstructive outflow pathology (COPD)

On the competency in managing ventilation on a patient with airway obstructive outflow pathology (COPD), Table 4.4 below shows that the incorrect interpretation has the greatest frequency than the correct. The respondents again coped with interpreting the respiratory parameters (question no 2.1, 2.2, 2.3 and2, 5) correctly though at low frequency rates of 51.6%, 54.8%, 54.8% and 62.9% respectively. The metabolic interpretation (Base Excess) is again incorrectly interpreted by almost two thirds (58.1%) of the respondents. The management of a patient with COPD in relation to oxygenation and ventilation (questions 2, 3, 4, 5 & 6) was done poorly with incorrect responses to all of the questions by 74.2%, 71.0%, 82.3%, 75.8% and 93.5% respectively.

Table4.4: Level of competence in managing mechanical ventilation on a patient with airway obstructive outflow (COPD)

Variable		***Frequency***	***Percent, %***
1.1 State whether the value is normal, raised or decreased(pH 7.3)	Incorrect interpretation	30	48.4
	correct interpretation	32	51.6
1.2 .State whether the value is normal, raised or decreased (Pa CO_2 60mm/Hg)	Incorrect interpretation	28	45.2
	correct interpretation	34	54.8
1.3. State whether the value is normal, raised or decreased (PaO_2 55mm/Hg)	Incorrect interpretation	28	45.2
	correct interpretation	34	54.8
1.4. State whether the value is normal, raised or decreased (BE -1)	Incorrect interpretation	36	58.1
	correct interpretation	26	41.9
1.5.State whether the value is normal, raised or decreased SaO_2	Incorrect	23	37.1
	Correct	39	62.9
2. patient who has COPD	Incorrect	46	74.2
	Correct	16	25.8
3.Interventions would be the most appropriate	Incorrect	44	71.0
	Correct	18	29.0
4.Appropriate ventilator setting combinations	Incorrect	51	82.3
	Correct	11	17.7
5. Prevent Auto- PEEP	Incorrect	47	75.8
	Correct	15	24.2
6. Interpret from this flow volume loop	Incorrect	58	93.5
	Correct	4	6.5

4.3.4 Overall competence on managing ventilation in patients with normal lung (post-operative patient), patient with lung pathology (ARDS) (predominantly oxygenation problem) and patient with obstructive outflow (COPD) (predominantly ventilation problem)

The study aimed to determine the level of competence regarding mechanical ventilation among nurses working in intensive care unit of two University teaching hospitals in Rwanda. The researcher used three clinical vignettes which were composed of multiple choice questions and few short descriptions. Regarding the results, the minimum mark was 4(11.76%), maximum marks were 26(76.47%), Mean: 13.51, Std. Deviation: 5.87. Referencing to the competence indicator of 75%, there is one participant (1.6%) who had 76.6%, others 61(98.4%) scored under 75%. See Table 4.5 below.

Table 4.5: Competences on managing mechanical ventilation in patients with normal lung (post-operative patient), lung pathology (ARDS) and with obstructive outflow (COPD)

Total marks/34	Total marks/100	Frequency	Percent,%
4	11.76	3	4.8
5	14.71	2	3.2
6	17.65	4	6.5
7	20.59	3	4.8
8	23.53	4	6.5
9	26.47	5	8.1
11	32.35	2	3.2
12	35.29	4	6.5
13	38.24	3	4.8
14	41.18	4	6.5
15	44.12	4	6.5
16	47.06	4	6.5
17	50.00	3	4.8
18	52.94	4	6.5
19	55.88	3	4.8
20	58.82	2	3.2
21	61.76	3	4.8
23	67.65	1	1.6
24	70.59	2	3.2
25	73.53	1	1.6
26	76.47	1	1.6

4.3.3. Association of socio demographic variable with competence level

In the present study, results from Table 4.6, display the cross tabulation (Chi^2) of socio-demographic variables and competence level which concluded that there was statistical insignificant association between gender, marital status , experience, training, number of training sessions on mechanical, duration of training, type of education based of their p-values which were above 0.05. Thus, they do not act as factors which influence the level of competence on mechanical ventilation.

On the other hand, there was a statistical significance between the level of competence and qualification, job position and age with respective p-values, p0.000, p0.000 and p.0.038 respectively. Hence, these demographic factors act as factors which are associated with the level of competence on mechanical ventilation.

