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LEVEL OF NURSES' COMPETENCE IN MECHANICAL VENTILATION IN INTENSIVE CARE UNITS OF TWO TERTIARY HEALTH CARE INSTITUTIONS IN GAUTENG

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Thesis submitted in fulfillment of the requirements for the degree of Masters of Science in Nursing, Faculty of Community and Health Sciences, Department of Nursing Education, University of the Witwatersrand

Johannesburg, 2012

DECLARATION

I hereby declare that the "*Level of Nurses' Competence in Mechanical Ventilation in Intensive Care Units in Two Tertiary Healthcare Institutions in Gauteng*" is my own work that it has not been submitted for any degree or examination in any other university, and that all the sources used or quoted have been indicated and acknowledged by complete references.

Signature……..
Lynn Botha

Signed at……

On this date……..

ABSTRACT

Studies generally agree the survival of the mechanically ventilated patient in the ICU is largely reliant upon the competence of the nurse undertaking this highly specialized role (Alphonso,Quinones,Mishra,et al. 2004; Burns 2005) However, an audit undertaken by the Critical Care Society of Southern Africa (2004) revealed that 75 % of nurses working in ICU are inexperienced and do not hold an ICU qualification, and as such are unlikely to have acquired the level of competency required to care for the mechanically ventilated patient (Binnekade 2004). A high index of suspicion exists around the competence levels of nurses' currently working in ICU in SA as revealed by local studies (Khoza & Ehlers 1998; Scribante & Bhagwanjee 2003; Moeti, van Niekerk, van Velden, 2004; Morolong & Chabeli 2005; Windsor 2005; Perrie & Schmollgruber 2010).

The purpose of the study was to determine and describe the level of competence with regard to mechanical ventilation, of nurses working in ICU, who have varying years of experience and training backgrounds, using study specific designed clinical vignettes, in two tertiary healthcare institutions in Gauteng.

A descriptive two phase design was utilized for the study. Phase one comprised the development and validation of three clinical vignettes to determine the level of competence of nurses working in ICU's with regard to mechanical ventilation. A modified Delphi technique technique using purposively sampled experts from medical technical and nursing backgrounds was used to validate the three clinical vignettes. Content validity was strengthened by computing CVI of the instrument. In Phase two consecutive sampling was used, and data collection comprised of participants (n=136) completing three validated clinical vignettes in the ICU's of two tertiary healthcare institutions in Gauteng. All nurses who participated in the study completed the same three clinical vignettes and demographic data. Nurses' perceptions regarding their own level of competence with regard to mechanical ventilation were quantified and compared with actual scores achieved in the clinical vignettes.

Descriptive and inferential statistics were used to analyse the data. The level of significance was set at <0,05 and confidence levels at 95%. The competency indicator for the vignettes was set at 75% by the expert group, and nurses' level of competence was graded according to vignette score outcomes using a grading scale. Statistical assistance was obtained from a statistician from the Medical Research Council (MRC).

Results: Results of the study showed that nurses regardless of training background, age, or experience showed a poor level of knowledge, the average score being 48% for ICU qualified nurses and 31% for non-ICU qualified nurses. There was a small significant difference between ICU qualified and non-ICU qualified nurses' competence levels in mechanical ventilation when analysed using a two tailed- t- test (p=0.039). Nurses also experienced a misperception regarding their own competence levels in mechanical ventilation when compared to their actual competence levels as determined by three clinical vignettes.

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

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ABBREVIATIONS

AACN	- American Association of Critical Care Nurses
ABG	- Arterial Blood Gas
ACMV	- Assist control mandatory ventilation
BIPAP	- Biphasic Positive Airways Pressure
bpm	- Breathes per Minute
$C0_2$	- Carbon Dioxide
CCN	- Critical Care Nurse
CCSSA	- Critical Care Society of Southern Africa
Cm/H_20	- Centimeters of Water
CMV	- Controlled Mandatory Ventilation
COPD	- Chronic Obstructive Pulmonary Disease
CPAP	- Constant Positive Airways Pressure
CVI	- Content Validity Index
ET tube	- Endotracheal Tube
FIO_2	- Fractional Index of Oxygen
FRC	- Functional Residual Capacity
ICU	- Intensive Care Unit
I-CVI	- Item Content Validity Index
IDBW	- Ideal Body Weight
IE ratio	- Inspiratory Expiratory Ratio
L/per/min	- Liters per Minute
MSOF	- Multi System Organ Failure
0_2	- Oxygen
PEEP	- Positive End Expiratory Pressure
SANC	- South African Nursing Council
S-CVI	- Scale Content Validity Index
Sec	- Seconds
SIMV	- Synchronized Intermittent Mandatory Ventilation
$Sp0_2$	- Oxygen Saturation
Ti	- Inspiratory Time
TV	- Tidal Volume
UK	- United Kingdom
USA	- United States of America
VILI	- Ventilator Induced Lung Injury
VTPC	- Volume Target Pressure Control
WFCCN	- World Federation of Critical Care Nurses
WOB	- Work of Breathing

CHAPTER ONE

OVERVIEW OF THE STUDY

1.1 INTRODUCTION AND BACKGROUND

Mechanical ventilation is a life saving/ support intervention which can determine the recovery or demise of the critically ill patient. It is the most common reason for admission of an adult patient to the Intensive Care Unit (ICU) as a result of primary or secondary respiratory lung pathology (Burns 2005; Dasta, McLaughlin, Mody,et al. 2005; Byrd & Roy 2006). However, in-appropriate setting of the ventilator in terms of the lung pathology and failure to recognise adverse events can have severe consequences for the patient, and can result in a variety of complications, some of which can be life-threatening (Subirara 2004).

The nurse who cares for the mechanically ventilated patient must demonstrate competence in order to be able to recognise adverse events which may occur, and carry out the necessary interventions which may prevent the patient from moving forward to the ultimate goal of liberation from the ventilator. In spite of potential life threatening complications, mechanical ventilation remains the most common therapeutic modality undertaken in intensive care units (Tobin 2001; Alphonso, Quinones, Mishra, et al. 2004).

1.2 MECHANICAL VENTILATION

Mechanical ventilation presents specific challenges to the nurse, as each patient is unique in terms of lung pathology and the type of ventilation strategy and settings required for the specific lung pathology of the individual patient (Engelbrecht & Tintinger 2007).

Inappropriate ventilator settings, failure by the nurse to recognise deteriorating lung function and complications can lead to ventilator induced lung injury (VILI), which may exacerbate the initial pathology of the lungs (Frank & Matthay 2003). As such this can lead to complications such as pneumothorax, tracheal necrosis, and ventilator associated pneumonia (Byrd & Mosenifar 2010). These complications can at best prolong the hospital stay of the patient, thereby significantly increasing costs, and at worst lead to increased morbidity and mortality of the patient (Dasta et al. 2005).

"*Discontinuation from mechanical ventilation is often the singular critical event hallmarking progression to recovery in the intensive care unit. Prolonged and unnecessary delays in tracheal extubation result in increased complication rates for patients receiving mechanical ventilation, including pneumonia, airway trauma, death, and increased hospital costs" (Perkal 2005:1).*

1.3 THE NURSE

The nurse caring for the mechanically ventilated patient must be competent and have a thorough understanding and specialist knowledge of mechanical ventilation in order to safely and optimally care for the patient undergoing mechanical ventilation. Specialist knowledge of mechanical ventilation is central to ensuring the patients' safe passage from the acute stage of ventilation to liberation from the ventilator (Burns 2005). Authors locally and internationally agree that this specialist knowledge engenders competence and is most likely to be gained from the nurse undertaking a post basic Diploma/Masters degree in intensive care nursing (Briggs, Brown, Keston, et al. 2006; Williams & Schmollgruber 2006). In contrast, within the South African context 75% of nurses who work in Intensive Care Units (ICU's) and care for the mechanically ventilated patient may not be qualified in intensive care nursing (Scribante & Bhagwangee 2007a). Nurses who are not qualified in intensive care nursing are deemed by virtue of their training, not to have been exposed to the specialist knowledge required to practice in the ICU environment, and therefore may not be competent to care for the mechanically ventilated patient. The depth and breadth of the competence required by the nurse (who cares for the mechanically ventilated patient) is only partially satisfied by the entry level nursing education (Briggs et al. 2006).The large percentage of non qualified nurses found in ICU's in South Africa (SA) has come about mainly as a result of the nursing shortage in SA, which has left the ICU's depleted of ICU qualified nurses who have been replaced out of necessity by non-ICU qualified nurses. The comprehensive nature of the four year training course for nurses, with its focus on primary health care, suggests that these nurses do not have an orientation towards intensive care nursing, and most likely will practice outside their scope of practice and be incompetent within the ICU arena (Schmollgruber 2007). Morrison, as cited by Scribante & Bhagwangee (2007b) suggests that nursing care without expertise may be considered a potentially harmful intrusion for the patient, and that adverse events and errors are more likely to occur when inexperience is combined with staff shortages, poor supervision and lack of support staff.

As a result of these varying backgrounds in training and experience, the competence of the nurses with regard to nursing mechanically ventilated patients in the ICU's in South Africa may

differ, and even compromise the patient. The implications of having a nurse who may not be competent by virtue of having not obtained the specialist knowledge required to care for the ventilated patient may lead to deterioration of the patient, failure of progression, and at worst increased mortality and morbidity (Burns 2005), and litigation against the nurse and/or the health institution (Oddi & Heurita1990).Thus it is of importance that nurses' level of competence in mechanical ventilation who care for adult mechanically ventilated patients in ICU's in South Africa be known.

1.4 PROBLEM STATEMENT

Currently in intensive care units in South Africa the mechanically ventilated patient is most likely to be cared for by a non-ICU qualified nurse (Scribante & Bhagwanjee 2007a), thus placing the patient at risk of complications which may not be correctly assessed by the non-ICU qualified nurse.

The varying levels of training and experience found amongst nurses in ICU's in SA may lead to varying levels of competence amongst nurses allocated to care for the mechanically ventilated patient. An extensive literature search found limited studies either locally or internationally regarding the competence of nurses in ICU with regard to mechanical ventilation. The gap in the literature, together with the researchers' own experience of varying levels of competence amongst nurses regarding mechanical ventilation in intensive care units, prompted the researcher to further investigate the level of nurses' competence in mechanical ventilation in ICU's in South Africa.

1.5 PURPOSE OF THE STUDY

The purpose of the study was to determine and describe the level of nurses' competence in mechanical ventilation in intensive care units of two tertiary healthcare institutions in Gauteng.

1.6 STUDY OBJECTIVES

To meet the purpose of the study the research progressed through two phases and the following objectives were set to:

1.6.1 Phase one objectives

- Develop three clinical vignettes to quantify the competence of ICU nurses with regard to mechanical ventilation in adult ICU in two tertiary healthcare institutions in Gauteng.
- Validate three clinical vignettes

1.6.2 Phase two objectives

- Determine and describe the competence of nurses with regard to mechanical ventilation of the adult patient in the intensive care units of two tertiary healthcare institutions in Gauteng, using three clinical vignettes developed and validated in phase one

- Describe any differences in levels of competence in mechanical ventilation amongst nurses working in adult intensive care units, in two tertiary healthcare institutions in Gauteng

- Compare nurses' perceptions of their own level of competence with regard mechanical ventilation with actual scores obtained from the completed vignettes

1.7 IMPORTANCE OF THE STUDY

The competence of nurses who care for mechanically ventilated patients in SA is currently unknown, and may vary due to the varying training backgrounds and years of experience of the nurses in the ICU's in SA. An extensive literature search using books, articles, journals, the World Wide Web, and search engines such as CINAHL, ERIC, GOOGLE, and online journals both locally and internationally revealed research to support whether nurses' competence in mechanical ventilation is adequate within ICU's in SA was limited.

As such it was important to quantify the competence of nurses caring for adult mechanically ventilated patients with regard to mechanical ventilation in ICU in SA, as poor competence may have severe implications for the mechanically ventilated patients, which at best may lead to increased length of stay in the ICU, and at worst lead to increased mortality and morbidity of the patient. Further, quantifying the competence levels of the nurses in ICU with regard to mechanical ventilation will facilitate appropriate interventions with regard to education programmes, and clinical teaching programmes in the ICU.

It is anticipated that different levels of guidelines may be required for nurses of varying experience and training backgrounds when caring for a mechanically ventilated patient.

1.8. DEFINITION OF TERMS

1.8.1 Competence

For the purpose of this study competence is used to inform the level of competence indicator of 75% or more. Competence refers to the nurses' understanding knowledge and thinking which informs the actions the nurse takes (Bruce, Langley, Tjale, 2008). According to Danish nurse, Bente Høy (Melgaard & Dam 2000), competence can be classified in two ways. Firstly, formal competence is when a nurse is assumed to be competent due to her qualifications and the specific duties she can perform. Secondly, and more importantly, real competence is defined as the ability to apply knowledge to clinical situations, practice and use skills safely, and demonstrate attitudes appropriate to the specific patient. Competence in this study refers to both formal and real competencies.

1.8.2 Knowledge

Knowledge underpins competence which includes skills and attitudes (Teaching strategies for outcomes Based Education). For the purpose of this study knowledge refers to the nurse's understanding of mechanical ventilation, and application to the clinical situation, which is reflected in the scores attained in the three clinical vignettes. The scores are graded from 50% to 75% according to a grading scale and scores of <50% indicate poor competence and scores of 75% or more are deemed to indicate competence.

1.8.3 Specialist knowledge

This is knowledge obtained by the nurse as a result of undertaking an additional qualification in intensive care nursing and having gained experience in the ICU unit. The nurse with specialist knowledge is considered an expert in the field of critical care nursing (Briggs et al. 2006).

1.8.4 Mechanical ventilation

A mechanical ventilator is a life support machine which generates a controlled flow of mixed gas into a patient's airways. Oxygen and air are received from cylinders or wall outlets, the gas is pressure reduced and blended according to the prescribed inspired oxygen tension (FiO_2), accumulated in a receptacle within the machine, and delivered to the patient using one of many modes of ventilation and settings, and generally using positive pressure to ensure delivery of

the mixed gas to the patient's lungs. For the purpose of the study mechanical ventilation refers to the delivery of a breath under positive pressure generated by the ventilator (Sessler 2009).

1.8.5 Tertiary healthcare institution

Refers to the third level of health care services within the public hospital system in South Africa, encompassing the more complex and costly in-patient treatment services, such as intensive care, provided by highly specialised health care providers, costly equipment and multidisciplinary organization in patient care.

1.8.6 ICU qualified nurse

For the purpose of this study an ICU qualified nurse refers to a registered nurse who has an additional qualification in intensive care nursing registered with the South African Nursing Council.

1.8.7 Non-ICU qualified nurse

For the purpose of this study a non-ICU qualified nurse refers to a nurse registered or enrolled with the South African Nursing Council, who does not hold an additional qualification in intensive care nursing but has ICU experience.

1.8.8 ICU

Refers to a specifically designated area within an academic tertiary healthcare institution in the Gauteng area, where critically ill patients are cared for and monitored and undergo mechanical ventilation.

1.9 OVERVIEW OF METHODS

An overview of the research methods is provided in this section, and includes the design, research methods, target population, sample and sampling method, data collection, data analysis for each phase of the study, limitations of the study, and an overview of ethical considerations.

1.9.1 Research design

A non-experimental descriptive two phase design was used to determine and describe the competence levels regarding basic mechanical ventilation amongst nurses working in adult intensive care units in two tertiary healthcare institutions in Gauteng.

1.9.2 Research methods

1.9.2.1 Phase one

The development of three clinical vignettes was based on an extensive up- to- date literature review, using books, articles, journals, the World Wide Web, and search engines such as CINAHL, ERIC, GOOGLE, and online journals. The researchers' own knowledge, together with ICU doctor experts' knowledge, and real case studies found in the ICU's was also used in the development of the clinical vignettes**.** Non- probability purposive sampling was used, and data collection was undertaken using a modified Delphi Technique. Validation of the clinical vignettes was undertaken using an expert group consisting of expert nurses (n=5) expert clinical engineers (n=3) and expert doctors (n=2) all of whom met the inclusion criteria discussed in chapter three. Content validity of the instrument was strengthened, by calculating the content validity index (CVI), as described by Lynn (1986) and modified by Polit, Beck & Owen, (2007) and include Item CVI (I-CVI) and Scale CVI (S-CVI)
Descriptive statistics were used to elicit the demographic profile of the sample and content validity of three clinical vignettes.

1.9.2.2 Phase two

The accessible population in phase two consisted of nurses in intensive care units in two tertiary healthcare institutions who care for adult mechanically ventilated patients in ICU regardless of training background and years of experience.

Non- probability, consecutive sampling was used, and entails the use of all available people as study participants (Polit, Beck, Hungler, 2001).This method was used to select the widest variety of participants that are typical of the population under study.

Data collection was undertaken using three clinical vignettes and participant scores achieved in the three clinical vignettes were calculated and converted to percentages, and the percentages graded according to a grading scale, to inform the level of competency of the participant with regard to mechanical ventilation. Participants' own perceptions of their competence of mechanical ventilation were quantified to percentages and compared with actual percentages achieved for the clinical vignettes. Data collected in phase two were analysed using descriptive and inferential statistics in order to synthesise and organise the data obtained.

A pilot study was undertaken to further strengthen validity and reliability, by ensuring clarity and understanding of the instrument, as was statistical analysis using descriptive and inferential statistics. Constancy of conditions for participants was ensured. The data were entered into a spreadsheet with multiple data integrity checks and verified by a biostatistician. This is discussed in more detail in chapter three.

1.10.OUTLINE OF THE STUDY

The study will be presented as follows:

- **Chapter 1: Overview of the study**
  Chapter one provides an overview of the study

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- **Chapter 2: Literature review**
  A literature review relevant to the main aspects of the study is covered.

- **Chapter 3: Research design and methods**
  The research design and methods are described in this chapter.

- **Chapter 4: Data analysis and results**
  In this chapter the results of phase one and phase two of the study are presented.

- **Chapter 5: Discussion of the results, main findings, study limitations, recommendations and conclusions.**
  In this chapter the results are discussed, and a summary and conclusions from the main findings are presented. Limitations of the study and recommendations are also presented

1.11 SUMMARY

An overview of the research study has been given in this chapter, and included the following: introduction, background, problem statement, purpose of the study, objectives and importance of the study. A brief overview of the methodology to be used in the study has also been given.

In the following chapter a review of the literature related to the topic under study will be presented.

CHAPTER TWO
LITERATURE REVIEW

2.1 INTRODUCTION

Consider the following two scenarios:
A patient requiring intubation and mechanical ventilation is admitted to the intensive care unit (ICU) in the late 1960's. The diagnoses of the lung pathology present is "shock lung". The ventilator is set in the volume control mode, with tidal volumes (Vt) of 10-15mls per kg/ body weight, rate of 15 breaths per minute (bpm), an oxygen supplementation of 70%, and PEEP (positive end expiratory pressure) of 10cm/H_2O. The trigger sensitivity is set at -4cm/ H_2O to prevent the patient attempting to take spontaneous breaths. The patient is placed into a medically induced coma with sedative and paralysing drugs, and is unable to take any spontaneous breaths. This therapy continues until the patient either recovers or succumbs.

A patient with the same lung pathology is admitted to the ICU in 2010. The same pathology is now known as ARDS (Acute Respiratory Distress Syndrome), and the nurse can choose between volume controlled and pressure controlled mandatory breath types, and a plethora of ventilation modes, e.g. ACMV (Assist control mandatory ventilation), SIMV (synchronised intermittent mandatory ventilation), VTPC (volume target pressure control), BIPAP (biphasic positive pressure ventilation). The patient is lightly sedated, and encouraged to take spontaneous breaths between or during the mandatory breaths of the ventilator. The nurse can choose between flow and pressure trigger and can manipulate both the inspiratory and expiratory phases of the mandatory and spontaneous breaths. The tidal volume is set at 4-8 mls/per kg/ideal body weight, (The ARDSNet Study 2000) and intrathoracic pressure is controlled at 35cm/H_2O. Positive end expiratory pressure (PEEP) is adjusted between 14-18cm/H_2O and recruitment maneuvers are undertaken (Gattinoni,Caironi,Cressoni, et al. 2006). The patient may be placed in the prone position to improve oxygenation (Sessler 2009).

These two scenarios illustrate how mechanical ventilation technology and knowledge of lung pathologies have exponentially progressed since the 1960's. Therefore the nurse caring for the mechanically ventilated patient in 2010 is required to be up to date with technological and clinical advances (Almerud 2008). This requires that the nurse has specialist knowledge of the technological and clinical aspects of mechanical ventilation, and is able to apply this knowledge to the clinical scenario.
Advances in medicine and technology, particularly mechanical ventilation in the Intensive Care Unit (ICU) over the past six decades have been exponential, making the ICU the most

technologically advanced environment in a hospital. The technology itself is of no benefit or value to the patient unless there is integration between the nurse, the technology and the patient. Technological equipment does NOT replace the art of nursing and healing, and to have any worth requires human expertise (Almerud 2008). The nurse in ICU is expected to acquire a level of competence in order to provide appropriate care to the critically ill patient and this must include keeping up to date and understanding the latest technological advances. The ICU nurse must have education and training beyond the basic preparation as a registered nurse to meet the needs of the critically ill patient (Nurses for a Healthier Tomorrow 2006). Patients in ICU in 2010 are older and sicker than ever before, creating an ever increasing demand for competent providers. Inappropriate settings of the mechanical ventilator by nurses can at best damage lungs and at worst lead to demise of the patient (Alphonso et al. 2004). Whilst mechanical ventilators sustain life they can just as easily take life. The competence of the nurse caring for the ventilated patient will largely determine the outcome of the mechanically ventilated patient. Once a patient is mechanically ventilated the process of maintaining safety must be continued.

2.2 OVERVIEW OF MECHANICAL VENTILATION

Modern day ventilators are micro processed computers with intelligent control and the ability to graphically depict the impact of ventilator breaths on the lungs. Ventilator settings e.g. breath type, modes, breath settings, and strategies such as protective lung ventilation have changed markedly over the past six decades. Mechanical ventilation is now focused on attempting to optimise ventilator settings and prevent damage to the lungs and the release of cytokines, which can lead to multi system organ failure (MSOF) and death (Gattinoni, Carlesso, Cadringher, et al. 2003).

Ventilator settings and strategies must be optimised in relation to the lung pathology of the specific patient, and the results of the delivered breaths monitored, interpreted, corrected, and manipulated by the nurse in terms of the patient specific lung pathology. For the sake of clarity ventilator breath types, modes and settings which are known as basic or standard settings will be discussed, followed by an explanation of how the standard settings can be manipulated for specific lung pathologies. Mechanical ventilation provides oxygen and CO_2 transport between the environment and alveolar pulmonary capillary interface by creating a flow of mixed gas in and out of the lungs by manipulating airway pressures, and altering the relationship between intrathoracic and extra thoracic pressures (Rodriques, Dojat, Brochard, 2005). How the breath is delivered to the lungs depends on the ventilator settings as set by the operator (nurse). The ventilator settings are required to be manipulated by the operator to optimise the delivered

breath in terms of the specific lung pathology of the specific patient, in order to prevent complications and further damage to the lungs.

In general, ventilators regardless of manufacturer, have what is termed standard settings. These are:

- Breath Types
- Modes
- Settings

These are briefly described in order to highlight their significance in this study.

2.3 BASIC MECHANICAL VENTILATION MODES

2.3.1 Breath types

'Volume' or 'pressure' controlled breaths delivered by the ventilator.
The control variables of ventilators are flow (or volume) or pressure. The ventilator controls only one variable, i.e. either flow/volume or pressure (Rodrigues et al. 2005). The selection of pressure or volume control breaths by the operator is determined by the lung pathology of the patient.

2.3.1.1 Volume-controlled breath type

Volume-controlled mechanical ventilation is delivered with a constant inspiratory flow, resulting in increasing airway pressure throughout inspiration. The flow is preset by the operator. To maintain this fixed rate of gas flow the pressure must rise through inspiration. The actual preset tidal volume remains constant as lung compliance and resistance change (Rodrigues et al. 2005).