Table4.6. Association between level of competence and socio-demographic variables

Variable	χ^{2}	**p-value**
Age of participant	31.232	.038
Gender of participant	17.218	.639
Marital status of participant	24.558	.219
Qualification of participant	49.573	.000
Experience of participant	30.195	.067
Job position of participant	47.522	.000
Training of participant	20.659	.417
Number of training sessions of participant	25.297	.117
Duration of training of participant	23.636	.167
Type of training	18.579	.418

CONCLUSION OF CHAPTER FOUR

This chapter has described social demographic characteristics, their level of competence on managing ventilation on patient with normal, lung pathology (ARDS), obstructive outflow disease (COPD) and overall competence

CHAPTERFIVE: DISCUSSIONS

5.1. INTROCUCTION

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

5.2. LEVEL OFCOMPETENCEREGARDINGMECHANICALVENTILATION

The overall score of the participants in relation to their competence level on mechanical ventilation as evidenced by the results of three clinical vignettes was poor. A percentage 98.4% (61) graded with less than 75% of the total score which is the competence indicator. Only 1.6 % (n=1) demonstrated the required score to be competent on managing mechanically ventilated patients while their perception show that 58.1% of participants have greater than 75% . This is very close to the study conducted in two tertiary health care institutions of Gauteng in South Africa where the results showed poor level of competency regarding basic mechanical ventilation, regardless nurse's training background, age and/or experience(Botha, 2012). For this study neither ICU qualified nor non ICU qualified achieved competence indicator of 75%.

Different research has been done to determine the ICU nurses' levels of competence on mechanical ventilation. A study done by Pradhan & Shrestha (2017) has found that, among the ICU nurses, 45.6% exhibited the required competence to use the mechanical ventilation while 54.4% of ICU nurses are incompetent in this domain.

A cross–sectional survey on education of ICU nurses regarding invasive mechanical ventilation, reported that the majority of ICU nurses (63%) had not received education about mechanical ventilation prior the allocation in ICU (Guilhermino et al., 2014, p 222-229). In that study, only 35% of ICU nurses reported to be equipped with adequate skills and competence to manipulate and handle the mechanical ventilators (Guilhermino et al., 2014, p 222-229).

It is suggested that the mechanically ventilated patients be cared for by an ICU qualified nurse, as it is assumed that the ICU qualified nurse comes to the bedside with superior education and training, beyond the basic preparation required to qualify as a registered nurse (Nurses for a Healthier Tomorrow 2006).ICU training includes an understanding of the modes and monitoring required of the mechanically ventilated patient, thus contributing to optimal outcomes of the patient (Pierce, 2002).

5.3. ASSOCIATED FACTORS WITH LEVEL OF COMPETENCE ON MECHANICAL VENTILATION

Nurses' years of experience in the ICU were included in the study to determine if experience of the nurses influenced the nurses' competency level of mechanical ventilation. Benner (1982) suggests that experience is a prerequisite to becoming an expert. Thus the researcher postulated that nurses, who had extended years of experience in the ICU, would demonstrate a superior level of competence in mechanical ventilation, than those nurses with less experience. However, analyses using cross tabulation on experience as a variable with level of competence showed that experience had no influence on competence level. This study is complementary to Scribante & Bhagwanjee (2003) who argue that, unless nurses continue to learn, and are responsible for their own learning, years of experience will have no influence on their levels of competence.

The present study showed that qualification affects competence level significantly (p0.000). This is the same as a study done in Califonia among Academic Emergency Medicine Physicians' to assess their Knowledge on Mechanical Ventilation. Correlation analysis revealed statistically significant relationships between their level of competency and qualification(Wilcox *et al.*, 2016).

The study done by Botha (2012) showed minimal influence of years of experience on improving the levels of competence of the nurses in contrast to the studies which show years of experience to be a factor in gaining further knowledge and providing higher quality nursing care (Toth,2003).

The result of this study showed that age influences the competence level on mechanical ventilation with the p0.038 while the study of Botha, (2012) showed that training background, age and/or experience, showed a poor level of competency with regard to basic mechanical ventilation.

5.4. CONCLUSION

This study intended to demonstrate the competence on mechanical ventilation of nurses. The findings highlighted that nurses working in ICU irrespective of experience have inadequate competence on managing mechanical ventilation on patients with different pathologies of ventilation and oxygenation. Qualification, job position and age showed that they had an association with competence while other factors included in this study had no significant influence on competence level.