In volume control the flow is usually set by the nurse and is usually set at 40-60 liters per minute. However, on some ventilators the operator may set inspiratory time (Ti). On older ventilators there is no choice but to set peak flow which continues throughout inspiration. New generation ventilators will normally allow the nurse the choice of invoking either peak flow or inspiratory time. A peak flow setting will allow a mandatory flow though the ventilator, and inspiratory time will be determined by the peak flow. If inspiratory time is chosen by the operator, the flow is calculated by the ventilator (Sessler 2009).

2.3.1.2 Pressure-controlled breath type

In pressure controlled breath types the ventilator pressurises the ventilator circuit to a preset pressure determined and set by the operator (pressure control limit) and then passive

exhalation occurs when inspiration is complete after a set inspiratory time (Ti). Thus the tidal volume (Vt) delivered is determined by the operator set pressure as when the pre-set pressure in the circuit and pressure in the lungs equilibrate, flow from the ventilator will cease and passive exhalation will occur. This indicates that Vt in pressure control ventilation will vary according to the compliance of the lung. Flow is automated and not set by the operator (Chatburn 2007). The pressure control limit is set between 30-35cm/H_2O, as strong animal and human data suggest that pressures in excess of this may produce direct lung injury with the release of inflammatory mediators (Brower, Larkin, MacIntyre, et al. 2004; Burns 2005).

Example:

A patient with stiff lungs is ventilated in volume control with a set Vt of 460mls. The pressure in the lungs will continue to increase until the volume is delivered or the pressure alarm setting is reached.The increased pressure may damage the lung parenchyma and lead to complications such as rupture of the alveoli leading to a pneumothorax (air in the pleural space which leads to collapse of the lung).

A patient with stiff lungs is ventilated in pressure control. The pressure in the lungs and the ventilator circuit equalise after a minimal amount of flow (volume) has entered the lungs. The flow will stop when the pressure in the lungs and the ventilator circuit have equalised and the Vt delivered may be small leading to increased $PaCO_2$ retention and decreased oxygenation. The nurse must have the specialist knowledge to be able to determine which of the breath types is clinically superior for the lung pathology at hand (see Figure 2.1).

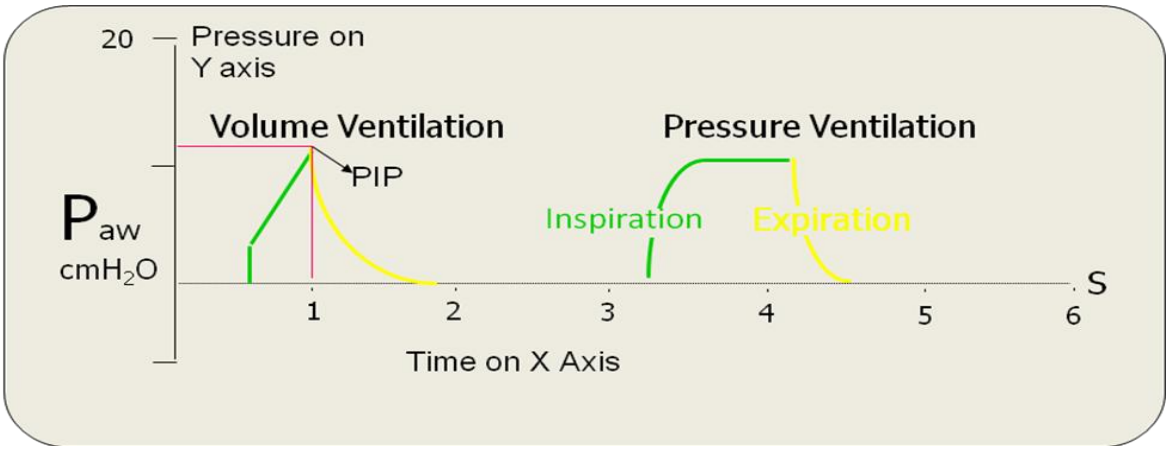

Figure 2.1:Pressure and volume control breath types

Cyndy Millar Newport Medical Instruments (2008)

2.3.2 Modes

A mode is how the ventilator allows the patient to interact with the set breaths (mandatory breaths) from the ventilator. More specifically the pattern of interaction refers to the sequence of mandatory (ventilator) breaths and spontaneous breaths (patient breaths) (Chatburn 2007).

The three basic modes are as follows:

- Assist control mandatory ventilation (ACMV) or control mandatory ventilation (CMV)
- Synchronised intermittent mandatory ventilation (SIMV)
- Spontaneous (Spont) or constant positive airways pressure (CPAP) (Tobin, 2001).

2.3.2.1 Controlled mandatory ventilation (CMV)

The ventilator will deliver a set number of breathes at a set tidal volume, as determined by the operator, and set on the ventilator. The breaths are known as mandatory breaths, and can be pressure controlled or volume controlled as determined by the operator. However in controlled mandatory ventilation (CMV) the patient cannot take any spontaneous breathes, and is normally required to be heavily sedated and occasionally medicinally paralysed. The ventilator will deliver the set number of breaths at the set Vt regardless of the patient lung pathology or discomfort experienced by the patient, and may cause damage to the lungs (Chatburn 2007).

Example:

The ventilator is set in volume controlled mandatory ventilation (CMV) at a rate of 15 bpm. The patient will receive 15 breaths at the set tidal volume regardless. The patient is not adequately sedated and attempts to take spontaneous breaths, thereby drawing a negative pressure. However the inspiratory valve of the ventilator will remain closed and no flow is available for the spontaneous breath. The patient has thus made the effort to breathe but has got no reward as the breath was not delivered. This will cause the patient to become anxious, unmanageable and tired, as the patient may feel he is suffocating and will try and take more spontaneous breathes which will have the same result. The outcome of this situation is a patient with increased work of breathing (WOB) who will tire and use up O_2 which is counterproductive, as O_2 reserves in these patients is usually limited.

2.3.2.2 Assist control mandatory ventilation (ACMV)

In ACMV mode the patient is able to make the effort to take a spontaneous breath, and draws a negative pressure. As soon as the ventilator detects the negative pressure, the ventilator completes the breath by delivering either a volume controlled or pressure controlled preset tidal volume. The patient can initiate the breath and this triggers the ventilator to deliver the preset mandatory breath (Sessler 2009). ACMV is a high support mode of ventilation and allows the patient to trigger a breath whilst the ventilator delivers the breath. This reduces the work of breathing (WOB) required by the patient.

Example:

The physician requests that a patient who has been ventilated for three weeks on CMV be placed on ACMV. The rationale is that the physician wants the patient to start making an effort to breathe on his own and strengthen his respiratory muscles without inducing increased work

of breathing for the patient. The mandatory rate is set at 15bpm. The patient triggers three extra breaths during the respiratory cycle. The normal minute volume at 15bpm would be rate X tidal volume. The rate now increases by three breaths causing the minute volume to increase. The patient in this mode of ventilation can very easily hyperventilate, and the nurse must be aware as to how the mode works, and assess the total respiratory rate and minute volume on a regular basis (Figure 2.2).

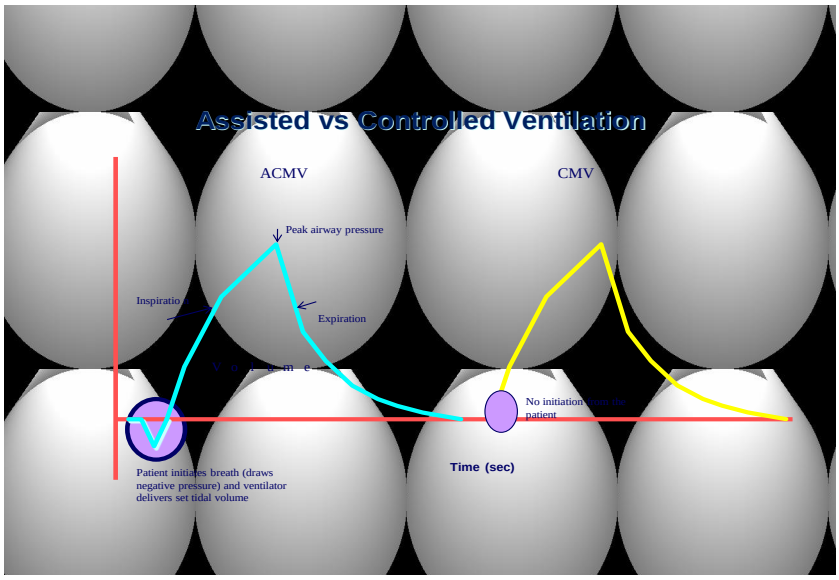

Figure 2.2: Assist control vs.controlled mechanical ventilation

Restrepo & Deshpande (2000)

2.3.2.3 Synchronised intermittent mandatory ventilation (SIMV)

Synchronised intermittent mandatory ventilation SIMV is the most popular mode used in ICU in South Africa (SA) and internationally. It is used to ventilate and wean patients from the ventilator (Hess 2010).SIMV allows the patient to breathe spontaneously between mandatory ventilator breaths, and synchronises the patient spontaneous breaths with the mandatory ventilator breaths. The mandatory breath can be volume or pressure controlled, whilst the spontaneous breath is always pressure controlled and usually supported with pressure support (Esteban, Raymondos, Apezteguia, et al. 2010).

During weaning, the mandatory rate is reduced, allowing the patient to increase the spontaneous breathing rate until mandatory support is reduced to two breaths per minute. The Synchronised Intermittent Mandatory Ventilation (SIMV) mode is more comfortable for the patient and leads to less dysynchrony between the patient and the ventilator, as the patient can take spontaneous breaths in-between mandatory breaths. It also reduces the dosage of sedation required, and uses an automated flow which prevents flow starvation. SIMV is usually used in combination with pressure support.

***Example*:**

A patient returns from theatre and is still fully sedated and not breathing spontaneously. The ventilator is set in controlled mandatory ventilation (CMV mode). Two hours later the patient starts to breathe spontaneously. If the ventilator is not manipulated and the mode changed from CMV to synchronized intermittant mandatory ventilation (SIMV) the patient will suffer all the consequences described under CMV. The nurse must be sufficiently competent to know that she must change the mode to SIMV to allow the patient to take spontaneous breaths in between mandatory ventilator breaths. (Figure 2.3)

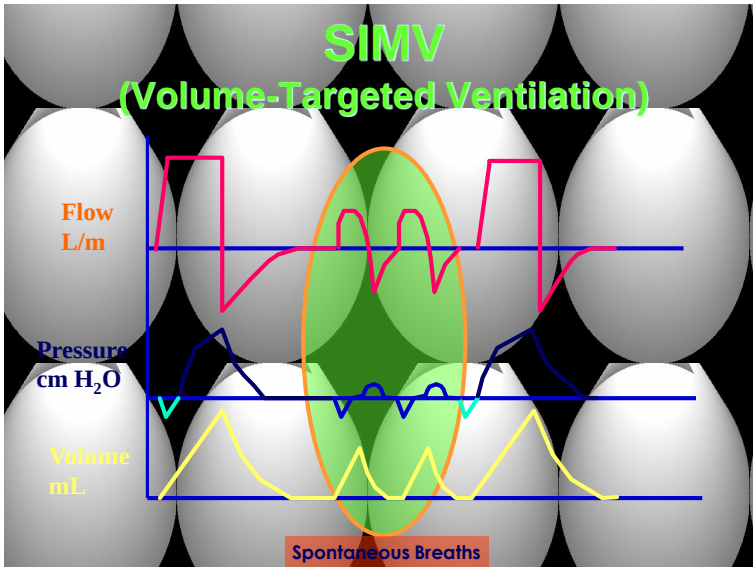

Figure 2.3:SIMV mode of ventilation with spontaneous breaths

Restrepo & Deshpande (2000)

2.3.2.4 Constant positive airways pressure (CPAP*)*

In this mode there is NO mandatory breath from the ventilator. The patient breathes completely spontaneously using the mixed gas flow from the ventilator. When a patient is placed in spontaneous mode, it is usually a precursor to extubation or liberation from the ventilator. The breath maintains a constant positive pressure which is set by the operator on the ventilator in relation to lung pathology, clinical condition, and reason for placing the patient in constant positive airways pressure (CPAP mode). CPAP relates ONLY to the spontaneous breath and can be used together with synchronized intermittent mandatory ventilation (SIMV) when CPAP will be activated each time a spontaneous breath occurs. CPAP improves oxygenation, decreases work of breathing (WOB) and helps to keep alveoli from collapsing. CPAP is used when the breath is triggered by the patient and is a spontaneous breath. Positive end expiratory pressure (PEEP) is used when the breath is a mandatory breath from the ventilator and keeps the alveoli open at the end of expiration. PEEP and CPAP both improve oxygenation (Slutsky & Hudson 2006).

Example:

A patient has been ventilated in synchronized intermittent mandatory ventilation (SIMV) mode. The lung pathology has reversed, and the patient needs less support from the ventilator and is placed into constant positive airway pressure (CPAP) mode with a view to weaning the patient from the ventilator. If the assessment by the nurse is that the patient is coping on the CPAP, and all criteria for extubation are met the patient may be extubated. Alternatively if the oxygenation of the patient deteriorates, and or the patient show signs of increased work of breathing (WOB) the patient is not ready to be extubated, and may be placed back in the SIMV mode. The nurse requires specialised knowledge to make these judgments and make the correct decision as to how to manage this patient in terms of the ventilator settings available. In many units weaning is a nurse led intervention. To make the correct decisions and interventions the nurse is required to have specialised knowledge of mechanical ventilation and the settings of the mechanical ventilator.

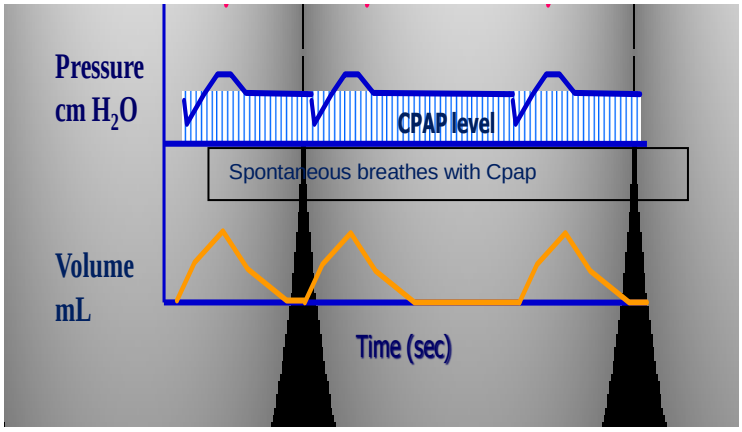

Figure 2.4: CPAP (spontaneous) breathing

Restrepo & Deshpande (2000)

2.4 VENTILATOR SETTINGS

2.4.1 Oxygen percentage ($Fi0_2$)

All modern ICU ventilators allow the operator to select an oxygen percentage in the range of 21%-100%, to be delivered to the patient by selecting the required percentage of oxygen. The percentage O_2 selected will be determined by the pathology of the lungs, arterial blood gasses (ABGs), saturation (SpO_2), chest X-Ray, and clinical status of the patient, amongst other more sophisticated parameters used to determine oxygenation. Seckel (2008) suggests that less than 60% is ideal, as over this O_2 toxicity can occur which in itself causes damage to the lungs and also causes nitrogen washout leading to collapse of the alveoli and consolidation of the lung (Seckel 2008).

2.4.2 Tidal Volume (Vt)

The tidal volume is the volume of gas inspired and passively exhaled per breath in a normal respiratory cycle (Chatburn 2006).

Tidal volume is set by the operator in Volume Control breath type selection. The operator must determine how much volume is required to be delivered per mandatory breath. Evidence suggests that tidal volume is calculated as 4-8mls/ kg/ ideal body weight, as volumes over this cause over distention of the lungs (volutrauma & atelectrauma) and may lead to ventilator induced lung injury (VILI).The low tidal volume is particularly pertinent to the patient with Acute Respiratory Distress Syndrome (ARDS) (Hager, Krishnan, Hayden, et al. 2005). Most ventilators will measure and display the inspired tidal volume and the exhaled tidal volume. A discrepancy between inspiration and exhalation tidal volume is indicative of a leak, either in the ventilator circuit, or at the patient. e.g. leaking endotracheal tube cuff, broncho-pleural fistula.

Example:

A patient weighs 120kg, with an ideal body weight of 80kg. The lung pathology is ARDS. The tidal volume is calculated as 80kg X 4mls per kg=320mls tidal volume. The inspired tidal volume reads 320mls. The exhaled tidal volume reads 260mls. This is indicative of a leak of 60mls, which indicates the patient is not receiving the desired ventilation tidal volume and may lead to decreased oxygenation and carbon dioxide retention.

The tidal volume is often increased to deal with CO_2 retention, however the nurse must be cognisant that she must make a decision between increasing tidal volume or allowing permissive hypercapnia, as the increase of the tidal volume (Vt) may lead to lung trauma as described (The ARDSNet study 2000). Such manipulation of the ventilator settings in terms of the lung pathology requires a competent nurse.

2.4.3 Peak flow

Peak flow is set only in volume control and is the amount of mixed gas passing through the ventilator from which the tidal volume is taken. It is set by the operator, normal values being 40-60L/per min for the adult patient (Amitai & Mosenifar 2011). If the flow is too low the patient will feel flow starved (akin to having a peg on your nose and being told to breathe through a straw when you have sprinted 100 meters and require substantially more air than normal). In volume control, the flow of air is set by the operator and if it is not sufficient to meet the demands of the patient the patient will be aggressive and unmanageable due to flow starvation.

Example:

A post operative patient is brought back to the ICU. The ventilator is set up in volume control, synchronized intermittent mandatory ventilation (SIMV), mandatory tidal volume (Vt) of 600mls per breath, with a peak flow of 30L. The patient wakes up, and starts breathing on his

own. His demand for flow has now increased, and he requires more than 30L per minute. The knowledgeable nurse will recognise the requirement for increased flow and will adjust the peak flow accordingly. In volume control the flow is set and does not change according to patient demand for flow. Should the nurse not increase the flow, the patient will be uncomfortable, unmanageable, and often combative. This is often interpreted by the staff as "not ready to wake up or wean" and patient is re-sedated. This can lead to complications associated with prolonged intubation. In pressure control ventilation the flow is automated by the ventilator to meet the demands of the patient and in this way is superior to volume control.

2.4.4 Rate or frequency

The rate or frequency setting on the ventilator determines how many mandatory breaths the ventilator will deliver per minute to the patient, and is not in any way connected to the rate of the spontaneous breath. The ventilator will deliver the set breaths regardless of the patient condition and interaction with the ventilator. If the rate is set to high, and the patient requires a longer than normal expiratory time (e.g. asthmatic), the patient won't have time to exhale fully, and air will be trapped in the lungs. This air trapping is known as Auto- PEEP. Auto- PEEP can be excessively dangerous as intrathoracic pressure continuously increases leading to pneumothorax, decreased venous return, and haemodynamic instability.

It is paramount that the nurse understands the relationship between the rate and expiratory time to avoid life threatening complications arising.

Example:

A patient with chronic obstructive pulmonary disease (COPD) is admitted with exacerbation of his respiratory problem due to infection and is intubated and ventilated. The CO_2 is found to be high. The nurse increases the rate on the ventilator to blow off the CO_2. The next arterial blood gas (ABG) indicates the PCO_2 as even higher than previously, and the patient is deteriorating. The increased rate has compounded the problem by decreasing the expiratory time leading to auto-PEEP which caused the initial increase in CO_2. The nurse then increases the rate which leaves even less time for exhalation and exacerbates the problem leading to further auto-PEEP. The nurse must be cognisant that when she changes ONE setting it will change other parameters on the ventilator, even if this is not the intention. For this a competent nurse with specialist knowledge is required.

2.4.5 Pressure support

Pressure support increases flow from the ventilator during inspiration up to a preset pressure determined by the operator which decreases work of breathing and facilitates weaning. The patient is in complete control of the rate and tidal volume of spontaneous breaths which helps to maintain CO_2 at normal values. Pressure support is active only in the spontaneous breath. Pressure support is under scrutiny presently due to recent research studies which reveal that

the pressure supported breath can in fact cause dysynchrony between ventilator and patient if the breath ending criteria of the ventilator are not adjusted correctly (Hess 2010). Pressure support is different from CPAP in that CPAP is a continuous pressure throughout the respiratory cycle (that is during inspiration and exhalation), whilst pressure support is only active during inspiration. Tobin, Jubran, Laghi, (2001) suggest that pressure support should be set to adjust tidal volume, and in accordance with the respiratory rate.

Example:

A patient is ventilated in SIMV (mixture of patient initiated spontaneous and ventilator mandatory breaths). Pressure support is set at 0. The patient will still take spontaneous breaths but all the ventilator induced work of breathing (breathing through a circuit, ET tube, etc) will be loaded onto the patient causing increased work of breathing (WOB) for the patients. This can lead to many adverse events, including prolonged intubation and failure to move to liberation from the ventilator. If pressure support is set, each spontaneous breath is supported during the inspiratory phase of the breath up to the level of the preset pressure support value, thus reducing work of breathing. The tidal volume (Vt) of the spontaneous breath is also manipulated by the pressure support setting. As the pressure is raised so more gas flows into the lungs and increases the tidal volume (Vt). Pressure support can be used in the spontaneous mode with CPAP, and also in SIMV when each of the spontaneous breathes will be supported during the patient inspiratory phase. The competent nurse will be able to titrate the pressure support value against the clinical outcome of the patient.

2.4.6 Positive end expiratory pressure (PEEP)

The preset operator set pressure retained in the lungs at the end of exhalation improves the functional residual capacity (FRC) by increasing the surface area of the alveolae which allows increased gas exchange.

PEEP relates to the ‘mandatory’ ventilator breath whilst CPAP relates to the spontaneous breath of the patient. (Byrd & Mosenifar 2010)

When the ventilator has delivered a mandatory breath the exhalation valve is controlled by the ventilator to maintain a pressure in the alveolar at a set PEEP determined by the operator at the end of exhalation. Under Normal circumstances the pressure is zero. However, in the sick lung, alveolae are inclined to collapse and PEEP thus prevents the alveoli from collapsing. The level of set PEEP depends on the patients’ lung pathology and arterial blood gasses (ABG). The goal of PEEP is to improve oxygenation by maintaining patency of the alveolae. However inappropriate or incorrect PEEP settings may drop the cardiac output, and increase the incidence of pneumothorax.

Positive end expiratory pressure (PEEP) and continuous positive airways pressure (CPAP) are often toggle settings on the ventilator, with the ventilator delivering CPAP if the breath is spontaneous, and PEEP if the breath is mandatory. PEEP can be compared to inflating a balloon, and not allowing complete deflation before inflating again. The 2nd breath is easier to inflate as the resistance is decreased. PEEP can lead to increased pressure in the lung causing barotrauma. The nurse must have the specialist knowledge required to correctly adjust PEEP/CPAP in terms of the clinical outcome of the patient and to understand the consequences of PEEP and thus avoid complications caused by PEEP.

Example:

A patient with Acute Respiratory Distress Syndrome (ARDS) shows an arterial blood gas (ABG) which demonstrates PaO_2 55 mm/Hg on 70% O_2. The nurse does not want to increase the O_2 any further and induce further O_2 toxicity complications. Her alternative is to increase the PEEP to keep alveoli open and improve oxygenation. She increases the PEEP to 10cm from 5cm/H_2O. However sustained increased pressure leads to increased intra thoracic pressure and can lead to barotrauma. High PEEP can lead to haemodynamic and respiratory complications. Many patients who are poorly oxygenated now have recruitment manoeuvres undertaken, when the PEEP is turned up high (up to 40cm-60 cm/H_2O) for 20 -90secs (Slutsky & Hudson 2006). The nurse must be cognisant of the complications of PEEP but also that PEEP is directly related to improved oxygenation and makes the appropriate decision as to how he/she manipulates the PEEP setting. In the face of a hypoxic patient the nurse must make a decision as to whether the O_2 is increased, the PEEP is increased, or a recruitment manoeuvre is required. For this she requires specialist knowledge.