CHAPTERSIX: SUMMARY, RECOMMENDATION, LIMITATION AND CONCLUSION

6. 1. INTRODUCTION

Chapter six is made of conclusions that are drawn from the findings of this study. In addition to that, recommendations to the nursing practice, nursing education and nursing research are made.

6.2. SUMMARY OF THE STUDY

The research on competence regarding mechanical ventilation among nurses working in ICUs of two University Teaching Hospitals, Rwanda, with objectives of determining the level of competence on mechanical ventilation and identifying factors associated with competence on mechanical ventilation among the intensive care unit's nurses at University teaching hospitals, Rwanda has been presented. The study's objectives were achieved.

Among the ICU nurses of CHUB and CHUK, 98.4% are under the competence indictor of 75%. Only 1.6% was above or competent. The identified associated factors on competence level were qualification, job position and age with p0.000, p0.000 and 0.038 respectively. Other factors included in this study were not significantly influencing the competence level, even experience.

6.3. RECOMMENDATIONS

The purpose of this study was to determine the level of competence regarding mechanical ventilation among nurses working in ICUs of two University Teaching Hospitals. The results found that nurses are incompetent to manage ventilation on patients with different ventilation and oxygenation pathologies. This goes hand in hand with practice, education and research. The study will now make recommendations to practice, nursing education and research so that nurse's competencies improve.

6.3.1. RECOMMENDATION TO THE NURSING PRACTICE

- Nurses who care for the mechanically ventilated patients should have ongoing clinical assessments with regard to their competency to care for such a patient, and be assessed by a senior member of staff who herself has been assessed as competent.
- Guidelines for practice and protocols must be developed and implemented.
- All nurses working in intensive care units must undergo a Post Graduate or Masters Training in Critical Care Nursing to enable them to provide highly specialized care.
- In areas where Doctors and/or critical care nurses are not available, Registered nurses should be empowered to identify, independently, clinical deterioration of mechanically ventilated patients.

6.3.2. RECOMMENDATION TO THE NURSING EDUCATION

- ICU lecturers must be up to date with current clinical practice on mechanical ventilation and ventilator technology. For example must teach ventilator graphics in the ICU curriculum and new modes of ventilation.
- ICU preceptor must be ICU qualified and their competency evaluated prior to be appointed to the post of ICU preceptor.

6.3.3. RECOMMENDATION TO THE NURSING RESEARCH

- A Pre- and post-test research design which implements a six month mechanical ventilation course must be undertaken

This study may be done to other staff who take decisions on mechanically ventilated patients, like general practitioners and residents within ICUs in Rwanda.

6.4. LIMITATION

The instrument was seen as a “test” by some of the participants and as such may have been threatening to them.

The tool was written in English by the one who developed it. We translated it from English to French because of some participants who did their study in French. It is known that translating something from one language to another can affect the original meaning and being in different cultural context can exaggerate or inhibit the real significance of the concept**.**

6.5. CONCLUSION

The overall competency level on mechanical ventilation among nurses working in ICUs discussed was poor; this is likely to affect negatively the patient who is mechanically ventilated. Although most of the recommendations were suggested in this study, it is important to state that none of the strategies alone could sort the problem of low competency levels on managing mechanically ventilated patients with different pathologies among nurses working in ICUs unless implemented collaboratively.

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APPENDIX 1:

INFORMATION SHEET

TOPIC: Competence regarding mechanical ventilation among the nurses in intensive care units of two university teaching Hospitals in Rwanda

Dear Colleague,

My names are Mahoro Jean de Dieu. I am currently registered to read for a Master's Degree in Critical Care and Trauma nursing at the University of Rwanda, Department of Nursing Sciences. As part of my course requirement I am expected to conduct clinical research under supervision. The title of my research is: **"Competence regarding mechanical ventilation among the nurses working in intensive care units of two university teaching Hospitals in Rwanda"** and I would like to invite you to participate in the study.

PURPOSE OF THE STUDY

The purpose of this study is to determine the level of competence on mechanical ventilation among the intensive care unit nurses at University teaching hospitals, Rwanda

PARTICIPATION

Participation in this study is voluntary. Participants, who are not interested in participating in this study, are free to refuse and withdrew as they wish, and this does not affect their working relationship at the institution. Those who are willing to participate are asked to sign a consent form as an agreement to participate. But this never results into any immediate benefits. Participants are advised to ask where they do not understand.