2.4.7 Trigger sensitivity

The trigger sensitivity is set by the operator on ALL ventilators. The trigger sensitivity alludes to the spontaneous breath only and determines how much effort the patient has to make to open the inspiratory valve to allow gas flow to be released from which the patient can take a breath. The normal setting is 1-2cm/H_2O (Amitai & Mosenifar 2011).This is considered the conventional safe standard setting (Tobin, Jubram, Laghi, 2001). This means the patient must generate a negative pressure to open the inspiratory valve and receive flow. As the patient condition changes the trigger sensitivity needs to be adjusted. The trigger sensitivity is one of the most important but ignored settings on the ventilator. A sensitivity which is too difficult for the patient will cause increased work of breathing and a sensitivity which is too high will cause auto triggering which means the ventilator imposes extra breaths on the patient which can lead to dysynchrony between patient and ventilator.The nurse must be able to assess and determine the work of breathing (WOB) of the patient and set the trigger appropriately for the patient to benefit. The nurse must re- assess the trigger setting frequently and adjust according to the patient clinical condition.

Example:

A patient who has been ventilated for two weeks, is malnourished, requires high support from the ventilator, but the doctor wants the patient to take spontaneous breaths in between the ventilator breaths. The trigger is set at -3cm/H_2O.The patient tries to take a breath but does not have the strength to pull a negative pressure of – 3cm/H_2O. The inspiratory valve does not open and the patient has made the effort with no reward for the effort. This may lead to dysynchrony between the patient and the ventilator and increased work of breathing (WOB) which is detrimental to the patient. The trigger must be adjusted to meet the requirements of the patient and will need to be adjusted on a regular basis to meet the progress of the patient. Should the nurse not have the knowledge to adjust the trigger setting in terms of the effort made by the patient, the patient can become exhausted and require prolonged ventilation.

2.4.8 Pressure control setting

Pressure control is active only in 'pressure control' ventilation. The inspiratory pressure limit of the mandatory breath is controlled at the selected preset pressure and is maintained at the preset inspiratory time before inspiration cycles off (Chatburn 2007). The pressure is set by the operator and should be <35cm/H_2O to prevent injury to the lung. (ARDSNet study 2000).The normal lung is fully expanded at 35cm/H_2O. The tidal volume delivered will be determined by the preset pressure limit and the lung compliance. Should the compliance be decreased the tidal volume may be reduced as gas will only flow into the lungs until the pressure in the alveoli and the ventilator circuit equilibrate.

Example:

An asthmatic patient is ventilated in pressure control with an operator selected set pressure of 35cm. The tidal volume delivered is 200mls and is insufficient to sustain adequate oxygenation and carbon dioxide removal. The nurse may increase the pressure limit to increase the TV, however this can lead to damage to the lung. The nurse could change the ventilator breath type to volume control where she will have control over the tidal volume delivered, but not the pressure. This will lead to increasing high pressures in the lung being induced in an attempt to deliver the volume. The volume itself may damage the lungs and the high pressures may also further damage the lungs, as well as lead to complications. The nurse must understand the pathology of the lung, and be clear as to what she wishes to achieve with any manipulation of the ventilator. BIG DECISIONS with BIG OUTCOMES which are reliant upon the specialist knowledge and competency of the nurse in the clinical situation.

2.4.9 Inspiratory time (Ti)

The inspiratory time setting is selected in pressure control mode on most modern ventilators. It can be selected in volume control on a few ventilators but this is the exception rather than the rule.

The inspiratory time (Ti) is the period of time that the inspiratory phase of the mandatory breath is held prior to the ventilator cycling to exhalation. The normal for an adult is 0.8 – 1.00 sec. Changing the Ti will automatically change the length of time available for exhalation. Ti is a vital control on the ventilator as it manipulates the inspiratory/expiratory ratio (I:E ratio).

Example:

The mandatory breath rate is set at 12 bpm for a patient. That is five secs per respiratory cycle of inspiration and exhalation. If the ti is set at 1sec then there will be 4 seconds for exhalation. Long Ti is the norm in ARDS and short Ti is often the norm in COPD to allow for a long exhalation time.

The patient with ARDS who has poor oxygenation may have a high mandatory respiratory rate together with a long Ti. (1-3secs). This may lead to auto-PEEP as the expiratory time is shortened.

The patient with COPD requires a long exhalation time so will require a short Ti. The Ti can be adjusted by adjusting the Ti setting. Increasing inspiratory flow in volume control, or rate of breaths per minute will also alter the Ti. It is the nurse's duty to set the Ti correctly and to monitor the patient for auto-PEEP depending on the lung pathology. The nurse must understand the relationship between Ti, IE, and rate. If Ti is changed the I:E will change, and vice versa. This requires the nurse to have specialist knowledge of mechanical ventilation.

2.4.10 Inspiratory to expiratory ratio (I:E ratio)

I:E is the ratio of time spent in inspiration vs. expiration. If exhalation is too short gas trapping can occur (Auto- Peep).

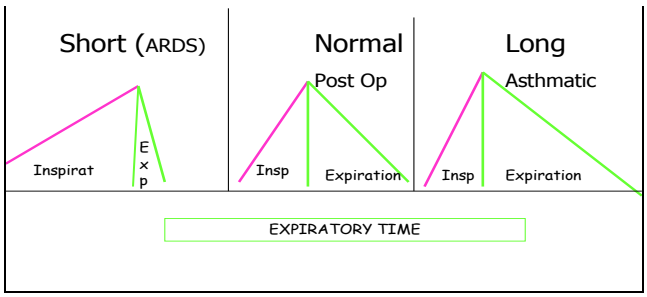

Figure 2.5:Three types of patients with varying expiration time

On older ventilators the I:E ratio is set by the nurse and the inspiratory time changes automatically. On newer ventilators the inspiratory time is set by the nurse and the I:E changes. Incorrect I:E ratios can have a profoundly negative effect on the patient leading to auto-PEEP, dysynchrony with the ventilator and desaturation of the blood. Attention to I:E setting is important to prevent barotraumas caused by auto-PEEP (Byrd, Kosseifi, Roy, 2009).

2.4.11 Biphasic positive airways pressure (BiPAP)

Biphasic positive airways pressure (BiPAP) in relation to the spontaneous breath allows the patient to breath at two different constant positive airways pressures (CPAP) levels. On inspiration the CPAP is set high (like pressure support) and then the ventilator cycles to a lower set level of CPAP for exhalation. The nurse must determine at what levels the inspiratory and expiratory CPAP are set in terms of the clinical condition and investigation results. Non invasive ventilation (NIV) combined with CPAP or BIPAP is the ventilation strategy of choice for the patient with chronic obstructive pulmonary disease (Paolo, Paolo, Aspesi, et al. 2003).

Example:

A patient with an exacerbation of asthma and known COPD is in respiratory failure. Most clinicians will attempt a trial of non invasive ventilation with BIPAP in an attempt to prevent intubating the patient, as it is well documented that COPD patients are very difficult to ventilate and also to wean from the ventilator.

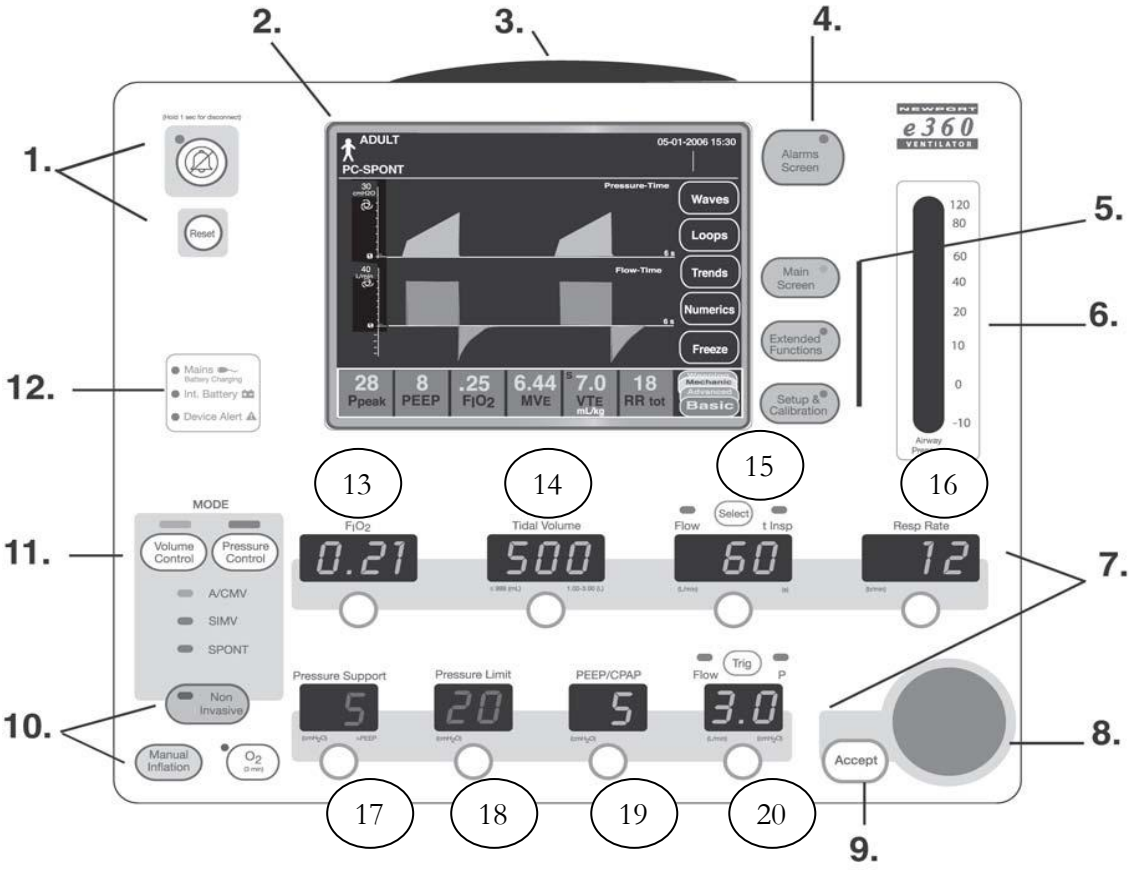

Figure 2.6: Ventilator Settings

Figure 2.6: Ventilator Settings (cont)

1. Alarm reset
2. Graphics screen and monitoring display
3. Alarm light
4. Alarm screen setting control
5. Menu selection buttons
6. Peak airway pressure display
7. Respiratory rate and trigger control settings
11. Breath Type control
12. battery status light
13. O_2 selection
14. Tidal volume
15. Peak flow (VC) Ti (PC) toggle setting
16. Mandatory respiratory rate (frequency)
17. Pressure Support

8. Change setting control
9. Change of setting acceptance button
10. Non invasive ventilation control
18. Pressure limit (PC)
19. PEEP/CPAP toggle setting
20. Trigger sensitivity

Diagram with permission NMI Newport US (2008)

2.4.12 Ventilator Graphics.

Ventilator graphics can aid clinicians in deciding which ventilator is most appropriate, or fine tuning the settings for a given mode in order to achieve the best combination for the patient (Pruitt 2002).Ventilator graphics are the "ECG of the lung" and give information regarding the improvement, or deterioration of the lungs long before the ABGs or chest X-Ray show any changes in the condition of the lungs. The ventilator settings can be "fine tuned" to optimally ventilate the lungs and prevent VILI. As mechanical ventilation is focused on preventing VILI, it is of a absolute necessity that the nurse in ICU can interpret the ventilator graphics so as to make an accurate assessment of patient clinical status and tolerance to mechanical ventilation (Burns 2003).

2.5 VENTILATOR SETTINGS IN TERMS OF LUNG PATHOLOGY

Engelbrecht &Tintinger (2007) group lung pathologies which may require mechanical ventilation into three distinct groups.

- The patient with normal lungs who may require mechanical ventilation for reasons other than lung pathology e.g. spinal injury leading to quadriplegia, neuromuscular disease, head injury.
- The patient with non compliant or "stiff" lungs e.g. Acute Respiratory Distress Syndrome (ARDS).
- The patient with obstructive outflow breathing patterns e.g. asthmatic, COPD.

Table 2.1 shows standard settings which can be used for normal lungs and how the standard settings vary for patients with chronic obstructive airway disease (COPD) and lung infiltrates (ARDS). It is no longer acceptable, nor advisable to use a single set of settings or lung strategies for all patients (Engelbrecht & Tintinger 2007)

Table 2.1: Standard settings for three groups of lung pathologies

	Normal Lungs	ARDS	COPD
FiO_2	<60%	100% until stabilised then <60	100% until stable then <60
Tidal volume	8-10mls/Kg/IDBW	4-8 mls/kg/IDBW	6-8mls/kg/IDBW
Respiratory rate	10-20bpm	16-24bpm	6-10bpm
PEEP	3-5cm/H_2O	8-18cm/H_2O	0-4cm H_2O
IE ratio	1:3	1:2, 1:1 Inverse	1:3, 1:4
Pressure/ Volume control	Either	Either	Usually volume

(Engelbrecht &Tintinger 2007*)*

Whilst there may be slight variations in the actual figures as depicted in the table above amongst authors, the principles of different settings for different pathologies is agreed upon.

2.5.1 Mechanical ventilation of the normal lung

A patient may require to be mechanically ventilated for reasons other than a lung pathology or respiratory failure e.g. post operative patients, high spinal injuries, and motor neuron diseases. The patient with normal lungs is also at risk of ventilator induced lung injury (VILI) if inappropriate settings are instituted. However the patient with normal lungs can usually be safely ventilated using “standard or conventional settings”. Standard settings may include: choice between pressure and volume control, mandatory rate 10-15bpm, synchronized intermittent mandatory ventilation (SIMV) mode, O_2 40%, tidal volume (Vt) 4-8mls/Kg/Wt, positive end expiratory pressure (PEEP) 5cm H_2O, I:E1:2, pressure support according to tidal volume and clinical outcome required, and trigger sensitivity -2.cm H_2O.

2.5.2 Mechanical ventilation of Acute Respiratory Distress Syndrome (ARDS) lung pathology

Acute respiratory distress syndrome (ARDS) is a syndrome of alveolar filling disorder resulting from alveolar injury and defined by decreased lung compliance, which may be exacerbated or caused by inappropriate ventilator settings and strategies. 8-11% of patients ventilated for acute respiratory failure will succumb to ARDS. The patient with ARDS requires low tidal volumes,(4-8mls/kg/IDBW) airway pressures under 35cm/H_2O, high PEEP (14-18cm/H_2O) and high mandatory respiratory rates (>20bpm) (ARDSNet study 2000; Galvin, Krishnamoothy, Saadia, 2004; Emery 2005; Tobin 2006).

Lung recruitment is used in the ARDS patient lungs whereby the PEEP is increased to 20-60cm/H_2O for 20-60seconds. This manoeuver opens collapsed alveoli inducing better oxygenation and ultimately reducing intrathoracic pressure.

The prone position is commonly used in conjunction with the recruitment manoeuver to improve oxygenation of the patient. The prone position allows for the lower lobes to be expanded and reduces pressure in the upper lobes, as proning splints the thoracic cage anteriorly. Diaphragmatic excursion is improved by freeing up the abdomen by placing a pillow under the chest and hips. This encourages preferential expansion of the lower lobes, and reduces over distention of the upper lobes (Hering 2001; Burns 2005; Robertson 2007). Proning does not appear to reduce mortality; however a sustained improvement in oxygenation may support the use of the prone position in patients with severe hypoxia and hypoventilation (Sud,Sud, Friedrich,et al. 2008).

2.5.3 Mechanical ventilation of severe outflow obstruction lung pathology

The patient who demonstrates chronic obstructive pulmonary disease (COPD) differs greatly from that of the patient with acute respiratory distress syndrome (ARDS). Non invasive ventilation (NIV) using Bi- level positive airway pressure (NIV with BiPAP) is considered the treatment of choice for the COPD patient. However, there are some patients for whom non invasive ventilation (NIV) may not be suitable and may require intubation and ventilation. In COPD the airway diameter is narrowed by bronchospasm, mucous and oedema causing the airways to collapse on expiration thus “trapping air” in the lungs (auto- PEEP) The COPD patient requires the ventilator to be set in such a way that a long expiratory time is selected or manipulated, using the Ti, I:E ratio, inspiratory flow or rate. Exacerbating auto-PEEP in the COPD patient by using inappropriate ventilator settings can lead to barotrauma, ventilator induced lung injury (VILI), and haemodynamic instability.

COPD disease requires low mandatory ventilator rates to allow for longer expiratory times. Thus the nurse must be aware and knowledgeable of the fact that settings are the same for both pathologies but ranges of settings are completely contrary for the ARDS and COPD lung. (Mah & Acourt 1999; Brown 2002).

The aforementioned explanations and examples are indicative of the competency levels the nurse must acquire of ventilation in order that she may safely and correctly manipulate ventilator settings and strategies in terms of the patient lung pathology. Big decisions and big choices often have to be made by the nurse, and she cannot make these decisions and choices without a specialised body of knowledge regarding mechanical ventilation.

Thus a lack of competence on behalf of the nurse regarding basic ventilation can lead to “failure to rescue” a situation when the patient condition deteriorates and undergoes rapid decline that could have been avoided or mediated had the nurse intervened early and appropriately. An experienced competent nurse is able to recognize significant symptoms and

respond accordingly, this could be critical in assuring optimal outcomes for the ventilated patient (Keane, Lubin, Emerson, et al. 2003).

2.6 NURSES' LEVEL OF COMPETENCE

Thus the nurse who works in ICU and cares for mechanically ventilated patients must come to the bedside with a body of specialist knowledge which is congruent with the specialist needs of the patient (World Federation of Critical Care Nurses 2005). Specialist knowledge of mechanical ventilation refers to an expert knowledge base, complex decision making skills and clinical competencies in caring for and understanding the theoretical, practical, and technological aspects of mechanical ventilation (American Association of Critical Care Nurses 2003). As such the nurse should demonstrate competence with regard to ventilator breath types, modes, settings and applying this knowledge competence to various lung pathologies found amongst patients in the ICU (Brunner 2002; Tobin 2001).The nurses' level of competence should include being up- to- date with new ventilator technology, ventilation strategies, new modes, as well as the ability to judge when it is appropriate to apply varying strategies and settings in terms of the underlying lung pathology. The competent nurse should be able to interpret and act upon the monitoring information displayed by the ventilator, in terms of the clinical manifestations of the patient (Keane et al. 2003). Should the nurse not be competent in the clinical application of the ventilator settings, and interpretation thereof the patient may suffer ventilator induced injury to the lung, which may ultimately lead to a prolonged stay in the ICU, and increased mortality and morbidity.

An extensive search of the literature, both internationally and locally, revealed no studies to-date to have been conducted to assess the competence of ICU nurses with regard to mechanical ventilation. However, similar studies were found internationally. In the United Kingdom, Alphonso et al.2004) assessed the knowledge of mechanical ventilation of registered respiratory therapists versus a cross section of ICU personnel (including intensive care nurses) within a university-based hospital, using a questionnaire. The author reported a significant difference in the basic knowledge competence of ventilation between the two groups, with the registered respiratory therapists attaining a significantly higher score than other participants. Cox, Shannon, Carson, et al. (2003) studied the effectiveness of a medical resident education programme with regard to resident doctors' knowledge of mechanical ventilation post a teaching programme having been undertaken by the medical residents, and concluded that the residents' knowledge of mechanical ventilation was suboptimal, and the programme had to be re-curriculated. Locally, a study conducted by Van Huyssteen & Botha (2004) on the knowledge of recovery room nurses with regard to post operative airway emergencies in adults

found that only one of the twenty one participants (4.8%) demonstrated the set competency, raising suspicion of poor competence (knowledge) amongst recovery room nurses. More recently, local research by Perrie & Schmollgruber (2006) and Windsor (2005) studied the knowledge of intensive care nurses with regard to weaning protocols and interpretation of ventilator graphics respectively. Both studies found that the knowledge of intensive care nurses to be below the set competency level for the respective studies.

Botha (2009) reviewed 11 studies which studied critical care nurses' knowledge of various critical care subjects e.g. haemodynamic monitoring, ventilator graphics. Competency Indictors (CI) for the 11 studies ranged between 60% -85%. Overall 565 nurses participated in these studies and results revealed only 10.5% of the nurses achieved the set competency level with 90.5% not achieving the set competency levels.

The results of these studies are cause for concern. Inappropriate management of the ventilated patient can actually damage the lungs leading to complications such as barotrauma, volutrauma, atelectrauma, tracheal injury and increased risk of infection, multiple organ failure and death (Tobin 2006).

The implications of having a nurse of questionable competency caring for the mechanically ventilated patient may lead to deterioration of the patient, failure of progression and at worst increased mortality and morbidity (Alphonso et al. 2004). Furthermore, inexperienced nurses are at risk of litigation if their level of competence is found to be lacking. This is highlighted by the Von Stetina case in the United States (Oddi & Huerta, 1990) whereby a patient suffered severe brain damage whilst being cared for in an intensive care unit, due to inadvertent ventilator disconnection.

Alphonso et al.(2004) argues that it is assumed by the public that the provider of care in ICU possesses the skills and knowledge to optimally utilize the ventilator equipment. In South Africa the intensive care nurse's specialist knowledge is assumed by virtue of the nurse having attained a post basic registration with the South African Nursing Council (SANC) in intensive care nursing. According to Williams & Clark, as cited by Scribante & Bhagwangee (2007) 75% of nurses in the ICU should hold a specialist certification. The South African situation is in stark contrast to this, as a national audit undertaken by the Critical care Society of Southern Africa (CCSSA 2004) revealed only 25% of nurses in ICU in SA to be registered intensive care qualified nurses. By extrapolation, only 25% of nurses in ICU in SA are competent to nurse the ventilated patient (Scribante & Bhagwangee, 2007).

The depth and breadth of knowledge required to care for the mechanically ventilated patient are only partially satisfied by the entry level nursing education provided by most nursing schools (Briggs et al. 2006). The basic curriculum for registration as a professional nurse with the SANC does not prepare the nurse nor does it engender the specialist knowledge required of the nurse, to care for the patient in the ICU who most likely will be mechanically ventilated. Binnekade, Vroom, de Mol, et al. (2003:191) state "*The accountability of sufficient specialised nurses in ICU to meet the needs of the patient is a major factor in ensuring patient safety and quality care, and employing non- trained ICU staff can result in a dilution of the specialist care provided by the specialist nurse."* The ICU patient requires the highest level of specialist education and experience (Fouche 2002).

Nursing interventions require to be tailored around reducing complications of mechanical ventilation. There is no critical care specific scope of practice, to guide the critical care nurse in practice. Within SA, the South African Nursing Council (SANC) regulates the practice and education of intensive nursing practice through the Scope of Professional Practice of persons registered and enrolled under the Nursing Act of 1978 (2598 of 1984 as amended), and the regulations setting out the Acts and Omissions (R387 of 1985 as amended) and is not specialist specific. Moreover, the mechanically ventilated patient is further compromised by the fact that there are no guidelines to guide the nurse in the care of the patient.
In contrast, internationally intensive care nurses are guided in their practice by guidelines laid down by professional bodies, such as the American Association of Critical Care Nurses (AACN) in the USA, the National Health Service in the UK and the Australian Council of Healthcare in Australia. It is suggested that the development and implementation of guidelines is the best way to improve the quality of care delivered to patients and to guarantee the application of evidence based nursing (Subirara 2004).
To this end the Critical Care Society of Southern Africa (CCSSA 2004) and the Critical Care Nursing Forum- a sub group of the CSSSA, are currently undertaking the task of generating guidelines for intensive care locally. In South Africa a non-intensive care qualified nurse can legally work in ICU as the SANC does not require a nurse to have specialist qualification to work in the ICU environment.

2.7 CONCLUSION

Managing and supporting the transition of patients from mechanical ventilation is perceived to be one of the pivotal roles of the critical care nurse (Williams, Schmollgruber, Alberto, 2006). For this the nurse requires a specialised body of knowledge regarding mechanical ventilation from which she can draw in order to demonstrate competency. As no studies either locally or

internationally were found regarding the competence of nurses in ICU with regard to mechanical ventilation, this led the researcher to embark on a study to assess the competence of intensive care nurses in South Africa (SA) with regard to mechanical ventilation.