PROCEDURE The study involves a set of questions in a structured questionnaire. After signing the consent form, participants will be given a self-administered questionnaire to answer.

RISKS AND DISCOMFORTS

There is no risk involved in this research though part of participants' time is utilized to answer some questions. Participants who need further discussion will be provided to help them understand the topic more.

BENEFITS This document is of academic nature, hence, there is no monetary gain by participating in this study, but obtained information will help policy makers to take measures that would ensure development of critical care nursing competence on mechanical ventilation level among nurses.

CONFIDENTIALITY

Participants' research records and any information will be confidentially handled to the extent permitted by law. Participants will be identified by a number, and personal information will not be released without their written permission except when requested by law.

Here are phone numbers you can call in case you have a concern:

Researcher: 0783329360

Supervisor: **0788760089**

If you are concerned about the process of the study, you can contact the research office chairperson CMHS IRB number is: **0788 490 522** and the Deputy Chairperson Number is **0783 340 040**

APPENDIX II

INFORMED CONSENT FORM

The purpose of this study has been explained to me and I understand the purpose, benefits, risks, and discomforts and confidentiality of the study.

If I agree to take part in this study I can withdraw at any time without having to give any explanation and taking part in this study is purely voluntary.

I………………………………………………….., hereby agree to take part in this study Signed:……………………………………………..Date ………………………………

APPENDIX 3: QUESTIONNAIRE

I. SOCIO-DEMOGRAPHIC

1 Age (in years): 20-35 ☐ 35-50 ☐

2. Gender: Male ☐ Female ☐

3. Marital Status: Married ☐ Single ☐

4. Education level: A1 ☐ A0 ☐ Post graduate diploma ☐ ’s ☐

5. Clinical experience (in years): ≤ 5 ☐ 6-10 ☐ ≥10 ☐

6. Job position: ward Nurse ☐ Bed side nurse ☐

7. Employment status: Full time ☐ Part time ☐

8. Rating of competence on MV: ≥75 %< 75% ☐ ☐

9. Training on mechanical ventilation Yes ☐ No ☐

I f yes: Number of training session ☐ Duration of session ☐

Formal training ☐ on the job training ☐

SECTION TWO: CLINICAL VIGNETTE

Instructions: Answer the questions by ticking the corresponding letter

VIGNETTE ONE: NORMAL POST OPERATIVE PATIENT

A 48 year old, with ideal bodyweight of 72kg is admitted to the ICU post operatively having undergone major elective abdominal surgery. Needs ventilation only overnight and extubation planned in 24hrs later. Soon after his admission to the ICU, patient becomes agitated and restless. ABG is normal.

QUESTION 1

1. Which **ONE** of the following is the **MOST LIKELY** cause of his agitation and restlessness?

b) Hypoxia
c) Uncontrolled pain
d) Low blood pressure
e) Angina
f) Don't know

2. The patient settles down after your intervention and his vital signs are stable. The ventilator mode is Pressure Control SIMV.

Select the **ONE** correct answer from the choices below with regard to SIMV mode of ventilation.

a) The ventilator cycles with each respiratory effort made by the patient
b) The ventilator supplements each breath with positive pressure
c) The ventilator delivers a preset number of ventilator breaths per min. ONLY
d) The ventilator delivers a preset number of ventilator breaths per minute and allows the patient to breathe spontaneously between ventilator breaths.
e) Don't Know.

3. The doctor having assessed the patient asks you to increase the pressure support from 10 to 15 cmH_20. The PEEP is 5 cmH_20

Select the **ONE TRUE** statement from the choices below regarding Pressure Support Ventilation (PSV)

b) PSV breaths always have the same tidal volume
c) PSV is used when weaning patients from the ventilator
d) PSV breaths are triggered and cycled by the ventilator
e) PSV aids in ventilation and is adjusted in response to $C0_2$ levels.

f) Don’t know.

4. Later that night an ABG is done on patient. Select the **ONE** Combination of diagnostic data that would best reflect oxygenation and ventilation from the choices given below.

b) Chest X-ray, $Sp0_2$
c) Heart rate, $ETC0_2$
d) $Sa0_2$, $ETC0_2$
e) Respiratory rate, $Sa0_2$
f) Don’t know.