The following chapter describes the methods used to undertake the study to ascertain level of nurses' competence in mechanical ventilation in ICU's in two tertiary academic healthcare institutions in Gauteng.

CHAPTER THREE
RESEARCH DESIGN AND METHODS

3.1 INTRODUCTION

In this chapter the research design and methods, study setting, sample criteria, the sampling process and data collection procedures, as well as the development and validation of the research instrument used for data collection are presented. The purpose of the study was to determine and describe the competence regarding basic mechanical ventilation amongst nurses working in adult intensive care units (General ICU's, Cardiothoracic ICU, Trauma ICU, Neurosurgical ICU and Surgical ICU) in two tertiary healthcare institutions in Gauteng, and the following objectives were set to meet the purpose of the study.

3.2 STUDY OBJECTIVES

The objectives to meet the purpose of this study were set in two phases as follows:

3.2.1 Phase one objectives

The objectives of phase one were to:

- Develop three clinical vignettes to determine the competence of ICU nurses who care for adult mechanically ventilated patients in ICU in two tertiary healthcare institutions in Gauteng.

- Validate three clinical vignettes using a modified Delphi technique, expert group, and content validity index (CVI)

3.2.2 Phase two objectives

Three objectives were set in phase two, namely to:

- Determine and describe the level of nurses' competence in mechanical ventilation of the adult patient in intensive care units of two tertiary healthcare institutions in Gauteng, using three clinical vignettes developed and validated in phase one.

- Describe the difference in levels of competence in mechanical ventilation amongst nurses working in adult intensive care units, that may exist within and

between groups of nurses, and between the two tertiary healthcare institutions in Gauteng.

- Compare nurses' perceptions of their own level of competence with regard to mechanical ventilation with actual scores obtained from the completed vignettes.

3.3 RESEARCH DESIGN

A non-experimental, descriptive two phase design was used to determine and describe the level of nurses' competence in mechanical ventilation in adult intensive care units in two tertiary healthcare institutions in Gauteng.

3.3.1 Non-experimental research

Non-experimental research is that in which there is no attempt to manipulate an independent variable, create a control group or randomize subjects between groups. When non-experimental research is used as a study design, there is no need to exert a rigid influence over the design features of the study, as the purpose of such studies is not to isolate cause-effects relationships, but usually to describe a phenomenon of interest (Sims & Wright 2002). Non- experimental research as applied to the study was chosen, as the purpose of the study was to determine and describe the level of competence of nurses working in ICU's in two tertiary healthcare institutions in Gauteng with regard to mechanical ventilation.

3.3.2 Descriptive research

Sims & Wright (2002:69) describe a descriptive study as one which often builds upon a body of knowledge or an existing theory and normally uses a non-experimental design. Polit, et al.(2001:180) state that "*there are also research questions for which experimentation design is not appropriate such as studies whose purpose is descriptive. That the purpose of descriptive studies is to observe, describe, and document aspects of a situation*". Therefore a descriptive design is suitable for this study as it aims only to describe levels of competence regarding mechanical ventilation amongst nurses working in adult intensive care units in two tertiary healthcare institutions in Gauteng, with no manipulation of the independent variable, and to describe and document the results without reference to cause and effect.

3.4 RESEARCH METHODS

The research methods progressed through two phases. For the sake of clarity each phase is discussed in its entirety. Research methods refers to the steps, procedures and strategies for gathering and analysing the data in a research investigation (Polit et al. 2001:465).

3.4.1 Phase one: development and validation of three clinical vignettes

3.4.1.1 Development of clinical vignettes

For the purpose of the study three clinical vignettes were developed. Clinical vignettes have been used as means of data collection since 1950, and published data using clinical vignettes has appeared since the 1960's (Veloski, Tai, Evans, et al. 2005). Vignettes have been found to be valid and reliable instruments to measure the application of knowledge to the clinical situation (Peabody, Luck, Glassman, et al. 2000; Noncini 2004; Peabody,Tozija, Murioz,et al. 2004; Veloski, et al. 2005).

Further Veloski et al. (2005) state that if knowledge competence is being evaluated (as for this study), Multiple Choice Questions (MCQ's) derived from a clinical scenario are sufficient to evaluate the level of knowledge competence being studied. As such each of the three clinical vignettes developed consisted of a clinical scenario developed with reference to one of the three lung pathologies as described by Engelbrecht & Tintinger (2007) (refer Table 3.1) followed by MCQ's with four single response options relating to the scenario. A fifth option of "I don't know" was included in an effort to reduce the number of "guess" answers, when the nurse did not know the answer.

Table 3.1: Vignettes relating to lung pathology

Vignette	Lung Pathology
Vignette One	Post operative patient with no lung pathology.
Vignette Two	Patient with Acute Respiratory distress Syndrome lung pathology.
Vignette Three	Obstructive outflow lung pathology.eg asthma.

It was necessary to develop the vignettes in terms of three different lung pathologies, as the strategies, ventilator settings, nursing care and nursing interventions differ for each of the lung pathologies previously alluded to."*It is no longer acceptable to apply a single strategy of ventilation for all (such) patients. This is especially true with increasing awareness of the complications of mechanical ventilation such as barotraumas, volutrauma,and biotrauma*." (Engelbrecht & Tintinger 2007:118).

Vignette one (post operative patient with no lung pathology) vignette two (ARDS lung pathology) and vignette three (obstructive outflow lung pathology) were scientifically developed using a systematic process, which included a wide literature search, journal articles, the world wide web and extracting exerts of scenarios and MCQ's from previously validated vignettes (Cox et al. 2003; Alphonso et al. 2004). Adaptations were made by the researcher to the case scenarios and MCQ's within the vignettes to place the developed vignettes within the South African setting e.g. the vignettes of Cox et al. (2003) and Alphonso et al. (2004) refer to assist control mandatory ventilation (A/CMV) whereas in South Africa the most commonly used mode of ventilation is synchronized intermittent mandatory ventilation (SIMV). The final clinical scenarios and MCQ's for the three clinical vignettes were an eclectic mix of the previously validated vignettes and MCQ's of Cox, et al, (2003) and Alphonso et al. (2004) together with information gained by the researcher from the literature search, and the researchers' own clinical and theoretical knowledge.

Demographic data and questions relating to the participants own perception of their competence with regard to mechanical ventilation were also developed in phase one.

The final structure of the three clinical vignettes was as follows: (see Appendix 3)

- **Vignette one clinical scenario** relates to mechanical ventilation of a post operative patient with normal lungs, and consists of ten (n-10) MCQ's.

- **Vignette two clinical scenario** relates to mechanical ventilation of a patient with decreased lung compliance (ARDS) and consists of six (n=6) MCQ's.

- **Vignette three clinical scenario** three relates to mechanical ventilation of a patient with airflow obstruction (asthmatic) and consists six (n=6) MCQ's.

3.4.1.2 Validation of three clinical vignettes

A three-pronged approach as suggested by Gould (1995) citing Flaskerud (1979) was used for the process of development and validation of the vignettes as shown in Figure 3.1

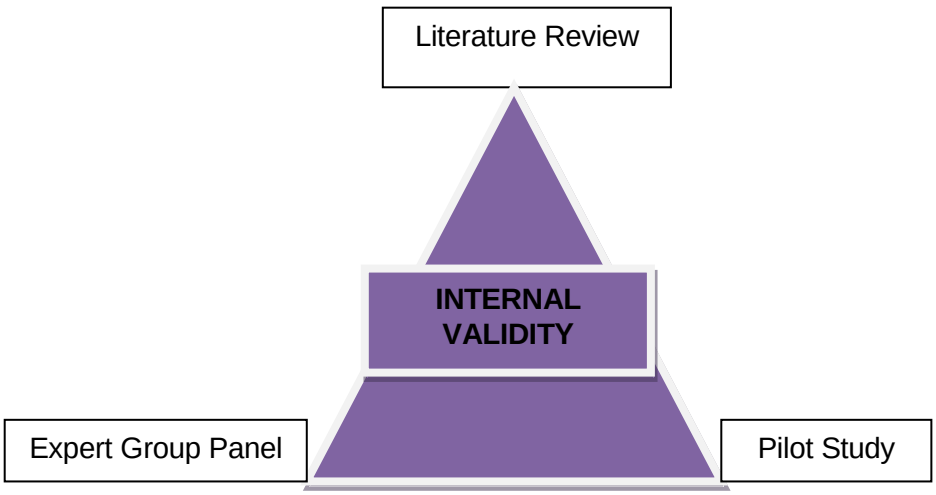

Figure 3.1: Approach to internal validity of clinical vignettes

The three provisionally developed vignettes consisting of 29 questions were presented to an expert group (n=10). An expert group is a group of individuals purposively selected for their expert knowledge of the subject being studied. A modified Delphi technique was used to collect data from the expert group for validation of the three clinical vignettes.

Experts are defined as informed persons in a particular discipline or field usually constituted as a panel, as individual members, or both (Burns & Grove, 2003) as cited by Bruce, Langley, and Tjale, (2008). For the purpose of this study individual experts, later formed the expert consensus panel.

The modified Delphi method was used for the collection of data and refers to when a panel of experts come together in a meeting coordinated by a facilitator, having previously recorded in writing their initial thoughts and opinions of the topic in question. Participants then contribute their ideas to the group (Sims & Wright 2002) and each question is ranked by the group and discussed until consensus is obtained.

3.4.1.3 Study population

The accessible population is the portion of the target population that is accessible to the researcher for the purpose of a specific study (Sims & Wright 2002:111). For the purpose of the study the accessible population to form the expert group in phase one was intensive care doctors, ICU qualified nurses from ICU units, universities and private clinics, and clinical engineers who have a special interest in mechanical ventilation.

Clinical engineers were included in the group to ensure that nomenclature and terminology were correct and clear, as nurses are subjected to many types of ventilators, which use different terms and settings for the same strategy e.g. BiPap /Biphasic/ Bi-level. The clinical engineers were asked to correct any inaccuracies e.g. that BiPap and Biphasic are in fact the

same thing in relation to the technology of the various ventilators. Intensive care doctors were included to ensure that the vignettes were clinically accurate, as were the expert nurses.

3.4.1.4 Sampling and sample

Purposive sampling was used to sample the expert group of nurses, doctors and clinical engineers from a variety of hospitals, clinics, and universities. The sample consisted of three clinical engineers, (n=3) two medical intensivists, (n=2) and five registered ICU qualified nurses (n=5) yielding a sample size of ten (n=10). Burns & Grove, (2001:400) suggest a sample of 5-10 experts is required if consensus amongst experts is required for validation of the content validity of the instrument. Purposive sampling is "*based on the assumption that a researchers' knowledge about the population can be used to handpick the cases to be included in the sample*" (Polit, et al. 2001:339). Bruce et al. (2008:59) describe purposive sampling "*as the identification of experts in disciplines or domains directly and indirectly represented in the research instrument or topic under discussion and who can provide rich data as evidence for the content related validity of the instrument*."

Heterogeneity of the selected experts was preserved in so much as there was variation amongst the experts with regard to qualifications (nurses doctors, clinical engineers) work experience (5-20+yrs) practice domain (nursing, medical, engineering) and age. Yousaf, (2007) as cited by Bruce et al.(2008:), posits that heterogeneity of participants is necessary to arrive at valid results of the data collected from participants for validation of the content validity. The experts were chosen by the researcher as they had known demonstrable expertise and experience in the field of mechanical ventilation. Each of the experts was required to be currently registered with their respective professional body, have had a minimum of five years experience in the ICU environment, and be currently working in the ICU, and have a special interest in mechanical ventilation.

3.4.1.5 Data collection

A modified Delphi technique was utilised to obtain data from the expert group. The modified Delphi technique was used as it is a "*method for the systematic collection and aggregation of informed judgments from a group of experts on specific questions or issues*" (Reid 1993:131) as cited by Sims & Wright (2002:79). An expert group was used as they "*generate questionnaire items that are consistent with a study's objectives and represent the opinions, attitudes, beliefs, perspectives, activities or practices of potential participants*" (Sims & Wright 2002:79).

Combining an expert group and using a Delphi method is a hybrid of the Delphi method and the expert group. The advantage of using this method being that all rankings of the clinical vignettes are done privately and independently thus minimising the opportunity for participants

to influence one another's views (Sims & Wright 2002:79). A consensus group consisting of the original selected experts was then held to obtain consensus on the individual rankings of the questions for the purpose of validation of the instrument.

The participants (n=10) were approached either personally by the researcher or sent an email requesting them to participate in the research and written consent forms were signed by the participants (Appendix 1).

An information letter detailing what was required of the participants was emailed to each participant, (Appendix 2) together with a copy of the three clinical vignettes (Appendix 3). The experts were asked to recommend changes to the provisional vignettes, add or delete questions, change wording or existing questions and scenarios, and delete what they deemed irrelevant or unimportant. Further the experts were asked to individually rate each question within each of the three clinical vignettes using a rating scale Lynn (1986) as shown in Table 3.2.

Table 3.2: Grading scale for vignette items

Question Rating	Score
Irrelevant	1
Relevant but not important	2
Relevant and important	3
Relevant and very important	4

On completion, the participants emailed the provisional vignettes back to the researcher, with any changes, comments made, and score ratings documented.

3.4.1.6 Quantification of the clinical vignettes

On return of the rated vignettes from the ten experts (n=10) the researcher compiled a question grid and entered the scores and comments received from each of the experts against the relevant question number, per vignette. The scores and comments were anonymous and no names appeared on the grid. The individual experts were then invited to attend an expert/consensus group which was held at a neutral venue. The purpose was to discuss and gain consensus on each of the questions as rated according to the rating scale (Table 3.2) individually by the experts.

A PowerPoint presentation was delivered by the researcher to orientate the group regarding the study, and compiled data received from individual experts collated by the researcher, were projected for viewing to the expert group. The expert group was encouraged to discuss each of

the questions and the allocated scores and comments. Each question was discussed until consensus was obtained with regard to scores allocated and comments made. The level of agreement was set by the researcher prior to the consensus meeting at 80% (Lynn 1986). Questions which received a rating of 1 or 2 by 80% of the group were amended altered or deleted. Questions scoring 3 or 4 by 80% of the group were included. (Lynn 1986) Clinical vignette scenarios were corrected for clinical accuracy and relevance to the questions asked.

3.4.1.7 Content validity

"…….the most widely used method of quantifying content validity for multi-item scales is the content validity index (CVI) based on expert ratings of relevance" (Polit et al. 2007). Content validity of the instrument was undertaken using the item validity index (I-CVI) and scale content validity index (S-CVI). For the purpose of the study a S-CVI/Ave of 90% was accepted as the minimal score for validation of content (Waltz, et al., 2005) cited by Polit et al. (2007).

The CVI value for the three clinical vignettes was computed as follows: a value for each question (item content validity index) or I-CVI as described by Polit et al. (2007) was computed using the 4 point scale as suggested by Lynn (1986). (SeeTable 3.1). To calculate the I-CVI experts were asked to rate the relevance of each question according to the 4 point scale. The I-CVI was then calculated as the number of experts (n=10) giving a rating of 3 or 4 divided by the number of experts, ie the proportion in agreement about relevance (Polit et al. 2007). An acceptable I-CVI according to Lynn (1986) as cited by Polit et al. (2007) suggests that if there are more than 6 experts the I-CVI must be at least 83% The overall scale content validity (S-CVI) as described by Polit et al. (2007) was also computed. The S-CVI was computed using the S-CVI/Ave method. The S-CVI/Ave is calculated by computing the proportion relevant for all the questions, and dividing the sum by the number of experts.For the purpose of the study a S-CVI/Ave of 90% was accepted as the minimal score for validation of content as suggested by (Waltz 2005) cited by Polit,et al. (2007) as there were more than six (n=6) experts in the group.

The purpose of the expert group consensus meeting was to validate and organise the vignettes into a usable format. The final instrument as agreed upon by the expert group and consisted of four sections, and 22 questions (appendix 3). The original instrument consisted of 29 questions. Seven (n=7) of the original questions were removed by the expert group, as the instrument was too long and experts could not find agreement on seven of the questions.

SECTION 1 : Demographic data of ICU qualified nurse participants

SECTION 2 : Demographic data of non ICU qualified nurse participants

SECTION 3 : Demographic data and questionnaire relating to mechanical ventilation for all participants

SECTION 4 : Three Vignettes

The final instrument was then tested on a pilot group of ICU nurses (n=24) who were not included in the main study. The nurses (n=24) consisted of ICU qualified, non-ICU qualified nurses, enrolled nurses and ICU students from a variety of hospitals. On completion of the pilot study the following intervention was made: One question was re-phrased as interpretation of the question differed amongst the pilot group and elicited different responses.

3.4.2 Phase two

3.4.2.1 Data collection

In Phase two the validated vignettes were used to collect data from nurses in ICUs. The research was conducted in six ICU units (n=6) within two tertiary healthcare institutions in Gauteng. The six units comprised all the adult ICU units in the two tertiary healthcare institutions. Academic tertiary hospitals typically admit patients who require mechanical ventilation, either as an acute intervention or for those patients demonstrating chronic respiratory failure. The six ICU units (n=6) were chosen using purposive sampling as they admit adult patients, and each unit is specific to a medical discipline (2X two General ICU's, 1XNeuro ICU, 1XCardiothoracic ICU, 1XTrauma ICU, and 1XFolateng ICU). The Folateng project is revenue generating initiative launched by the department a few years ago. The Folateng units which are situated in four of the Gauteng public hospitals serve as a bridge between public and private health sectors. The money generated from these units make the acquisition of major items of medical equipment more affordable to participating hospitals and allows affording members of the community an opportunity to receive high level medical care at a rate lower than that of private hospitals. The Folateng unit referred to in this study was opened in May 2002.

Full time medical officers have been appointed at all Folateng units and this move has resulted in an increase in utilization of these services.

The two hospitals chosen for the study are both attached to the University of the Witwatersrand, and are categorised as two tertiary healthcare institutions in Gauteng and are involved in training of nurses. Nurses in both these hospitals have the same training opportunities e.g. attending academic ward rounds, undertaking in-service training, caring for critically ill patients in ICU, and opportunities to further their education and training.The ICU units in both hospitals admit critically ill patients, regardless of their paying status, providing a wide range of exposure and pathologies of patients requiring mechanical ventilation.

3.4.2.2 Study population

The target population consisted of all nurses in ICUs in South Africa (n=5458) (Scribante & Bhagwangee 2007) whilst the accessible population consisted of all nurses in six ICUs (n=6) in two tertiary healthcare institutions in Gauteng who care for mechanically ventilated adult patients regardless of training background or experience.

3.4.2.3 Sample and sampling

The sample size as determined by a statistician was 120 participants. However a sample of 136 nurses was realised for the study. Consecutive sampling was used in phase two of the study. "*Consecutive sampling entails the sampling of every available individual within an accessible population who meets the inclusion criteria and agrees to participate in the research study and will potentially result in an adequate sample being realised. It is the best choice of non random sampling methods"* (Endecott & Botti 2005:53). Each participant who agreed to participate in the study signed a consent form prior to the instrument being handed out (appendix 4).

3.4.2.4 Data collection process

Permission to conduct this study in the selected ICU units (n=6) was obtained from the CEO of the individual hospitals, (Appendix 6) and medical heads of each unit. Charge nurses of each ICU were approached personally by the researcher to gain permission to conduct data collection in the respective units. A date and time for the data collection process was agreed upon with the charge sisters of the respective units.

The instrument was placed in individual unsealed blank envelopes and taken to the ICU units at the specified time and date. A separate envelope was used in which to place the consent forms of those participants who consented to participate in the study. This was to ensure that anonymity of participants was maintained. An information sheet (see appendix 5) was also included, attached to the consent form.

The researcher was accompanied by two experienced researchers both of whom had completed a Masters Dissertation and who were familiar with the procedure required to collect data. The researcher, assisted by the two experienced researchers visited each of the selected units, where the nurses were given a brief oral overview of the purpose of the study, an explanation of the format of the instrument, and what was required of them with regard to completing the instrument. The nurses who agreed to participate in the study then signed a consent form which was placed in the envelope not associated with the instrument to ensure confidentiality. The nurses were then handed the instrument and either sat in the tea lounge

with a research assistant present, or alone in a patient cubicle with the researcher and second assistant constantly moving around the unit to ensure no collaboration between the nurses took place. On completion of the instrument the participants handed the instrument back to the researcher in the envelope which they were asked to seal in front of the researcher. The researcher then removed the completed instruments from the units and placed them in safe keeping.

All participants were assured of anonymity and confidentiality and no names or identifying information were placed on the instrument. The data were handled confidentially as only the researcher and her supervisor had access to the raw data.

The researcher was contactable via email or cell phone during and after the data collection period. The envelopes with completed instruments were only opened by the researcher once they were removed from the unit and data collection from the particular institution had been completed.

3.5 INSTRUMENT

For the purpose of the study clinical vignettes were chosen to collect data for the purpose of describing the competence regarding basic mechanical ventilation amongst nurses working in adult intensive care units in two tertiary healthcare institutions in Gauteng.

A research instrument is a means of gathering data about a concept of interest e.g. hope pain caring knowledge. "*The device that a researcher uses to collect data e.g. questionnaires etc*" (Polit et al.2001:463). For the purpose of this study "competence in mechanical ventilation" is the concept of interest that needs to be defined in more concrete and measurable terms.

3.6 DATA ANALYSIS

Data analysis was conducted to reduce, organise and give meaning to the data collected (Burns & Grove, 2003). Numerical data was loaded into an Excel 2007 spreadsheet, descriptive statistics were used for analyses of phase one whilst descriptive and statistical analysis were used in phase two.

3.7 ETHICAL CONSIDERATIONS

The conduct of nursing research requires not only expertise and diligence but also honesty and integrity (Burns & Grove 2003). Ethical research is essential to generate sound knowledge for practice, while at the same time protecting the rights of human subjects. Ethical review and clearance is necessary to ensure a balance between risks and benefits of a study and prevent research misconduct. The following steps were taken to ensure ethically sound research.

- The research proposal and instrument were submitted to the Postgraduate Committee (Faculty of Health Sciences) of the University of the Witwatersrand for approval of the study (appendix 7).
- The proposal and instrument were submitted to the Committee for Research on Human Subjects of the University, and a clearance certificate was obtained (appendix 8).
- Permission to conduct the research was obtained from appropriate management structures of the two tertiary healthcare institutions. (appendix 6) and also from the Department of Health Gauteng (appendix 9).
- An information letter was sent to the expert group and handed to the participants (appendix 2).
- Informed consent was obtained in writing from all participants of the expert group who agreed to participate in the study (appendix 1).
- An information letter explaining the study was handed to the participants in phase two (appendix 5).
- An informed consent form was signed by participants in phase two (appendix 4).
- Anonymity of the participants was guaranteed in that neither names nor hospital wards, or hospitals were not recorded. Consent forms and instruments were separated at time of data collection to maintain anonymity of participants.
- Confidentiality was guaranteed in that the researcher and the supervisor were the only people with access to raw data.
- Participants were given the option to withdraw from the study at anytime without fear of penalty or intimidation.

3.8 SUMMARY

In this chapter the research methods used in the study have been described. The design, study setting, inclusion criteria, population, sample were described, and the methods of data collection and analysis were presented.

The following chapter deals with analysis and results of the data obtained in phase one and phase two of the study.

CHAPTER FOUR

DATA ANALYSIS AND RESULTS

4.1 INTRODUCTION

In this chapter the method of data consolidation is described together with the approach to data analysis. The results are reported using bar graphs, pie graphs, tables, and scatter graphs. The data were cross-checked in conjunction with a statistician for accuracy, and the data files set within the statistical computer packages SPSS and Excel 2007 for analyses. Descriptive and inferential statistics were used to analyse the data to ensure the study objectives were met. The level of significance was set at <0,05 and confidence levels at 95%. The competency indicator for the vignettes was set at 75% by the expert group and nurses' level of competence was graded according to vignette score outcomes using a grading scale. (Table 4.1)

Table 4.1

Grading scale for results of vignettes	
Poor	<50%
Average	50-59%
Good	60-69%
Very Good	70-75%
Excellent	>75%

Dept of Nursing Education University of Witwatersrand (2011)

A total of 150 instruments were handed out, with 136 being completed, resulting in a sample of 136 nurses (n=136).The study design progressed through two phases and as such the data analyses and results are presented in two phases, commencing with phase one.

4.2 APPROACH TO DATA ANALYSIS

(Refer to Fig 4.1)

Data analysis was undertaken in two phases. Phase one consisted of analysis of socio-demographic data, and validation data of three vignettes. Phase two consisted of analysis of results of three clinical vignettes, influence of age and experience, and nurses perceptions of their own levels of competence in mechanical ventilation.

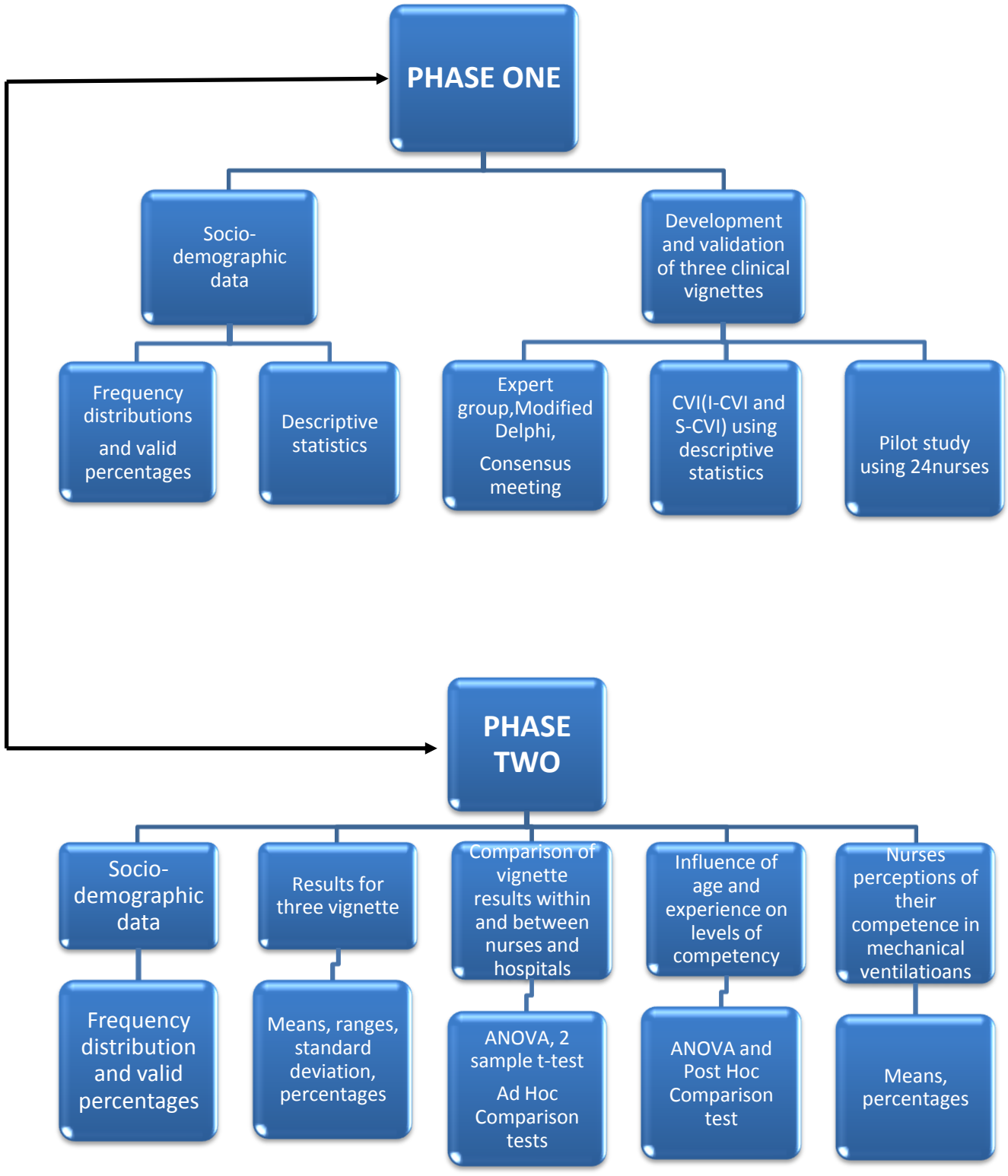

Figure 4.1: Approach taken for analysis of the data

4.2.1 Phase one-socio-demographic distribution of expert group, instrument development, and validation

Socio-demographic data of the expert group was analysed using descriptive statistics, and three clinical vignettes were developed and validated.

4.2.2 Phase Two - Data collection, analyses and results

In phase two frequency distributions were computed to organise the socio- demographics of the participants. Data was entered into the statistical computer package SPSS, and missing data was coded as 99 and taken into account by the SPSS program. Therefore results presented are valid percentages. Inferential and descriptive statistics were used to analyse and compute the results of three clinical vignettes. Scores achieved by the nurses were quantified as percentages and graded accordingly (seeTable 4.1 in order to indicate levels of competence. Statistical tests used included mean scores, standard deviations, ranges, as well as two sample t-test, one way ANOVA, Welch Brown-Forsythe equality of means, and Post Hoc Multiple Comparison tests.

Standard deviation was computed and is a measure of the scatter of the individual values around the mean (Sims & Wright 2002). The span from the minimum value (score) to the maximum value (score) is called the range, and is a measure of variability. However, range is an unstable measure of variability since it is affected by atypical values at one or other end of the distribution (Sims & Wright 2002).The scatter of values refers to the individual scores obtained by individual nurses for each of the questions within each of the three clinical vignettes and are presented as scatter graphs.

ANOVA tests mean differences among three or more groups by comparing the variability between the groups to the variability within them (Polit et al., 2001). For the purpose of this study the groups pertain to ICU qualified and three categories of non- ICU qualified nurses. (ICU experienced, ICU students, and enrolled nurses). One way ANOVA was used in this study to determine the significance of the contribution of individual variables (age and experience) towards the competence levels of the ICU qualified and non- ICU qualified groups of nurses. One way ANOVA was also used to compute differences within and between the non- qualified nurses' competence levels for each of the three clinical vignettes as determined by mean vignette scores. Post Hoc tests using Scheffe, LSD, Ganes, and Howell tests were used if the null hypothesis was rejected when ANOVA was computed.

Differences between the levels of competence of the ICU qualified and non-ICU qualified nurses, and sub categories of non-ICU qualified nurses were computed using a two sample t-test. Two sample t-testing is a statistical analysis designed to test for differences between two

means from two independent samples For the purpose of this study the two independent samples refer to the ICU qualified and non-ICU populations of nurses.
The two sample t-test with equal variances assumed is one of the most common analyses used to test for significant differences between two samples (Burns &Grove 2003) The t-test gives the probability that the null hypothesis is true. A value of 0.05 or greater suggests there is no significant difference between the means of the two groups and any actual difference is likely to be due to chance. If the value is <0.05 it is suggested that the means are significantly different.

4.3 PHASE ONE RESULTS

Results of analysis of socio-demographics of expert group, and content validity of three clinical vignettes were undertaken in phase one.

4.3.1 Socio-demographics of expert group and content validity

In phase one the results of the sector distribution and qualifications of the expert group, are presented, as well as results of content validation of the instrument.
Five nurses (n=5) two intensive care doctors (n=2) and three clinical technologists (n=3) formed the expert group. The mean years of experience post ICU qualification of the expert group participants was 19.6 years. The sector distribution and qualifications of the expert group are shown in Table 4.2

Table 4.2: Sector distribution and qualifications of the expert panel

Professional Designation	Sector	N	Qualifications	Yrs ICU Exp
Registered Nurse	Private	1	**Nurse 1** BSc.Nursing, Diploma Critical Care Nursing, Diploma Nursing Administration and Community Health, Diploma Nursing Education	24yrs
Registered Nurse	Private	1	**Nurse 2** B Cur, PhD, Senior university lecturer in ICU	29yrs
Registered Nurse	Private	1	**Nurse 3** Diploma General Nursing and Midwifery. Diploma Critical Care Nursing Diploma Nursing Education Diploma Nursing Admin Certificate in Nephrology	10yrs

Table 4.2: Sector distribution and qualifications of the expert panel (cont).

Registered Nurse	Private	1	**Nurse 4** Diploma General Nursing. Diploma Critical Care Nursing Diploma in Education	25yrs
Registered Nurse	Academic	1	**Nurse 5** Diploma General Nursing and Midwifery Diploma Critical Care Nursing Certificate in Nephrology	20 yrs
Clinical Engineers	Private	3	1 Clinical Technologist 1 Clinical Technologist 1 Clinical Technologist	20yrs 23yrs 15yrs
Intensivist Doctor	Academic	2	1MBBCh, FCP, Intensivist. 1MBBCh, FCP Intensivist	20yrs 10yrs

4.3.2 Content validation of three clinical vignettes

The method advocated by Polit & Beck (2006), Polit, Beck,Owen, (2007) was used to determine the content validity for three clinical vignettes. I-CVI was confirmed when 80% or more of the experts reached agreement on a score of 3 or 4 for each item (question). S-CVI/ave. was confirmed when the average proportion of items given a rating of 3 or 4 across the experts was 90% or more for each of the question (Waltz,et al. 1981) cited by Lynn, (1986). The expert group CVI results for each of the three clinical vignettes are shown in Table 4.3. Table 4.4 and Table 4.5.

Table 4.3 Content validity for vignette one

Item	**EXPERTS RATINGS FOR VIGNETTE ONE (n=10)**										**Experts in Agreement**	**Item CVI**
	Expert 1	**Expert 2**	**Expert 3**	**Expert 4**	**Expert 5**	**Expert 6**	**Expert 7**	**Expert 8**	**Expert 9**	**Expert 10**		
1	4	4	4	3	2	2	4	4	3	4	8	.80
2	4	4	3	3	3	4	3	3	2	3	9	.90
3	4	3	4	2	2	3	4	4	3	3	8	.80
4	3	4	4	1	2	4	3	4	4	4	8	.80
5	4	4	4	3	2	3	3	3	4	3	9	.90
6	3	4	4	3	4	4	3	4	4	4	10	1.00
7	Question 6 subdivided to 4 questions for input into SSP program											
8												
9												
10	3	3	3	4	4	4	4	2	2	3	8	.80
										Ave I-CVI		.86
	1.0	**1.0**	**1.0**	**.80**	**.45**	**.90**	**1.0**	**.90**	**.80**	**1.0**	**S-CVI**	**.89**

Vignette one was found to be content valid with I-CVI scores of .80-1.00 and a S-CVI of 89

Table 4.4: Content validity for vignette two

Item	EXPERTS RATINGS FOR VIGNETTE ONE (n=10)										Agree	Item CVI
	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Expert 7	Expert 8	Expert 9	Expert 10		
1	3	4	4	4	3	4	2	4	4	3	9	.90
2	4	4	4	3	1	4	4	4	3	3	9	.90
3	4	4	4	2	4	4	4	4	2	3	8	.80
4	4	2	4	4	4	2	3	3	3	4	8	.80
5	3	4	4	2	4	4	4	4	4	4	9	.90
6	4	4	3	4	4	3	4	4	3	3	10	1.00
										Average I-CVI		.88
	1.0	**.90**	**1.0**	**.80**	**.90**	**.90**	**.90**	**1.0**	**.90**	**1.0**	**S-CVI/ Ave**	**.93**

Vignette two was found to be content valid with I-CVI scores of .80-1.0 and S-CVI/ave of .93

Table 4.5: Content validity for vignette three

Item	EXPERTS RATINGS FOR VIGNETTE THREE (n=10)										Experts in agreement	Item CVI
	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Expert 7	Expert 8	Expert 9	Expert 10		
1	4	4	2	4	2	4	4	3	3	4	9	.90
2	4	3	4	2	3	4	4	4	4	3	9	.90
3	4	4	4	3	4	2	3	3	3	2	8	.80
4	4	4	4	3	4	4	4	3	3	4	10	1.0
5	4	4	2	4	4	3	4	3	4	4	10	1.0
6	4	4	4	4	4	4	4	4	3	3	9	.90
										Average I-CVI		.92
	1.0	1.0	1.0	.80	.80	.80	.80	1.0	1.0	.80	**S-CVI/Ave**	**.90**

Vignette three was found to be content valid with I-CVI scores of.80-1.0 and S-CVI/Ave of.90

4.3.3 Instrument content validity- Ave I-CVI and S-CVI across three vignettes

The content validity for the three clinical vignettes was computed. Content validity for vignettes one, two and three are shown in Table 4.6.

Table 4.6: Content validity of the instrument as determined by expert group (n=10)

Vignette	Ave I-CVI	S-CVI/ave
Vignette One	.86	.89
Vignette Two	.88	.93
Vignette Three	.92	.90
	.88	**.90**

The average I-CVI across three vignettes was .88 and the S-CVI/Ave .90 Thus the instrument was considered content valid.

4.4 PHASE TWO RESULTS

4.4.1 Sample characteristics

The coded demographic data collected from the nurses who participated in the study and completed and returned the instrument (n=136) in six ICU (n=6) units in two tertiary healthcare institutions in Gauteng were entered into the SPSS statistical computer programme, frequencies calculated and valid percentages computed. Nurses who did not answer the question, or who answered the choice given of "I don't Know" were taken into account by the programme, and the frequencies and means calculated on the actual number of nurses who answered the question (valid number). Missing data were coded as 99.

Frequency distribution revealed two groups of nurses of equal numbers:
ICU qualified nurses (n=68)
Non- ICU qualified nurses (n=68)

The non-ICU qualified nurses formed a further three categories according to their training background and qualifications.

a) ICU experienced registered nurses (n=36)
b) ICU students (n=11)
c) Enrolled nurses (n=20)
d) Other (n=1) (enrolled nurse who was helping out in ICU and participated in the research but does not normally work in ICU. For the purpose of the study further analyses of data included the nurse in the non-ICU qualified group of enrolled nurses. Thus data analyses and results are reported on twenty one enrolled nurses.

Of the nurses from the two tertiary healthcare institutions 50% (n=68) were ICU qualified, and 50% (n=68) were non-ICU qualified nurses. Of the non-ICU qualified nurses 26.5% (n=36) were registered nurses with ICU experience, 8% (n=11) were ICU students either at the end of

their year course or half way through the course, and 14.8 % (n=21) were enrolled nurses. (Figure 4.2)

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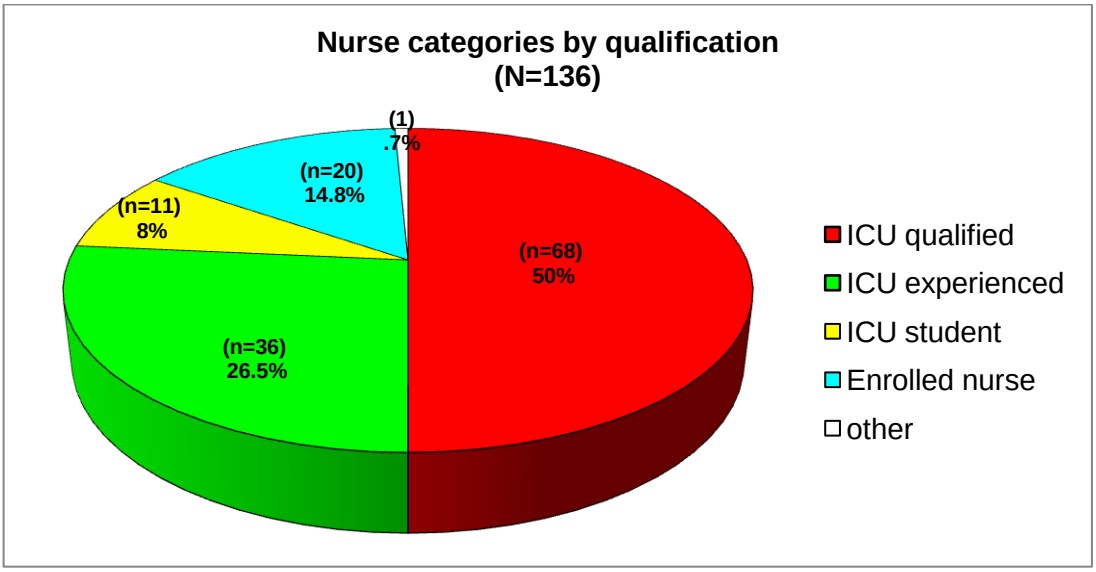


Figure 4.2: Nurse categories by qualification

4.4.2 Nurses' years of experience in the ICU

One hundred and seventeen (n=117) 86,02% nurses answered the question relating to years of experience in the ICU of which 55.6% (n=65) were Intensive care qualified and 44.4% (n=52) were non-intensive care qualified. The intensive care qualified nurses' years of experience was calculated from the year they qualified as intensive care nurses, and the non-intensive care qualified nurses for the total number of years they had spent in ICU. Analysis of the data revealed that of the intensive care qualified nurses,(n=65) 27.7% (n=18) had 1-2yrs experience, 26.1% (n=17) had 3-5yrs experience in ICU, 18.5% (n=12) had 6-11 years experience, and 27.7.% (n=18) had >11 years experience in the ICU. Further analysis revealed that 53.8% (n=35) of intensive care qualified nurses had worked in the ICU for 1-5yrs. With regard to non- intensive care qualified nurses,(n=52) 55.8% (n=29) had 1-2 years experience in the ICU, 17.3% (n=9) had 3-5yrs, and the remaining 26.9.1% (n=14) had 6->11years experience. Figure 4.3 shows the years of intensive care experience of intensive care qualified and non- intensive care qualified nurses.

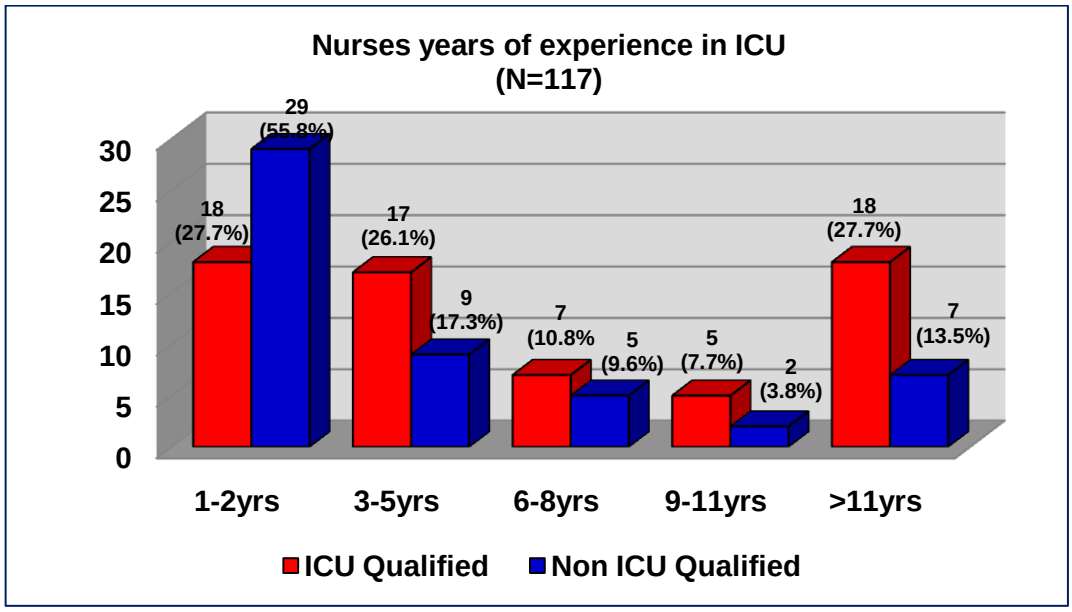


Figure 4.3: ICU qualified and non- ICU qualified nurses' years experience in ICU

4.4.3 Age distribution

Sixty Six ICU qualified and 55 non-ICU qualified nurses (n =121) answered the question relating to current age.

Of the ICU qualified nurses (n=66) 1.5% (n=1) were 20-30yrs, 36.4% (n=24) and 40.9% (n=27) were 41-50 years , with 18.2% (n=12) being 51-60 years. Three percent (n=2) nurses were found to be >60yrs of age. The non-ICU qualified nurses' results showed 18.2% (n=10) were 20-30yrs of age, 32.7% (n=18) were 31-40 years of age, 38.2% (n=21) were 41-50yrs of age. Seven point three percent (n=4) were 51-60 years of age and 3.6% (n=2) were >60years of age. The greater number of nurses in both groups were in the age range of 31-50 years.

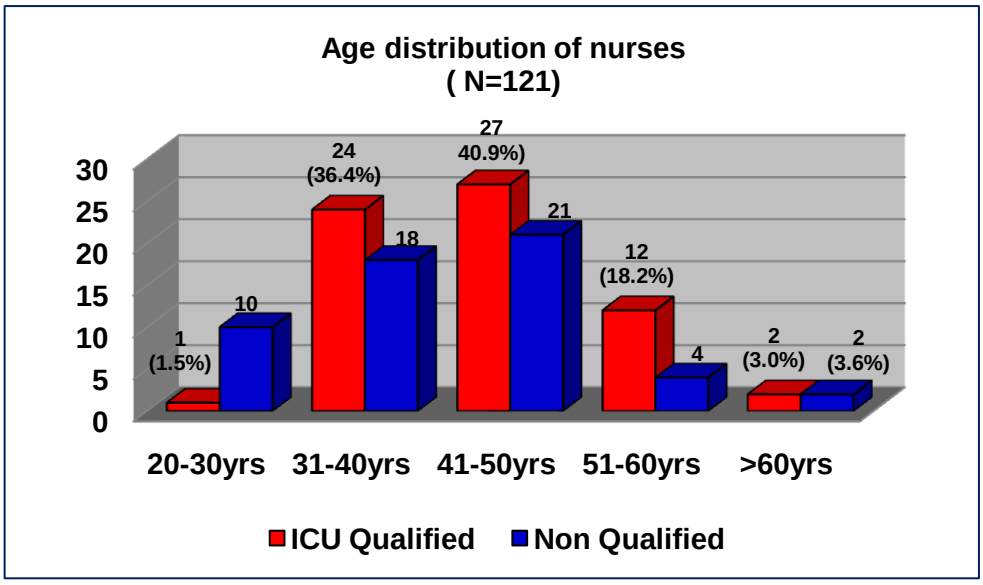


Figure 4.4: Age distribution of nurses

4.4.4 Nurses working overtime as agency nurses

Nurses were asked whether they work extra shifts as agency staff on their days/nights off (moonlight). The results showed that 84% of ICU qualified staff and 67% of non-ICU qualified staff worked as permanent members of staff in a hospital but also “moonlighted” (see Table 4.8 question 8).