5. During the night you notice patient’s exhaled tidal volume is 100mls less than his inhaled tidal volume. Select the **ONE INCORRECT** statement from the choices below.

b) There is a leak in the ventilator circuit.
c) The ventilator was not calibrated with the humidification system in place
d) The exhaled tidal volume SHOULD be larger than the INSPIRATORY tidal volume
e) The ET tube cuff is leaking
f) Don’t know

6. The nurse who is helping you with patient is doing the ventilator observations for the hour, and asks “what is the difference between volume controlled ventilation and pressure controlled ventilation?”

Fill in the blank spaces in the chart below to show the nurse the differences between volume control and pressure control ventilation. If you would set the parameter for that type of ventilation place a tick in the box. If the parameter is NOT set and is variable then write VARIABLE in the box.

Comparison chart

	Volume	Pressure	Flow	I-time
Spontaneous				
Volume Control V				
Pressure control V				
Pressure Support				

7. Whilst you and the nurse are doing the ventilator observations the following hour you notice that the trigger sensitivity on the ventilator is set at -4cm/H20. Select the **CORRECT** statement from the choices with regard to trigger sensitivity.

b) A trigger sensitivity of -4 is a normal setting for a post-operative patient being ventilated
c) Trigger sensitivity setting has no effect on the patient breathing efforts.
d) The trigger sensitivity should be set at -2 to commence ventilation and then adjusted to the specific patient.
e) Trigger sensitivity is only related to ventilator breaths
f) Don't know.

8. The following morning an assessment is made by you and the doctor that patient is ready to be weaned from the ventilator with a view to extubation. Which **ONE** of the signs and symptoms listed below is **NOT** indicative of patient who is ready to be weaned?

b) Patient still dependent on Inotropic support to maintain hemodynamic stability
c) RR rate > 10 and <30 breaths per min

d) Temp 36 degrees.

e) $PC0_2$ 35-40mm/Hg

f) Don't know

9. The decision to wean patient from the ventilator with a view to extubation is made. With regard to the weaning process which **ONE** of the following is the correct sequence of weaning?

b) O_2 is reduced to 35-40% followed by a decrease in mandatory respiratory rate, followed by decreasing the pressure support, followed by decreasing CPAP.

c) CPAP /PEEP is decreased first, followed by reduction in pressure support, followed by reduction of 0_2 % followed by reduction of mandatory respiratory rate.

d) Pressure support reduced first, followed by reduction of mandatory respiratory rate, followed by reduction in 0_2% followed by reduction in PEEP/CPAP.

e) Rate reduced first, followed by reduction of 02% followed by reduction of pressure support, followed by reduction of PEEP/CPAP.

f) Don't Know

10. Patient has coped very well and is ready for extubation. Select the **ONE INCORRECT** answer below with regard to extubating a patient.

b) The oropharynx must be suctioned and then down the ET tube.

c) The cuff of the ET tube must be inflated to prevent aspiration on extubation

d) The patient is asked to cough

e) Post extubation the patient must be sitting up in bed and 40% 0_2 administered.

f) Don't know

VIGNETTE TWO: ARDS

A 48 year old sustained bilateral fractured femurs in an accident. She weighs 100kg with an ideal body weight of 75kg. She has been mechanically ventilated in your ICU for 3 days and the doctors say she has ARDS as a result of fat embolus. She has a "white-Rayout"and her lung bilateral compliance is decreased. The doctor says she must be ventilated using protective lung strategies.

1. With regard to mechanically ventilating the patient with ARDS. Which ONE of the choices below is **NOT** correct?

b) The Tidal volume should be calculated as 4-8mls/kg/ideal body weight
c) The patient airway pressure should not exceed 45cm/H20
d) High Peep levels are often required to prevent shearing injury of the lung
e) The patient with ARDS usually has non compliant (stiff) lungs
f) Don't know

A blood gas (ABG) taken from Mrs. Mayeke on 60% 02 reveals the following

Ph 7.2	
$PaC0_2$ 66mm/Hg	
$Pa0_2$ 60 mm/Hg	
BE +4	
SBC 28/mm/L	

2. Interpret the above ABG by placing an arrow ↑ indicating an increased value, or ↓ indicating a decreased value, or → indicating normal value in the blank box next to the individual values.