4.4.5 Data analysis with regard to position held in the unit by nurses and requirement to take charge of the ICU

In respect of the question asking the position the nurse held in the ICU unit, 115 responses were received (n=115) of which 63 (54.7%) were ICU qualified nurses and 52 (45.2%) were non- ICU qualified nurses. Table 4.7 shows that unit managers (n=9) were all ICU qualified, whilst 65% (n=41) of ICU qualified nurses and 13.5% (n=7) of non qualified nurses were shift leaders in the ICU. There was a total of 6% (n=7) clinical facilitators within the sample of one hundred and fifteen nurses. Four (n=4) (6.4%) of the facilitators were ICU qualified whilst 5.7% (n=3) were non-ICU qualified. When asked if they were required to take charge of shifts sixty seven (n=67) ICU qualified and sixty six (n=66) responded (n=133) to the question. Sixty two point two percent (n=43) of ICU qualified nurses and 30.4% (n=20) of non- qualified nurses replied in the affirmative. Eighteen of the ICU qualified nurses (n=18) (26.9%) and 16.6 % (n=11) of non- qualified nurses responded that they sometimes have to take charge of the ICU. Thus a total of 69.1% nurses were deemed to be sufficiently competent to undertake the responsibility of taking charge of the ICU Unit. The results of the nurses’ position in ICU and requirement to take chart are summarized in Table 4.7

Table 4.7: **Frequency distribution of nurse’s position in ICU and requirement to take charge**

Question	**ICU Qualified N=63**	**Non ICU Qualified N=52**
Position in the ICU ▪ Manager ▪ Shift Leader ▪ Clinical facilitator ▪ Bedside nurse	 N=9 (14.3%) N=41 (65.0%) N=4 (6.4%) N=9 (14.3%)	 N=7 (13.5%) N=3 (5.7%) N=42 (80.8%)
Question	**ICU Qualified N=67**	**Non ICU Qualified N=66**
Required to take charge on shifts ▪ YES ▪ NO ▪ Sometimes	 N=43 (64.2%) N=6 (8.9%) N=18 (26.9%)	 N=20 (30.4%) N=35 (53%) N=11 (16.6. %)

A summary of the nurses’ demographic data is shown in Table 4.8

Table 4.8: Summary of demographic data

Question	Qualified Valid Number and Percentage	Non Qualified Valid Number and Percentage
Question 1	**N=68**	**N=68**
Hospital 1 Hospital 2	28 (41%) 40 (59%)	40 (59%) 28 (41%)
Question 2: What is Your Qualification?(N=68)		**N=68**
▪ Diploma ICU ▪ ICU Exp ▪ ICU student ▪ Enrolled nurse ▪ Ward nurse	68(100%)	0 (0%) 36 (52.9%) 11 (16.2%) 20 (29.4%) 1 (1.5%)
Question 3: Year of Qualification (N=64)		**N= 53**
▪ 2003-2008 ▪ 1997-2002 ▪ 1992-1996 ▪ 1983-1991 ▪ 1974-1982	35 (54.6%) 12 (18.8%) 12 (18.8%) 5 (7.8%) Nil	20 (37.7%) 11 (20.8%) 13 (24.5%) 3 (5.7%) 6 (11.3%)
Question 4: How Long Worked in ICU before ICU Qualification (N=63)		
▪ 1-2yrs ▪ 3-5yrs ▪ 6-8yrs ▪ 9-11yrs ▪ >11yrs	28 (44.4%) 23 (36.5%) 8 (12.7%) 1 (1.6%) 3 (4.8%)	N/A
Question 5: How Long Worked in ICU since Attaining ICU Qualification (N=65)		
▪ 1-2yrs ▪ 3-5yrs ▪ 6-8yrs ▪ 9-11yrs ▪ .11yrs	18 (27.7) 17 (26.2%) 7 (10.7%) 5 (7.7%) 18 (27.7%)	N/A
Question 6: How Long been working in ICU		**(N=52)**
▪ 1-2yrs ▪ 3-5yrs ▪ 6-8yrs ▪ 9-11yrs ▪ >11yrs	N/A	29 (55.8%) 9 (17.3%) 5 (9.6%) 2 (3.8%) 7 (13.5%)
Question 7: Do You Work Full Time (N=67)		**(N=67)**
▪ Yes ▪ No ▪ Agency only	64 (95.5%) 3 (4.5%)	48 (71.6%) 4 (6%) 15 (22.4%)
Question 8: Full Time Employee and do Agency Shifts (N=66)		**(N=63)**
▪ Yes ▪ No	56 (84.8%) 10 (15.2%)	43 (68.3%) 20 (31.7%)

In Section three of the demographic data questions were asked so as to ascertain that the nurses' own perceptions of his/her level of understanding and level of competence in mechanical ventilation (refer appendex 3 Section three question 7). (appendix three Section 3 question 10). A question relating to autonomous changing of ventilator settings was asked (refer appendix 3 Section three question 8). A further question relating to the nurses' position in the ICU at the time of the study was included (Refer appendix 3 Section one, question 7 and Section two question 6). The results for the four questions are presented in phase two, together with the vignette score results, in order that a comparison can be made between the actual competence levels of the nurses and the nurses perceptions of their own competence levels, and congruence of competence with levels of responsibility undertaken in the ICU with regards to mechanical ventilation

4.5 RESULTS OF NURSES LEVELS OF COMPETENCE IN MECHANICAL VENTILATION

4.5.1 Vignette one: nurses' level of competence in mechanical ventilation of the patient without lung pathology

Vignette one was based upon a scenario and questions relating to the patient who had no lung pathology and required only post operative ventilation. The vignette included questions on basic mechanical ventilator settings, everyday diagnostic tests such as ABGs, assessing common problems such as circuit leaks, knowing the differences between volume and pressure control ventilation, and weaning the patient from the ventilator and extubation. The vignette consisted of 13 questions relating to the scenario and the highest score achievable was 13/13. The set competency of 75% was achieved in four questions (n=4) as depicted by the ringed percentages within the ICU qualified group of nurses as shown in Table 4.6. Within the non ICU qualified group of nurses, the CI of 75% was not attained in any of the questions. Neither the ICU Qualified group of nurses nor the non-ICU qualified group of nurses achieved the CI of 75% for vignette one

Results of nurses' competence levels of mechanical ventilation of the patient without lung pathology are summarised in Table 4.9

Table 4.9: Summary of results for vignette one

Question	Response	ICU Qualified Valid Number Frequency Valid Percentage	Non Qualified Valid Number Frequency Valid Percentage
1	Correct	67 55 82.1%	67 49 73.1%
2	Correct	68 58 85.3%	65 46 70.8%
3	Correct	67 30 44.8%	65 25 38.5%
4	Correct	67 24 35.8%	60 18 30%
5	Correct	67 21 31.3%	57 20 35.1%
6	Correct	57 10 17.5%	28 8 28,6%
7	Correct	57 26 45.6%	28 7 25 %
8	Correct	57 10 17.5%	29 4 13.8%
9	Correct	57 10 17.5%	28 5 17.8%
10	Correct	65 54 83.1%	66 30 45.4%
11	Correct	66 45 68.2%	65 40 61.5%
12	Correct	66 46 69.7%	62 31 50%
13	Correct	67 53 79.1%	65 37 56.9%

The results of Vignette one were further analysed and show the ICU qualified nurses' (n=68) level of competence with regard to mechanical ventilation of the patient with no lung pathology to be average, as determined by a mean score of 50% (34; SD 18.5), whilst the non- qualified ICU nurses (n=68) scored 38% (24; SD 15.7), indicating a poor level of competence. The mean scores for the three sub categories of non-ICU qualified nurses for vignette one were as follows: registered nurses with ICU experience (n=36) 39% indicating a poor level of

competence; ICU students (n=11) 51%, indicating an average level of competence, and enrolled nurses (n=21) 22%, indicating a poor level of competence. It should be noted that enrolled nurses with an overall score of 22% formed 30% of the total number of non-qualified nurses (n=68) who administer direct care to the ventilated patient. The ICU students who participated in the study were either part of a group who had completed the ICU course and were awaiting results, whilst the others were six months into their ICU course and had undertaken their respiratory teaching block and had had experience in the ICU units. Competence levels regarding mechanical ventilation for the patient with no lung pathology amongst ICU qualified nurses, non-ICU qualified nurses as a group, and sub categories of non- ICU qualified nurses are shown in Figure 4.5.

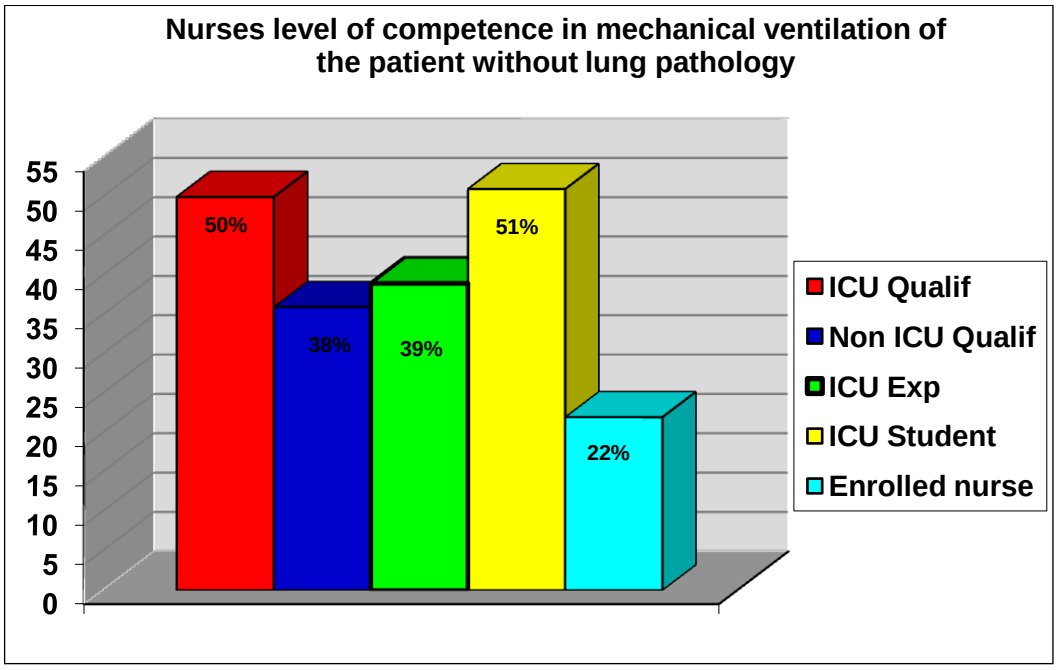


Figure 4.5: Nurses level of competence for vignette one

A scatter plot of individual scores achieved for vignette one by the ICU qualified nurses and non-ICU qualified nurses are shown in Figures 4.6 and 4.7. The lowest score was 1 and the highest 11 with a range of 10, (6.2; SD 2.25) for the ICU qualified group of nurses. For the non-ICU qualified nurses the lowest score was 0 and the highest 11 with a range of 11 (4.6; SD 2.41)

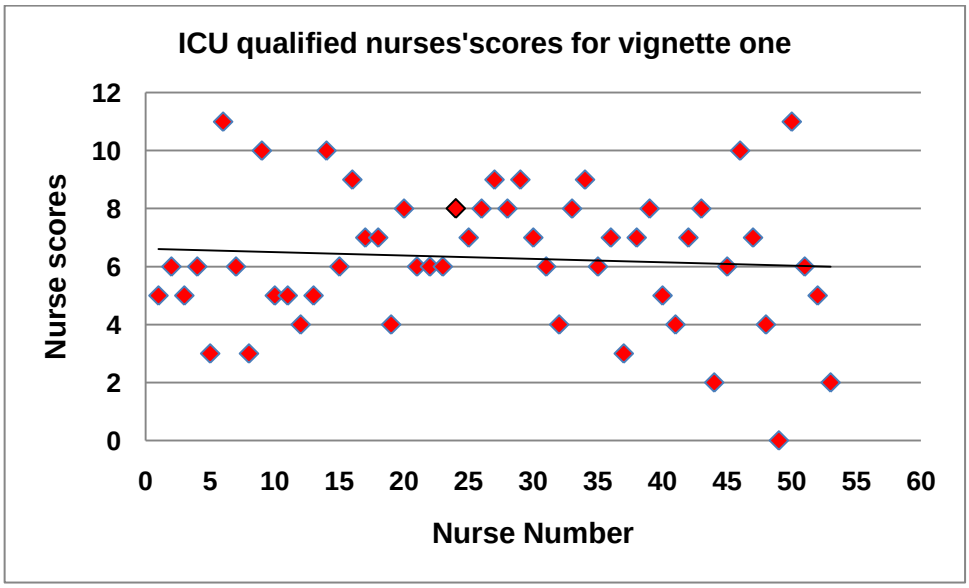


Figure 4.6: ICU qualified nurses' individual scores for vignette one

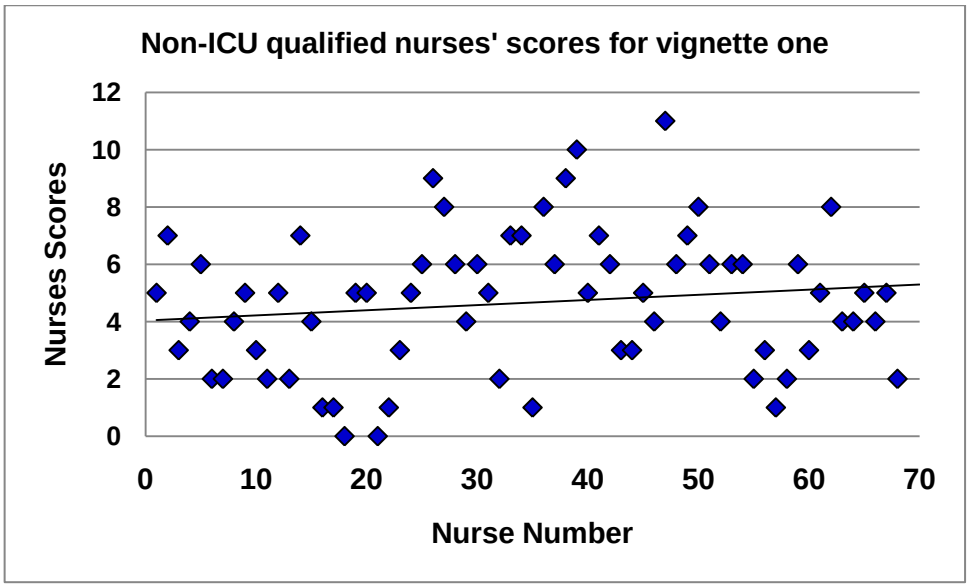


Figure 4.7: Non-ICU qualified nurses' individual scores for vignette one

A comparative analysis of scores of non-qualified sub-categories of nurses (ICU experienced, ICU students, enrolled nurses) using one way ANOVA, showed a significant difference (p=0.000) between the competence levels of the three categories of non-qualified nurses as shown in Table 4.10 for vignette one. Post Hoc tests were not performed for the non-qualified group of nurses for vignette one as at least one of the groups had less than two cases

Table 4.10: Comparative analysis of non -ICU qualified nurses' level of competence for vignette one

Non Qualified Nurses	Sum of Squares	df	Mean Square	F	Sig
Vignette One					
Between Groups	7299.221	3	2433.074	9.735	0.000
Within groups	15996.015	64	249.938		
Total	23295.235	67			

The competence levels for both groups of nurses, ICU qualified and non-ICU qualified were below the set competency of 75% for vignette one. There was no significant difference between the competence levels of the ICU qualified nurses between the two tertiary healthcare institutions for vignette one (p=0.997). However a significant difference existed between the competence levels of the non-ICU qualified nurses between hospitals when an independent samples test was computed. (p=0.046) as shown in Table 4.11.

Table 4.11: Competence level difference between non- ICU qualified nurses in two tertiary healthcare institutions for vignette one

	Levene's Test for Equality of Variances	t-Test for Equality of Means							
									95% Confidence Interval of the Difference
	F	**Sig**	**t**	**df**	**Sig (2tailed)**	**Mean Diff**	**Std Error Diff**	**Lower**	**Upper**
NQvigtwo Equal Variances Assumed	0.082	.776	-2.036	66	0.046	9.143	-4.490	18.108	-178

Further analyses using a two sample t-test found a significant difference between the non- ICU qualified experienced nurses and the ICU students (p=0.049) levels of competence with the ICU students scoring higher (51%) than the non- ICU qualified experienced nurses (38%) as shown in Table 4.12.

Table 4.12: Comparative analysis of competency levels differences between non- ICU qualified experienced nurses and ICU students for vignette one

	Levene's Test for Equality of Variances	t-Test for Equality of Means							
									95% Confidence Interval of the Difference
	F	**Sig**	**t**	**df**	**Sig (2tailed)**	**Mean Diff**	**Std Error Diff**	**Lower**	**Upper**
NQvigtwo Equal Variances Assumed	.312	.579	-3.300	45	0.002	-27.263	8.263	-43.904	-10.621

A significant difference was found between the competency levels of the non-ICU qualified experienced nurses (scored 39%) and enrolled nurses (scored 22%) (p=0.000) as shown in Table 4.13.

Table 4.13: Comparative analysis of competency levels between non-ICU qualified experienced nurses and enrolled nurses for vignette one

	Levene's Test for Equality of Variances	t-Test for Equality of Means							
									95% Confidence Interval of the Difference
	F	**Sig**	**t**	**df**	**Sig (2tailed)**	**Mean Diff**	**Std Error Diff**	**Lower**	**Upper**
NQvigtwo Equal Variances Assumed	.396	.532	-4.042	54	0.000	-17.539	4.339	8.839	26.239

A further significant difference was also found between the competence levels of the ICU students (scored 51%) and enrolled nurses (scored 22%) (p=0.000) as shown in Table 4.14.

Table 4.14: Comparative analysis of competency levels between ICU students and enrolled nurses for vignette one

	Levene's Test for Equality of Variances	t-Test for Equality of Means							
									95% Confidence Interval of the Difference
	F	**Sig**	**t**	**df**	**Sig (2tailed)**	**Mean Diff**	**Std Error Diff**	**Lower**	**Upper**
NQvigtwo Equal Variances Assumed	.460	.503	5.137	29	0.000	-29.059	5.657	--17.490	40.628

Further analyses using one way ANOVA showed that neither age nor years experience influenced the competence levels for either the ICU qualified nurses (p=0.438) or non ICU qualified nurses (p=0.703) for vignette one.

An independent two sample t-test showed no significant difference between the levels of competence between the ICU qualified and non-ICU qualified nurses (p=0.176) regarding mechanical ventilation of the patient with no lung pathology.

4.5.2 Vignette two:nurses' level of competence in mechanical ventilation of the patient with ARDS lung pathology

Vignette two related to the patient with ARDS. The clinical scenario related to basic mechanical ventilation of the patient with ARDS, and questions included, pertained to small tidal volumes (4-8mls/kg/wt) and a plateau pressure under 35cm/H_2O (protective lung strategy) (Tobin, 2001). A question on PEEP was included as the role of PEEP is considered important in recruiting collapsed alveoli as well as a question on recruitment and proning as these procedures are commonly used in the ICU in the academic units (Burns 2005; Hering, 2001). Interpretation of ventilator graphics is essential in order to optimize ventilator settings for the ARDS patient and as such a ventilator graphic was included in the scenario.

The set competency of 75% was achieved in 50% (Questions 2,4,5) of the questions by the ICU qualified nurses as depicted by the ringed percentages within the ICU qualified group (Refer Table 4.15). Within the non- ICU qualified group of nurses the set competency of 75%

was not achieved in any of the questions. Neither the ICU qualified nor the non-ICU qualified groups of nurses achieved an overall competenct of 75% for vignette two.

Results of nurses' levels of competence in mechanical ventilation of the patient with ARDS lung pathology.are summarized in Table 4.15

Table 4.15: Summary of results for vignette two

Question	Response	ICU Qualification Valid number Frequency Valid Percentages	Non ICU Qualification Valid Number Frequency Valid percentages
1	Correct	67 19 28.3	61 11 18%
2	Correct	66 60 90.9%	52 35 67.3%
3	Correct	65 38 58.5%	57 17 29.8%
4	Correct	67 50 74.6	63 27 42.8%
5	Correct	67 62 92.5%	63 40 63.5%
6	Correct	65 7 10.8%	62 11 17.7%

The competence levels for ICU qualified nurses, and non- ICU qualified nurses, and sub categories of non- ICU qualified nurses for vignette two are shown in Figure 4.8.

Whilst the competence level of 75% was achieved in three of the individual questions by the ICU qualified nurses,neither the ICU qualified nor the non- ICU qualified groups of nurses achieved an average score of 75% for vignette two thus the set competence level of 75% for vignette two was not achieved by either group. The ICU qualified nurses (n=68) level of competency in mechanical ventilation for the ARDS lung was shown to be average as determined by a score of 58% (3.47; SD 1.05) for vignette two, whilst the non ICU qualified nurses (n=68) level of competence in mechanical ventilation for the ARDS lung was shown to be poor as determined by a score of 35% (2.07; SD 1.66). The competency levels for the sub-categories of non- qualified categories for vignette two were as follows: registered nurses with ICU Experience (n=36) 37% indicating a poor level of competence; ICU students(n=11) 64%, indicating a good level of competence, and the enrolled nurses (n=20) 17% indicating a poor level of competence. The ICU students (n=11) achieved the highest score (64%), and were either part of a group who had completed the ICU course and were awaiting results, whilst the

others were six months into their ICU course and had undertaken their respiratory theory block and had experience in the ICU units. The enrolled nurses who comprised 30% of the non qualified group scored 17% and again achieved the lowest scores. Nurses' level of competence for vignette two are shown in Figure 4.8

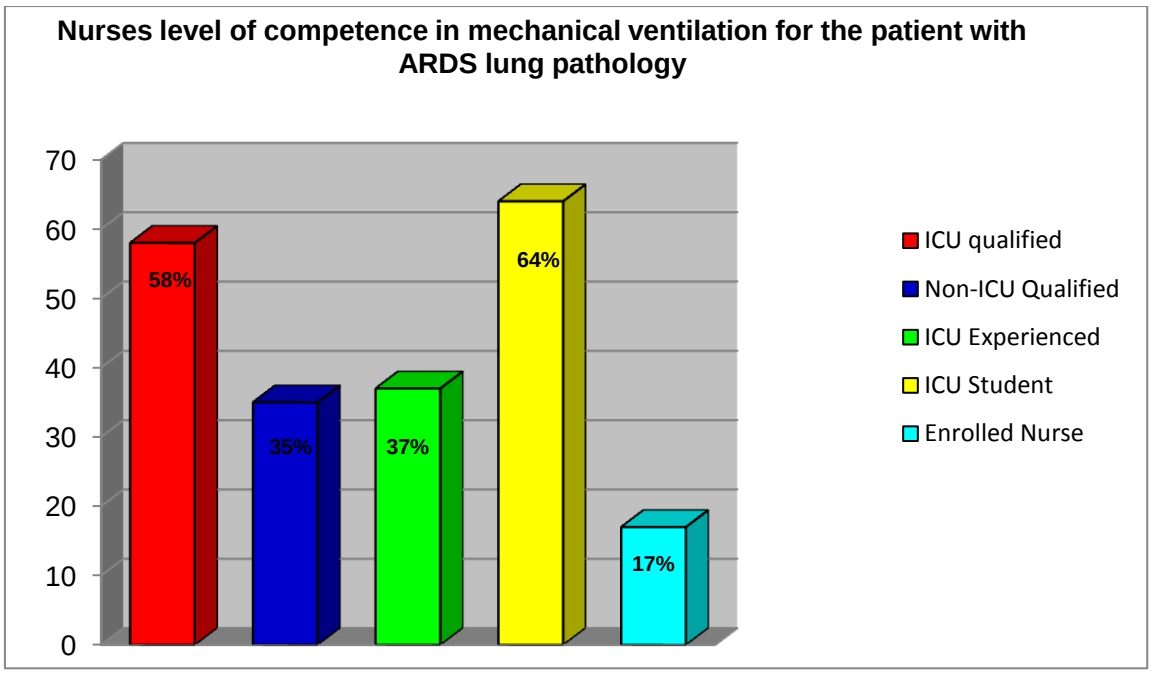


Figure 4.8: Nurses' level of competence for vignette two

Individual scores for vignette two for the ICU qualified and non-ICU qualified nurses are shown in scatter plots in Figures 4.9 and 4.10. The lowest score for the ICU qualified nurses for vignette two was 0 and the highest was 5 with a range of 5, (3.47; SD of 1.05). The lowest score obtained by the non-qualified group was 0 and the highest 6 with a range of 6, (2.07; SD 1.66).

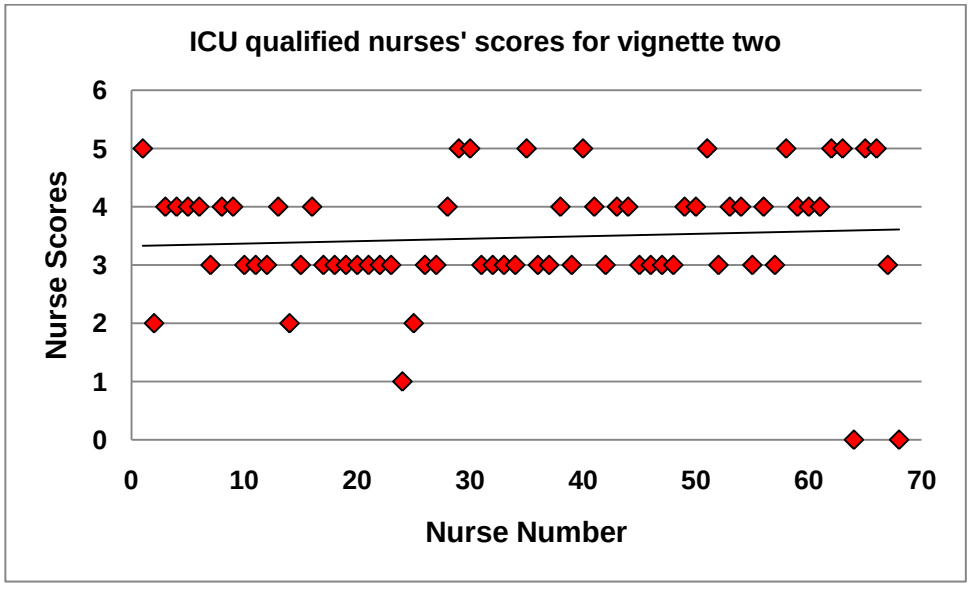


Figure 4.9: ICU qualified nurses' individual scores for vignette two

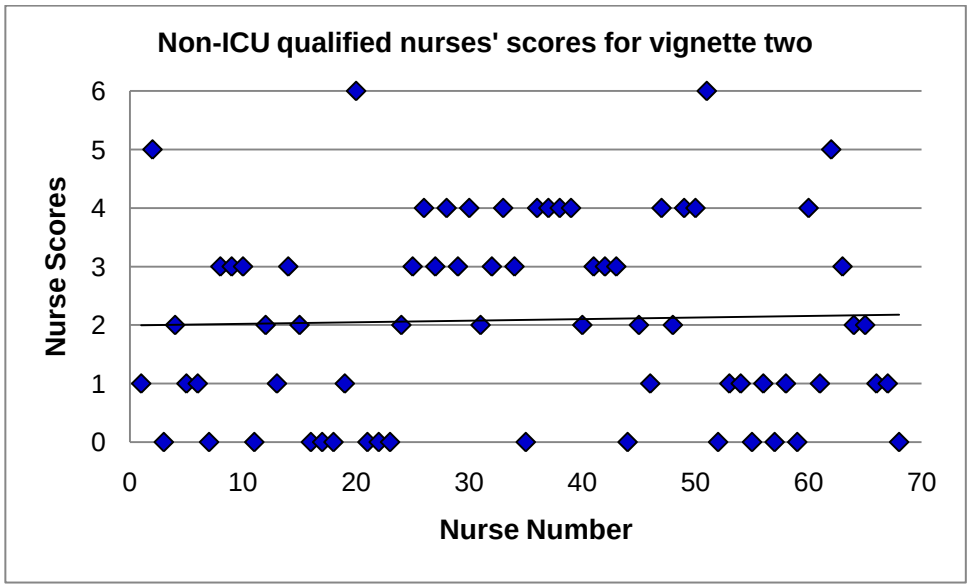


Figure 4.10: Non- ICU qualified nurses' individual scores for vignette two

A comparative analysis of scores of non qualified subcategories of nurses (ICU experienced, ICU students, enrolled nurses) using one way ANOVA, showed a significant difference (p=0.000) between the competence levels of the three categories of non qualified nurses as shown in Table 4.16

Table 4.16: Comparative analysis of non-ICU qualified nurses' level of competence for vignette two.

Non Qualified nurses	Sum of squares	df	Mean square	F	Sig
Vignette two Between Groups Within groups Total	 17062.334 34251.725 51314.059	 3 64 64	 5687.445 535.183	10.627	.000

There was no significant difference between the competence levels of the ICU qualified nurses (p=0.097) or the non- ICU qualified nurses (p= 0.231) between the two tertiary healthcare institutions for vignette two.

A two sample t-test found a significant difference between the non-ICU qualified experienced nurses and ICU students (p=0.002) levels of competence with regard to mechanical ventilation of the patient with ARDS lung pathology. (Table 4.17)

Table 4.17: Comparative analysis between non- ICU qualified experienced nurses and ICU students' levels of competence for vignette two

	Levene's Test for Equality of Variances	t-Test for Equality of Means							
									95% Confidence Interval of the Difference
	F	**Sig**	**t**	**df**	**Sig (2tailed)**	**Mean Diff**	**Std Error Diff**	**Lower**	**Upper**
NQvigtwo Equal Variances Assumed	.312	.579	-3.300	45	0.002	-27.263	8.263	-43.904	-10.621

Further analyses showed a significant difference between non-ICU qualified experienced nurses and enrolled nurses levels of competence (p=0.003), as shown in Table 4.18.

Table 4.18: Comparative analysis between non-ICU qualified experienced nurses and enrolled nurses' level of competence for vignette two

	Levene's Test for Equality of Variances	t-Test for Equality of Means							
									95% Confidence Interval of the Difference
	F	**Sig**	**t**	**df**	**Sig (2tailed)**	**Mean Diff**	**Std Error Diff**	**Lower**	**Upper**
NQvigtwo Equal Variances Assumed	1.254	.268	3.098	54	0.003	19.756	6.378	6.969	32.542

Further analyses showed a significant difference between competence levels of qualified ICU students and enrolled nurses (p=0.000) as shown in Table 4.1

Table 4.19: Comparative analysis between ICU Students and enrolled nurses' competence levels for vignette two

	Levene's Test for Equality of Variances	t-Test for Equality of Means							
									95% Confidence Interval of the Difference
	F	**Sig**	**t**	**df**	**Sig (2tailed)**	**Mean Diff**	**Std Error Diff**	**Lower**	**Upper**
NQvigtwo Equal Variances Assumed	.069	.794	5.625	29	0.000	47.018	8.359	29.923	64.113

Further analysis using one way ANOVA showed that neither age nor experience influenced the levels of competence for vignette two, for either the ICU qualified nurses (p=0.566) or the non-ICU qualified nurses (p=0.237).

An independent two samples t-test showed no difference between the scores for vignette two between the ICU qualified and non- ICU qualified nurses (p=3.25).

4.5.3 Vignette three: nurses' level of competence in mechanical ventilation of the patient with obstructive outflow lung pathology

The scenario for vignette three related to the patient with acute exacerbation of asthma and the ventilation strategies and settings required for the patient with obstructive outflow. The basics of ventilating the patient with COPD is to ensure that the expiratory time is set to prevent stacking of the breaths (auto-PEEP). The COPD patient also requires a slower mandatory ventilation rate, and is often ventilated in volume control. The consequence of incorrect ventilator settings on the ventilator, for the asthmatic patient, especially with regard to the I:E ratio and mandatory breath rate, is auto-PEEP, which if not diagnosed timeously can be quickly fatal. It is essential that nurses who care for mechanically ventilated patients understand that different lung pathologies require different settings and strategies.

The competency of 75% or more was achieved in one question (n=1) as depicted by the ringed percentages within the ICU qualified group of nurses. Within the non-ICU qualified group of nurses, the CI of 75% was not attained in any of the questions.

A summary of the results of vignette three are presented in the Table 4.20.

Table 4.20 Summary of results for vignette three

Question	Response	ICU Qualification Valid Number Frequency Valid Percentages	Non ICU Qualification Valid number Frequency Valid Percentage
1	Correct	62 48 77.4%	44 31 70.5%
2	Correct	61 36 59%	55 19 34.5%
3	Correct	61 38 62.3%	57 16 28.1%
4	Correct	60 13 21.7%	56 12 21.4%
5	Correct	59 12 20.3%	55 8 14.5%
6	Correct	50 5 10%	39 1 2.6%

The mean scores, for ICU qualified nurses, non-ICU qualified nurses as a group, and sub categories of non- ICU qualified nurses are shown in Figure 4.11

Results showed the ICU qualified nurses' (n=68) level of competence with regard to mechanical ventilation of the patient with obstructive outflow pathology of the lungs to be poor as determined by a score of 37% (2.23; SD 1.3) for vignette three, whilst the non-ICU qualified nurses (n=68) scored 21% (1.27; SD 1.20) indicating a poor level of knowledge. The levels of competence for the non-ICU qualified categories of nurses for vignette three were as follows: Non-ICU qualified nurses with ICU experience (n=36) 24% indicating a poor level of competence; ICU students (n=11) 29%, indicating a poor level of competence and the enrolled nurses (n=20) 13%, indicating a poor level of competence. It should be noted that the enrolled nurses with a score of 13% formed 30% of the total number of non qualified nurses (n=68) who care for the mechanically ventilated patient. The ICU students (n=11) were either part of a group who had completed the ICU course and were awaiting results whilst the others were six months into their ICU course and had undertaken their respiratory theory block and had experience in the ICU units.

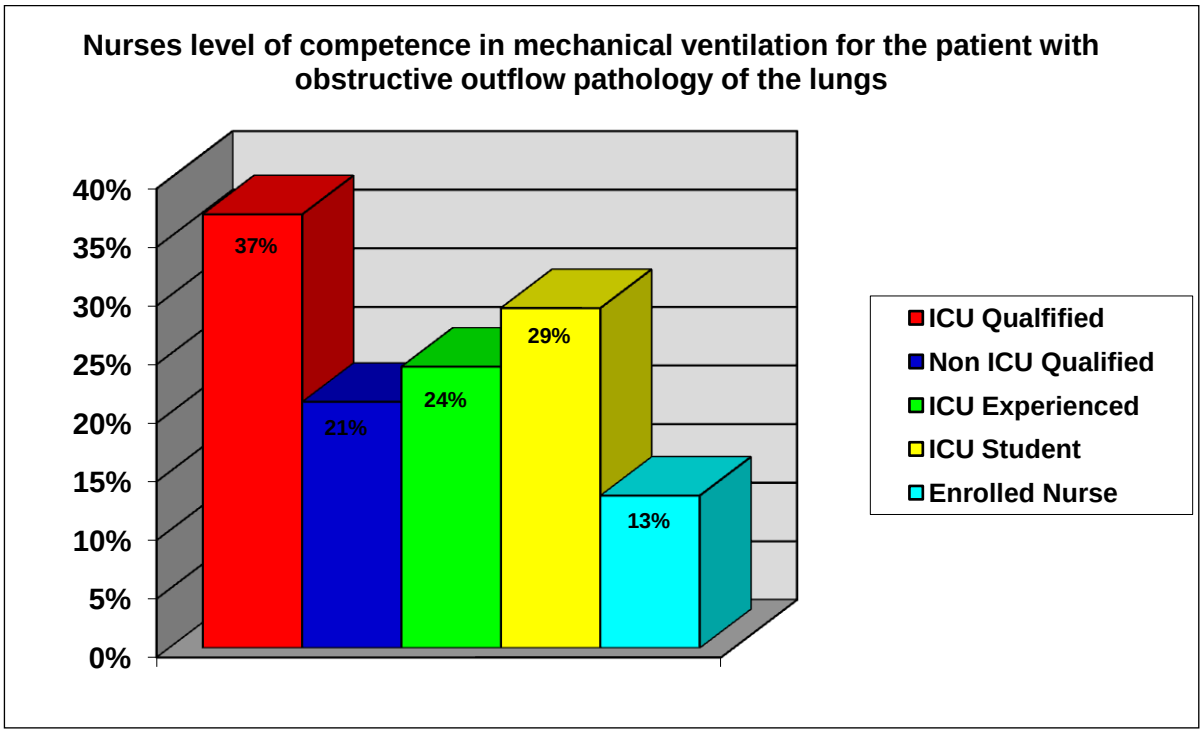


Figure 4.11: Nurses' level of competence for vignette three

All the nurse categories showed competence levels well below the competency indicator of 75%.

Scatter graphs for vignette three for the ICU qualified nurses and non-ICU qualified nurses are shown in Figures 4.12 and 4.13.

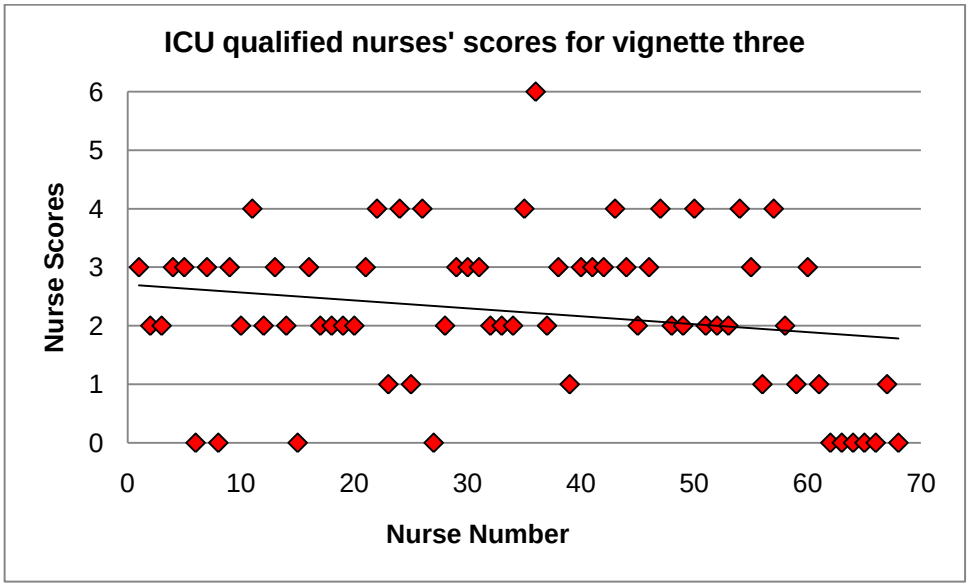


Figure 4.12: ICU qualified nurses' individual scores for vignette three

The lowest score was 0 and the highest 6 with a range of 5.(2.23; SD 1.31).

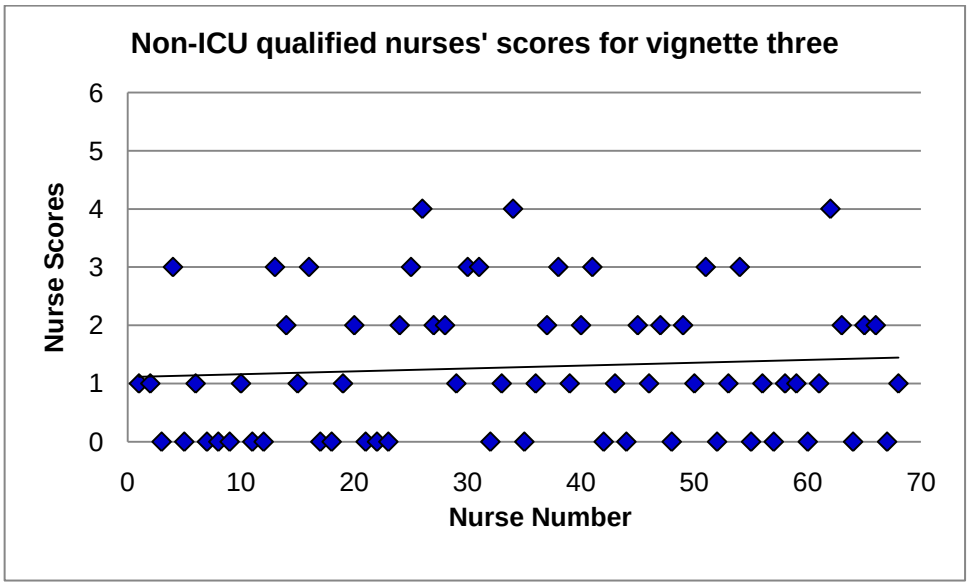


Figure 4.13: Non- ICU qualified nurses' individual scores for vignette three

The lowest score was 0 and the highest 4 with a range of 3, (1.27; SD 1.19).

A comparative analysis of competency levels between non-qualified subcategories of nurses (ICU experienced, ICU students, enrolled nurses) using one way ANOVA, showed no significant difference within and between groups in vignette three. (p= 0.113) as shown in Table 4.21.

Table 4.21: Comparative analysis of sub-category non-qualified ICU nurses' level of competence for vignette three

Non Qualified Nurses	Sum of Squares	df	Mean Square	F	Sig
Vignette three Between Groups Within groups Total	 2357.688 23936.163 26293.851	 3 63 66	 785.896 379.939	2.068	0.113

There was no significant difference between competence levels of the ICU qualified nurses between the two tertiary healthcare institution hospitals for vignette three (p= 0.997) or between the non-ICU qualified nurses' level of competence between the two tertiary healthcare institutions.(p=0.714).

A two sample t-test showed no significant difference between the competence levels of the non-qualified ICU experienced and ICU students for vignette three. (p=0.521) as shown in Table 4.22.

Table 4.22: Comparative analysis between non-ICU qualified experienced nurses and ICU student's competence levels for vignette three

	Levene's Test for Equality of Variances	t-Test for Equality of Means							
									95% Confidence Interval of the Difference
	F	**Sig**	**t**	**df**	**Sig (2tailed)**	**Mean Diff**	**Std Error Diff**	**Lower**	**Upper**
NQvigtwo Equal Variances Assumed	5.129	.028	.647	45	0.521	-4.485	6.932	-18.448	9.478

No significant difference was shown between the competence levels of the ICU experienced nurses and enrolled nurses (p=0.086) as shown in Table 4.23.

Table 4.23: Comparative analysis between non-ICU qualified experienced nurses and enrolled nurses' competence levels for vignette three

	Levene's Test for Equality of Variances	t-Test for Equality of Means							
									95% Confidence Interval of the Difference
	F	**Sig**	**t**	**df**	**Sig (2tailed)**	**Mean Diff**	**Std Error Diff**	**Lower**	**Upper**
NQvigtwo Equal Variances Assumed	2.730	.104	1.751	53	0.086	10.175	5.813	-1.483	21.834

However, t-test analysis revealed a significant difference between the scores of ICU student nurses and enrolled nurses (p=0.024) for vignette three as shown in Table 4.24.

Table 4.24: Comparative analyses between ICU students and enrolled nurses' levels of competence for vignette three

	Levene's Test for Equality of Variances	t-Test for Equality of Means							
									95% Confidence Interval of the Difference
	F	Sig	t	df	Sig (2tailed)	Mean Diff	Std Error Diff	Lower	Upper
NQvigtwo Equal Variances Assumed	.516	.478	2.383	28	0.024	14.660	6.151	2.061	27.260

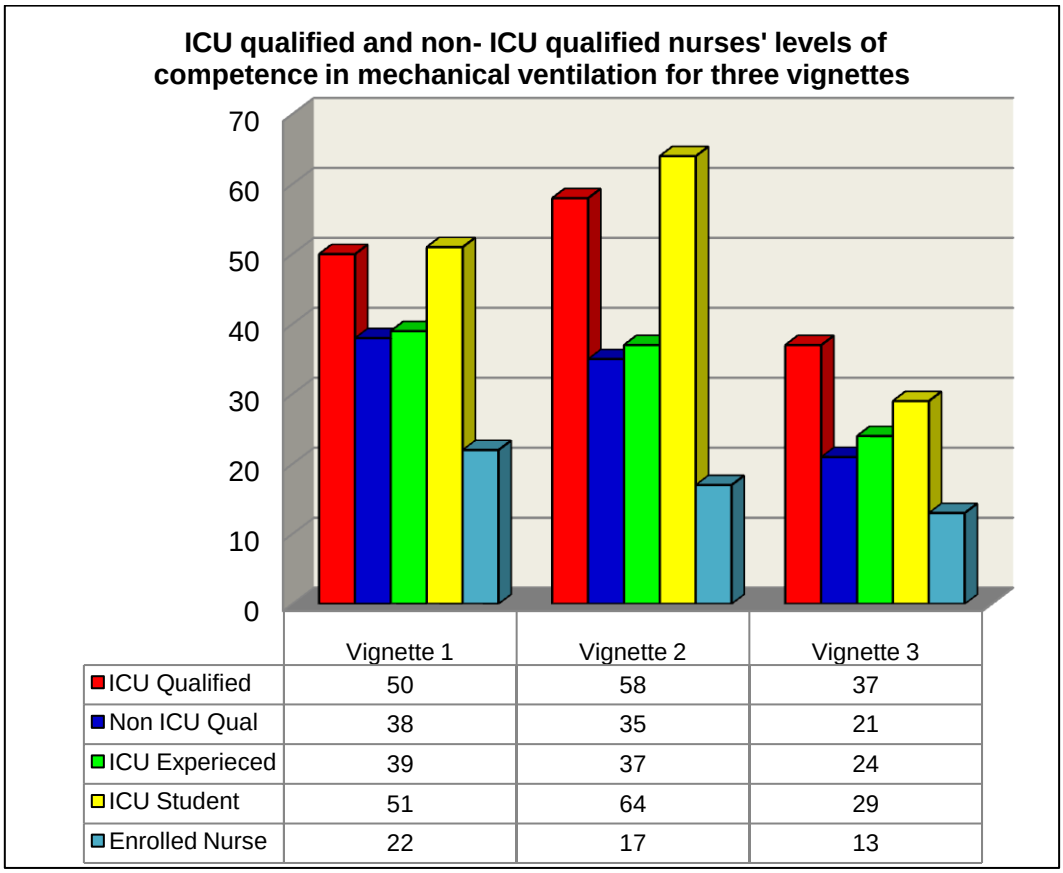
One way ANOVA showed that experience levels had no influence on competency levels within the non-ICU qualified nurses (p=0.388), however age influenced the competence levels of the non-ICU qualified nurses for vignette three (p=0.010). Within the ICU qualified group of nurses experience had a significant influence on the competency levels for vignette three as determined by one-way ANOVA (p=0.036) whilst age did not influence the competence levels for vignette three when one-way ANOVA was computed (p=0.877).

A two sample t-test showed there was no significant difference between the competence levels with regard to mechanical ventilation of the patient with obstructive outflow pathology between the ICU qualified nurses (p=0 .905) and non-ICU qualified nurses (p=0.348) within the two tertiary healthcare institutions.

A two sample t-test showed no significant differences between the competency levels for vignette three between ICU qualified and non ICU qualified nurses (p=1.25)

4.6 SUMMARY OF RESULTS FOR NURSES' LEVEL OF COMPETENCE IN MECHANICAL VENTILATION AS DETERMINED BY THREE CLINICAL VIGNETTES

A summary of the levels of competence levels regarding mechanical ventilation for all categories of nurses for three clinical vignettes is shown in Figure 4.14.



	Vignette 1	Vignette 2	Vignette 3
ICU Qualified	50	58	37
Non ICU Qual	38	35	21
ICU Experieced	39	37	24
ICU Student	51	64	29
Enrolled Nurse	22	17	13

Figure 4.14:Nurses' level of competence in mechanical ventilation for three clinical vignettes

The competence levels of the ICU qualified, non-ICU qualified, and sub categories of non-qualified nurses with regard to mechanical ventilation was found to be well below the set CI of 75% as determined by three clinical vignettes.