3. Having interpreted the above ABG which ONE of the ventilator settings choices below would **be the most appropriate** for patient at this time?

b) P/C SIMV, 0_2 65%, Rate 20bpm, Pressure limit 30cm/H20, PEEP 12cm/H_2O, Pressure support 22cm/H20, Trig -2
c) V/C SIMV 0_2 40%, rate 10bpm Peak Flow 40L, Tidal Volume 750mls, PEEP 5 cm/H_2O,

Pressure Support 15cm/H20, Trigger -4cm/H_2O

d) P/C SIMV, 02 100%, rate 35bpm, Ti 1.5 secs, PEEP 20cm/H_20, pressure Support 20 cm/H_20, Pressure limit 35cm/H_20, trigger -1
e) V/C SIMV, 0_2 100% TV 450mls, Peak flow 40L rate 25bpm PEEP 5, Pressure support 5cm/H_20 trigger -2cm/H_2O
f) Don't know

4. Four hours later patient continues to deteriorate. Her lungs have become stiffer and she requires higher levels of 0_2 to maintain her $P0_2$ at 60mm/Hg. Her high airway pressure alarm is constantly alarming.

Which **ONE** of the following would be the **MOST APPROPRIATE** intervention at this stage?

a) Increase the 0_2% to 100%
b) Increase the mandatory rate to blow of the $C0_2$
c) Decrease the peep
d) Place the patient in the prone position and recruit the lungs.
e) Don't know

5. Patient improves after you have instituted the correct intervention.

With regards to PEEP, what is the effect of optimal PEEP at alveolar level of the lungs? Select the **ONE CORRECT** statement.

b) Decreases the risk of barotrauma
c) Decreases the FRC of the lung
d) Opens up the alveoli and prevents alveolar collapse at the end of expiration
e) Decreases oxygenation
f) Don't know

6. Below is a pressure/volume loop as displayed on Mrs. Mayeke ventilator graphics monitor of the ventilator.

Which **ONE** statement listed below the graphic is **CORRECT**, in relation to the graphic depicted on the screen.

VIGNETTE THREE: COPD

Mrs. Smith aged 64yrs, and a history of smoking 30-40 cigarettes a day for the past 30years, is admitted to casualty. She complains that over the past week she has been coughing up yellow purulent sputum, and she has had to use her bronchodilator inhalers more frequently than usual. Respiratory assessment reveals the following:

A respiratory rate of 35 breaths per minute.

Using accessory muscles of breathing

Decreased breath sounds bilaterally

Only able to complete short sentences

Prolonged forced expiration

Chest X-ray reveals hyperinflation of both lungs

An ABG drawn whilst Mrs. Smith is receiving 2 L of oxygen via nasal cannula shows:

pH:7.3	
$PaCO_2$:60mmhg	
PaO_2:55mmhg	
BE : -1	
SBC :24mm/l	
SaO_2:90%	

1. In the table above in the blank block next to each parameter of the ABG state whether the value is normal, raised or decreased.

2. With regards to the patient who has COPD. Select **the ONE INCORRECT** answer.

a) The COPD patient normally has a hypoxic drive to breathe

b) Forced prolonged expiration is a sign of expiratory airway obstruction
c) The ABG above is normal for the COPD patient
d) The administration of 100% oxygen at this stage would be the correct therapy for Mrs. Smith?
e) Don't know

3. Two hours later it is clear that Mrs. Smith is deteriorating and the nurse places her on a 35% oxygen face mask, and she is admitted to the high care unit for monitoring. Her respiratory rate is now 40 breaths per minute, her work of breathing is markedly increased, and she is sweating profusely, and is extremely anxious. She is however still co-operative and awake.

Which **ONE** of the following interventions would be the most appropriate? Choose the **ONE** best answer.

a) Increase the supplemental 0_2 to 100%

b) Commence a continuous infusion of bronchodilator therapy ONLY

c) Intubate and ventilate Mrs. Mbusi

d) Give Mrs. Smith a trial of non-invasive ventilation using Bipap

e) Don't know

4. Two hours later in spite of her therapy Mrs. Smith continues to deteriorate and the decision is made by the doctor present to intubate and mechanically ventilate her. A size 7.0 ET tube is inserted without difficulty and post intubation X-ray shows the ET tube to be correctly positioned in the trachea.

Which **ONE** of the following ventilator setting combinations would be **the MOST appropriate** at this stage for Mrs. Smith?

Volume control SIMV, O_2 100%, Peak Flow 40 liters, Mandatory rate 22 bpm; Pressure

Support 15cm/H_2O, PEEP 5 cm H_20, TV 400mls, trigger sensitivity -2cm/H_2O, IE 1;2

c) Pressure control SIMV, Pressure limit 35cm/H_20, Ti 0.8 secs, Pressure support 15cm/ H_20, PEEP 5 cm/H_20, 02 100% Mandatory respiratory rate 22,

d) Spontaneous mode, PEEP 7.5cm/H_20 and Pressure support 25cm/H_20

e) Volume control SIMV, Peak Flow 40L, Mandatory rate 10 bpm, Pressure support 15 Cm/H_20, PEEP 7.5 cm/H_20, $0_2$35%, IE 1:4

f) Don't know

5. Auto-PEEP is a problem when ventilating the COPD patient. Which of the following would be adjustments you would make to the ventilator settings to PREVENT Auto- PEEP from occurring. Select **TWO** correct answers.

b) Increase the respiratory rate

c) Decrease the respiratory rate

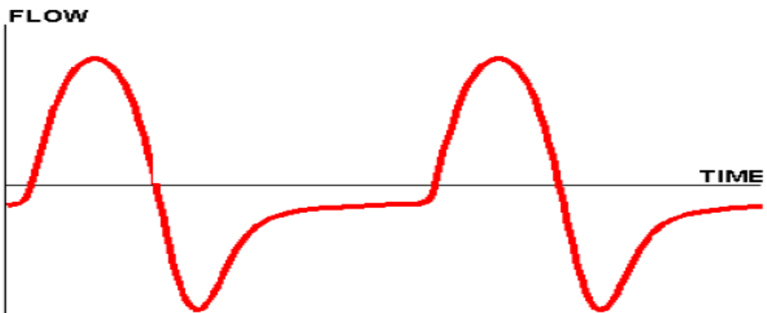
d) Increase the inspiratory time

e) Decrease the expiratory time

f) Don't know

6. Below is the ventilator graphic shown on the graphics screen of Mrs. Smith ventilator? What problem can you interpret from this flow volume loop?

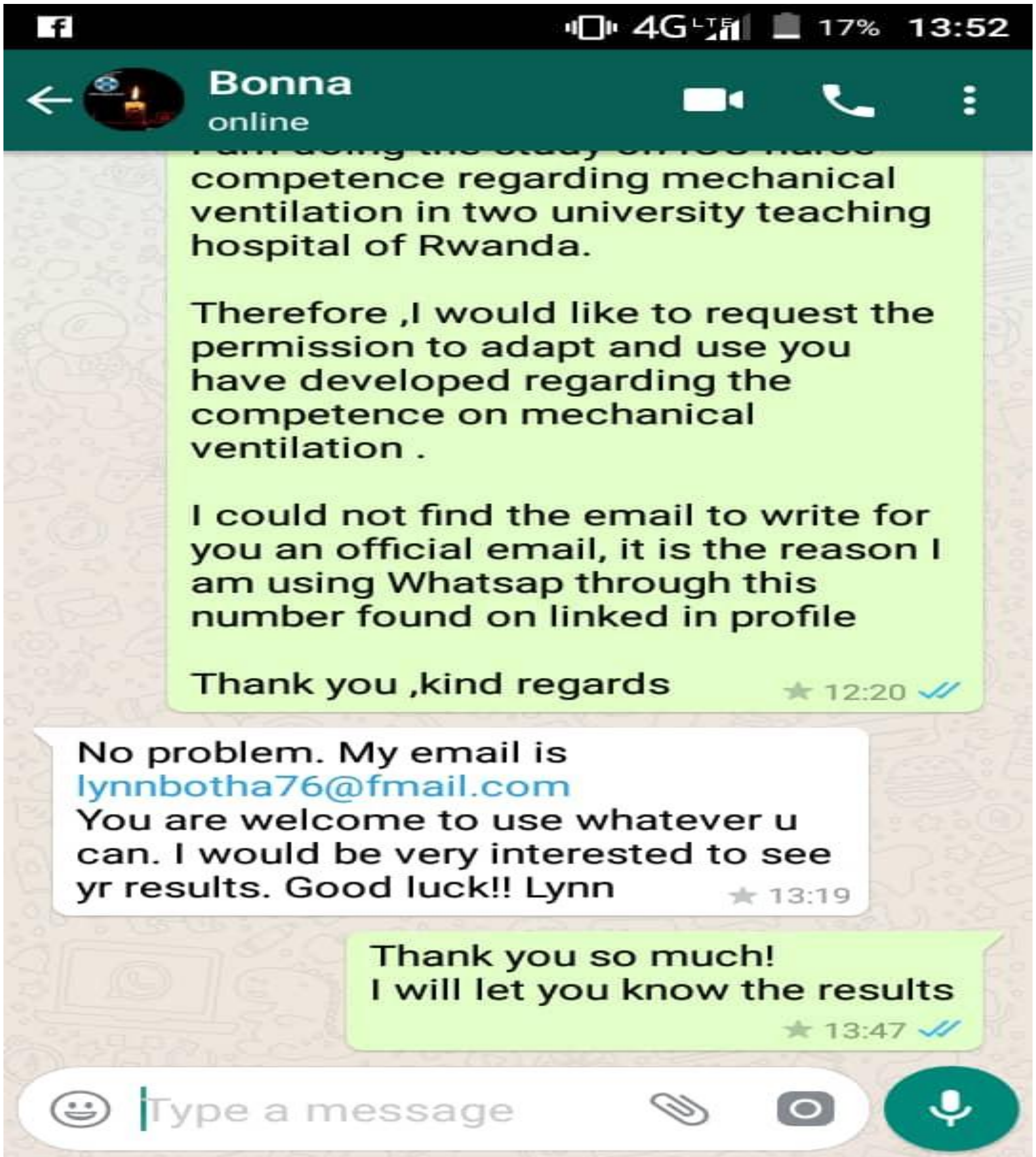
Explain your answer in the space provided below the graphic.



Answer:--

Thank you for participating in my research, your identity, score, and unit remain anonymous even to the researcher.

APPENDIX: PERMISSION TO USE THE TOOL



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OFFICE OF DIRECTOR GENERAL

Huye, 08/04/2019

N° Ref: CHUB/DG/SA/04/0597/2019

Mr. Jean De Dieu Mahoro
UR-CMHS
Phone: +250783329360
Email: jadomahoro@outlook.com

Dear Mahoro,

Re: Your request for data collection

Reference made to your letter requesting for permission to collect the data within University Teaching Hospital of Butare for your research proposal entitled **"Competence regarding mechanical ventilation among the nurses working in intensive care units of two University Teaching Hospitals in Rwanda"**, and based to the different approvals **Ref: CMHS/IRB/089/2019** from Institution Review Board of University of Rwanda and **No: RC/UTHB/027/2019** from our Research-Ethics committee, we are pleased to inform you that your request was accepted. Please note that your final document will be submitted in our Research Office.

Sincerely,

Dr. Augustin SENDEGEYA
Director General of CHUB

Cc:

- Head of Clinical Education and Research Division
- Director of Research
- Chairperson of Research-Ethics Committee
- Research officer

CHUB

CENTRE HOSPITALIER UNIVERSITAIRE
UNIVERSITY TEACHING HOSPITAL

Quality Health Care
Training & Research

Ethics Committee / Comité d'éthique

February 25th, 2019 **Ref.: EC/CHUK/034/2019**

<u>Review Approval Notice</u>

Dear Mahoro Jean de Dieu ,

Your research project: **"Competence regarding mechanical ventilation among nurses working in intensive care unit at CHUK".**

During the meeting of the Ethics Committee of University Teaching Hospital of Kigali (CHUK) that was held on 25th February, 2019 to evaluate your request for ethical approval of the above mentioned research project, we are pleased to inform you that the Ethics Committee/CHUK has approved your research project.

You are required to present the results of your study to CHUK Ethics Committee before publication.

PS: Please note that the present approval is valid for 12 months.

Yours sincerely,

ETHICS COMMITTEE CHUK

Dr.Emmanuel Rusingiza
The Chairperson, Ethics Committee,
University Teaching Hospital of Kigali

<<University teaching hospital of Kigali Ethics committee operates according to standard operating procedures (Sops) which are updated on an annual basis and in compliance with GCP and Ethics guidelines and regulations>>