The mean scores for the three vignettes were computed for each group of nurses and the results showed all the nurses to have a poor level of competency(<50%) in mechanical ventilation,as shown in Figure 4.15

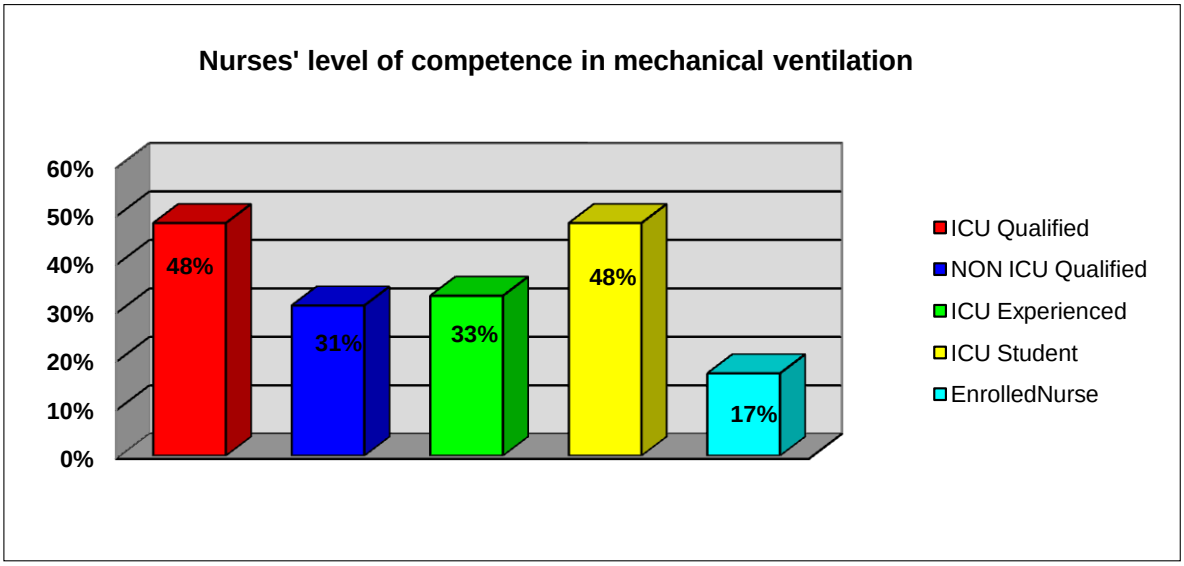


Figure 4.15:Nurses' level of competence in mechanical ventilation

An independent two tailed t-test showed a significant difference between the competence levels of the ICU qualified and non-ICU qualified nurses when computed for the three vignettes. (p=0.039)

4.7 RESULTS OF NURSES' PERCEPTIONS OF THEIR COMPETENCY IN MECHANICAL VENTILATION

Nurses were asked four (n=4) questions with regard to their perception of their own level of competence with regard to mechanical ventilation, position held in the ICU, and changing of ventilator settings. The nurses' responses were quantified and presented as percentages, which were then graded according to a grading scale. The nurses' responses were compared to the actual scores achieved by those nurses across the three vignettes

Question one

Do you regard your level of competence in mechanical ventilation to be?

a) Excellent	>75%
b) Very good	70-75%
c) Good	60-69%
d) Average	50-59%
e) Poor	<50%

Sixty six (n=66) ICU qualified nurses and sixty four (n=64) non-qualified-ICU nurses answered the question giving a total number of responses of one hundred and thirty (n=130). Of the ICU qualified nurses 16.7% (n=11) responded they had excellent levels of competence (>75%) in mechanical ventilation; 39.4% (n=26) felt their level of competency in mechanical ventilation was very good (70-75%); 30.3% (n=20) perceived their level of competence as good(60-69%), whilst the remaining nine (n=9) 13.6% ICU qualified nurses felt their competence levels in mechanical ventilation were average to poor (<50-59%)

Of the non-ICU qualified nurses (n=65) 4.6% (n=3) perceived they had excellent levels of competence (>75%) in mechanical ventilation; 10.8 % (n=7) perceived they had very good (70-75%) levels of competence in mechanical ventilation; 50.8 % (n=33) perceived they had good (60-69%) competency levels whilst the remaining twenty two (33.8%) non-ICU qualified nurses (n=22) responded they had poor to very poor (<50%) levels of competency in mechanical ventilation. The results for question one are shown in Figure 4.16.

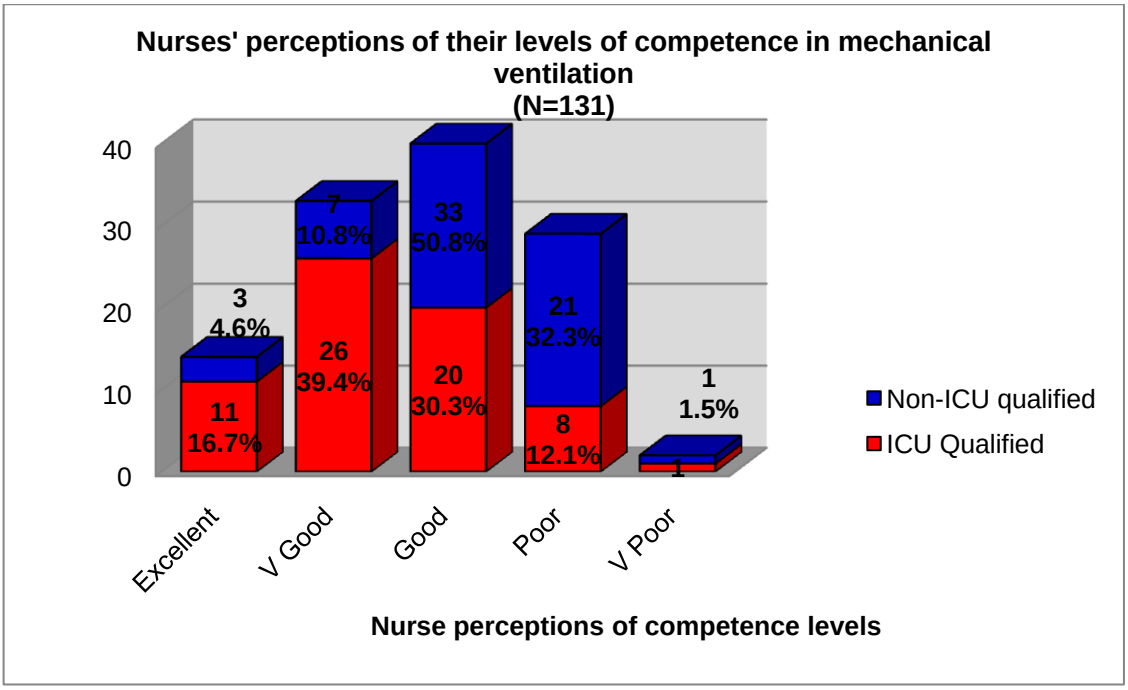


Figure 4.16: Nurses perceptions of their competence levels in mechanical ventilation

The nurses' responses were quantified to percentages and the percentages graded according to the grading scale and compared to the mean score achieved by the nurses who responded to the questions for the three vignettes. The ICU qualified nurses (n=11) and non- ICU qualified nurses (n=3) who perceived they had excellent levels of competency in mechanical ventilation(>75%) achieved a mean score of 42% (poor competence) and 31% (poor competence) respectively for the three vignettes.

The ICU qualified nurses (n=26) who perceived they had very good competence levels (70-75%) in mechanical ventilation were shown to have achieved a mean score of 53% across the three vignettes (average competence), whilst the non-qualified ICU nurses (n=7) who perceived their competency levels as very good (70-75%), scored a mean of 36% (poor competence) across the three vignettes.

The ICU qualified nurses (n=20) who perceived they had good competency levels in mechanical ventilation (60-69%) were found to have achieved a mean score of 50% (average competency) across the three vignettes, whilst the non-qualified nurses (n=33) achieved a mean score of 31% (poor competency) across the three vignettes.
Results of the nurses perceived levels of competence as compared with actual competence are shown in table 4.25

Table 4.25: How nurses perceived their level of competence in mechanical Ventilation as compared to results of three vignettes.

How nurses perceived their competence level in mechanical ventilation as compared with scores for three clinical vignettes			
	Excellent (>75%)	**Very Good (70-75%)**	**Good (60-69%)**
ICU qualified responses	**n=11**	**n=26**	**n=20**
Mean scores for three vignettes	**42%**	**53%**	**50%**
Non ICU Qualified responses	n=3	n=7	n=33
Mean scores for three vignettes	31%	36%	31%

Question 2

Are you required to make autonomous decisions regarding changes of ventilator settings? 49% of ICU qualified nurses (n=33) replied that they change ventilator settings autonomously. These nurses (n=33) achieved a mean score of 51% for the three vignettes (average competency).
Of the non qualified nurses 31 (48%) replied that they change ventilator settings autonomously. The scores for non- ICU qualified nurses showed a mean score of 34% for the three vignettes (poor competency).

The responses to the above question and the scores achieved across the three vignettes are shown in Table 4.26.

Table 4.26: Nurses who change settings autonomously and mean scores achieved for three vignettes

	Change settings	Mean score achieved for three vignettes
ICU qualified responses	n=33 (49%)	51%
Non-ICU qualified responses	n=31 (48%)	34%

Question 3

Are you of the opinion that you are competent to care for the mechanically ventilated patient? The replies to the above question and the scores achieved across the three vignettes are shown in Table 4.27. Of the ICU qualified nurses 91% (n=62) felt they were competent to care for the mechanically ventilated patient. In contrast to this perception of being competent the ICU qualified staff scored 50% (average competence) across the three vignettes.

86% (n=57) of the non-ICU qualified nurses felt they were competent to care for the mechanically ventilated patient, however the non-qualified nurses achieved a mean score of 33% (poor competency) for the three vignettes.

Table 4.27: Nurses competent to care for mechanically ventilated patients and mean scores achieved for three vignettes

	Felt Competent (75%)	Mean Score Achieved for Three Vignettes
ICU Qualified Responses	n=62 (91%)	50%
Non ICU Qualified Responses	n=57 (86%)	33%

Question 4

The nurses were asked if they take charge of the ICU unit. The results are shown in Table 4.28. 88% of ICU qualified nurses (n=61) and 46% of non qualified nurses (n=31) responded that they take charge/ sometimes take charge of the ICU unit. The mean scores for the respondents for the three vignettes were 49% (poor competency) for the ICU qualified nurses and 34% (poor competency) for the non-qualified ICU nurses respectively.

Table 4.28: Nurses response to taking charge and mean scores achieved for three vignettes

	Take Charge/ Sometimes Take Charge	Mean Score Achieved for Three Vignettes
ICU Qualified Responses	(n=61)88 %	49%
Non ICU Qualified Responses	(n=31) 46%	34%

4.8 SUMMARY

This chapter presented results of the study.

The results show a poor level of competence (<50%) amongst the nurses both ICU qualified and non-ICU qualified with regard to mechanical ventilation, with a significant difference (p=0.039) found between the competence levels of the ICU qualified and non-ICU qualified nurses. Age and years of experience (training background) appear to have had minimal influence on the levels of competency demonstrated by both ICU qualified and non-ICU qualified nurses.
How nurses perceived their own level of competency with regard to mechanical ventilation was in contrast to scores achieved in three clinical vignettes and the responsibility the nurses took in the units (shift leader, changing ventilator settings, taking charge of the unit) was not congruent with their level of competence.

Chapter Five of this study will present the discussion of the results, main findings, limitations of the study, recommendations and conclusions.

CHAPTER FIVE

.DISCUSSION OF RESULTS, MAIN FINDINGS, STUDY LIMITATIONS RECOMMENDATIONS, & CONCLUSIONS

5.1 INTRODUCTION

The purpose of the study was to determine and describe the level of competence of nurses working in ICU with regard to mechanical ventilation. As such three clinical vignettes representing three lung pathologies found in the ICU, and most likely to require mechanical ventilation, were returned from one hundred and thirty six nurses (n=136) of varying nursing training backgrounds and years experience in the ICU, to determine the level of competence of nurses with regard to mechanical ventilation.

Results of the study showed that nurses regardless of training background, age and/ or experience, showed a poor level of competency with regard to basic mechanical ventilation. The CI of 75% was not achieved by either the ICU qualified or non-ICU qualified nurses. Nurses' perceptions regarding their own competence levels of mechanical ventilation when compared to their actual competency levels as determined by three clinical vignettes was of concern. An in-depth discussion of the results follows.

5.2 PROFILE OF NURSES

5.2.1 Categories of Nurses

The nurses (n=136) naturally formed two even groups. 50% (n=68) were ICU qualified and 50% (n=68) were non ICU qualified. Of the non qualified nurses (n=68) 30.8% (n=21) were enrolled nurses, 52.9% (n=36) were ICU experienced nurses, and 16.1% (n=11) were ICU students.

The distribution of ICU qualified nurses in the study exceeded the findings of the CCSSA.(2004) audit, which found only 25% of nurses in the ICU units in S.A. held an ICU qualification, as opposed to this study, which found 50% of nurses in the ICU to be ICU qualified. The discrepancy in the percentages of ICU qualified nurses found in this study may be due to the small sample number (n=136) used in this study vs the CCSSA (2004) audit, which sampled 5821 nurses nationwide in both the public and private sectors in S.A. In spite of the 25% increase of ICU qualified nurses found in this study, which may be a local phenomenam due to the small sample, Williams & Clarke, as cited by Scribante &

Bhagwangee (2007), argue that at least 75% of nurses in the ICU should be ICU qualified to ensure optimal care of the patient.
It is recommended that the mechanically ventilated patient 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), and includes an understanding of the modes and monitoring required of the mechanically ventilated patient, thus contributing to optimal outcomes of the patient (Pierce, 2002). The competent nurse should be able to interpret and act upon the monitoring information displayed by the ventilator in terms of the clinical manifestations of the patient (Fulbrook, 2007). As 50% (n=68) of the nurses in this study were found to be ICU qualified, it was expected that these nurses would achieve the competency indicator of 75% by virtue of their training background and experience in the ICU. In contrast however the study results showed the ICU qualified nurses to have a poor level of competence (48%) with regard to mechanical ventilation. Binnekade (2003:191) argues that ICU qualified nurses have superior knowledge to non -ICU qualified nurses, and states: "*The accountability of sufficient specialized nurses in ICU to meet the needs of the patient is a major factor in ensuring patient safety and quality care, and employing non-ICU qualified nurses can result in a dilution of the specialist care provided by the specialist nurse".*

Results of this study suggest that ICU qualified nurses' level of competence is questionable and casts doubt on whether the mechanically ventilated receives quality safe care. The results of this study suggest that ICU certification did not result in superior competency levels of the ICU qualified nurses as argued by Briggs et al. (2006) and Binnekade (2003).

In contrast to Binnekade's (2003) suggestion that increased numbers of ICU qualified staff are required in ICU, this study found the nurse workforce in ICU's in two tertiary healthcare institutions in Gauteng to consist of 50% non- ICU qualified nurses. The non-ICU qualified nurses "replace" the ICU qualified nurses to "make up the numbers" of nurses available to care for the patients. This situation has come about due to the critical shortage of ICU qualified nurses in S.A. (Fouche, 2002).The competency levels of non-ICU qualified nurses in this study (who made up 50% of the workforce) regarding mechanical ventilation were found to be poor as determined by a score of 31% for three clinical vignettes. Thus results of this study suggest that the mechanically ventilated patient is cared for by nurses both ICU qualified and non-ICU qualified, who show poor levels of competency in mechanical ventilation, which may lead to poor outcomes for the patient.

Further analysis showed that of the 50% (n=68) non- ICU qualified nurses 30% (n=21) were enrolled nurses who by virtue of their training background are unlikely to have acquired the

competency levels congruent with the needs of the mechanically ventilated patient. This perceived lack of competency was affirmed by the enrolled nurses' scores for the three clinical vignettes namely 22%, 17% and 13% for vignettes one, two, and three respectively. Such poor competency levels in mechanical ventilation may lead to catastrophic complications for the patient. The enrolled nurse is delivering direct care to the patient in ICU's in S.A, is in direct contrast to the Canadian Association of Critical Care Nurses (1999) who recommend that non regulated nurses should not be used to provide direct care to the ICU patient and accepts that care delivered by registered nurses may reduce mortality and morbidity rates, decrease length of stay and lower re-admission rates. The WFCCN (2005) supports this recommendation by suggesting in the guidelines of the WFCCN (2005) that the patient in ICU has the right to be nursed by a registered nurse, as does the British Association of Critical Care Nurses as cited by Pilcher, Odell, Bray, et al. (2001). In contrast the Department of Health strategic framework for modernisation of tertiary services (2003) suggests that enrolled nurses be used in ICU in South Africa to relieve the nursing shortage.

Thus the study results found the competency levels of nurses working in six (n=6) ICU units in two tertiary healthcare institutions in Gauteng, regarding mechanical ventilation, to be below the set competency indictor of 75%, and as such to place the mechanically ventilated patient at risk of poor progression towards the goal of liberation from the ventilator (Burns 2005).

5.2.2 Influence of age and experience on knowledge of mechanical ventilation

Nurses' years of experience in the ICU and current ages were included in the study to determine if experience or age 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 one way ANOVA with age and experience as variables, showed that neither age nor years of experience had an influence on the competency levels of either the ICU qualified or non- ICU qualified nurses in this study with the exception of vignette three where experience and age were found to influence the competency levels of the ICU qualified and non-ICU qualified nurses respectively.

The minimal influence of years of experience on improving the levels of competence of the nurses is in contrast to local and international studies which show years of experience to be a factor in gaining further knowledge and providing higher quality nursing care (Toth,2003). Scribante & Bhagwanjee (2003) 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, and in fact they may regress and become less competent, as appears to be the

case in this study, as affirmed by the vignette score results. The competency levels of the nurses were found to be poor in spite of thirty (n=30) of the ICU qualified nurses and 14 (n=14) of the non ICU qualified nurses having 6 to >11years of experience in ICU.

5.2.3 Nurses working overtime as agency nurses

Agency nurse refers to nurses who work additional shifts in their off duty time usually at a hospital where they are not permanently employed, and in an ICU unit with which they are not familiar. In this capacity they are often referred to as “agency staff”. Results showed that 84% (n=56) of the ICU qualified nurses and 67% (n=43) of the non ICU qualified nurses “moonlight”.

This has implications for mechanically ventilated patients, as the nurses level of competency in mechanical ventilation in this study was shown to be poor, as determined by three clinical vignettes (ICU qualified 48% and non-ICU qualified 31%). Thus this poor competency level in mechanical ventilation is not “contained” only to the unit where the nurse is permanently employed, but is widely disseminated to other patients in other units, when nurses moonlight. “Agency staff often display a lack of commitment, and their work is not always up to the standards of quality patient care” (De Beer, Brysiewiez, Bhengu. 2011:2). An added problem is when permanently employed nurses work as agency staff and the double shifts worked lead to exhaustion and unproductive nursing care (Rispel, 2008).Thus according to results of this study, the mechanically ventilated patient is placed at risk of being cared for by a nurse who is not competent in mechanical ventilation, may be exhausted, and may not be committed to delivery of optimal quality care.

5.2.4 Nurses position in the ICU and requirement to take charge

It is of concern that nurses with poor levels of competence in mechanical ventilation are shown in this study to occupy highly responsible positions in the ICU units. With reference to the ICU qualified nurses, 65% (n=41) took the responsibility of leading shifts in the ICU, 6.4% (n=4) were employed as clinical facilitators, and 14.3% (n=9) were bedside nurses, i.e. actually undertaking the nursing care of the patient. These positions are highly responsible positions and require the nurse to have specialized knowledge of mechanical ventilation in order to be competent, as a large majority of patients in the ICU are mechanically ventilated (Tobin, 2001). The positions the ICU qualified staff occupied in the unit, in spite of poor competency in mechanical ventilation, may place the patient at risk, as these nurses are assessing, making decisions, manipulating ventilator settings, whilst the facilitators are charged with teaching staff about mechanical ventilation. These same nurses (ICU qualified) scored 49% for the three clinical vignettes and as such are not competent to undertake such responsible positions as alluded to. A participant in a study undertaken by Scribante & Bhagwanjee (2003) on competency of ICU nurses in the ICU, supports this view, stating that being ICU qualified does

mean the nurse is competent. Scribante, Schmollgruber, Nel (2004) further elaborate that competency of ICU qualified nurse may not be what people believe it to be.

Of further concern is 13.5% (n=7) of the non-ICU qualified nurses whose level of competence in mechanical ventilation was shown to be less than that of the ICU qualified nurses (mean score of 32% for three clinical vignettes), responded they were leading shifts in the ICU. Eighty percent (n=42) of the non-ICU qualified nurses were responsible for bedside nursing of the mechanically ventilated patient, and 5.7% (n=3) were employed as clinical facilitators. Results of the study suggest that these non-ICU qualified nurses are not competent in mechanical ventilation, and as such are unlikely to deliver safe optimal nursing care to the mechanically ventilated patient. Thus the study shows that greatest number of nurses caring for the mechanically ventilated patient at the bed side were non-ICU qualified nurses (n=42) who demonstrated poor levels of competency with regard to mechanical ventilation. Mechanical ventilation is a crucial component of the care of the patient in the ICU and the competence level of the nurse with regard to mechanical ventilation is pivotal to moving the patient forward towards liberation from the ventilator (Williams & Schmollgruber, 2007). Thus results of the study do not bode well for the mechanically ventilated patient to receive optimal safe care with regard to their ventilator requirements from either the ICU qualified or non-ICU qualified nurses in ICU's in two tertiary healthcare institutions in Gauteng.

5.3 CLINICAL VIGNETTES

An in-depth discussion of the level of competence in mechanical ventilation as determined by three clinical vignettes of the nurses follows. Discussion regarding the nurses' perceptions of their own level of competence with regard to mechanical ventilation follows in order that the nurses own perceptions of their competency levels in mechanical ventilation can be compared with actual levels of competence as determined by three clinical vignettes.

5.3.1 Vignette one: nurses level of competence of standard ventilation settings for patients with no lung pathology

Vignette one was based upon a scenario and questions relating to the patient who had no lung pathology and required only post operative ventilation. The vignette included questions on basic mechanical ventilator settings, everyday diagnostic tests such as ABGs, assessing common problems such as circuit leaks, knowing the differences between volume and pressure control ventilation, and weaning the patient from the ventilator and extubation. The vignette consisted of 13 questions relating to the scenario and the highest score achievable was 13/13.

Neither the ICU qualified group of nurses nor the non-ICU qualified group of nurses achieved the CI of 75% for vignette one.

The levels of competence demonstrated by the ICU qualified (50%) and non- ICU qualified nurses (38%) for vignette one, are not congruent with optimal care of the mechanically ventilated patient. Standard ventilator settings and an understanding of the clinical application thereof are fundamental to safely and optimally ventilating the patient in ICU. The competence levels for three vignettes of 48% (ICU qualified nurses) and 31% (non-ICU qualified nurses) suggest the nurses are not competent to care for the mechanically ventilated patient and may put the patient at risk of prolonged hospital stay, increased costs, and increased mortality and morbidity.

Within the non- ICU qualified group of nurses, the ICU students were found to have attained the highest level of competence when compared to the ICU qualified nurses, and the non-ICU qualified experienced nurses in vignette one scoring 51% which was the highest score amongst the non- qualified ICU group and within 1% of the ICU qualified nurses (50%). These results support Scribante & Bhagwanjee's (2003) suggestion that nurses require to keep learning to move along the competency continuum towards expertise. It would be expected that ICU qualified nurses would demonstrate a significantly superior level of competence when compared with non- ICU qualified nurses, by virtue of their certification as ICU nurses (Briggs, 2006). However the study results suggest that the ICU qualified nurses appear to have remained static or regressed along the competency curve, whilst the ICU students who were on a steep learning curve to pass their ICU exams were seen to be moving forward on the learning continuum and improving their levels of competence (Scribante & Bhagwanjee 2003).

5.3.2 Vignette two: nurses level of competence in mechanical ventilation of the patient with Acute Respiratory Distress Syndrome lung pathology

Vignette two related to the patient with ARDS. The clinical scenario related to basic mechanical ventilation of the patient with ARDS, and questions included, pertained to small tidal volumes (4-8mls/kg/wt) and a plateau pressure under 35cm/H_2O (protective lung strategy) (Tobin, 2001). A question on PEEP was included as the role of PEEP is considered important in recruiting collapsed alveoli as well as a question on recruitment and proning as these procedures are commonly used in the ICU in the academic units (Burns 2005; Hering, 2001). Interpretation of ventilator graphics is essential in order to optimize ventilator settings for the ARDS patient and as such a ventilator graphic was included in the scenario.

There was no significant difference between the competence levels of the ICU qualified nurses and non ICU qualified nurses for vignette two ($p=0.325$). Overall the nurses knowledge of mechanical ventilation for the ARDS lung was below the CI of 75% for both the ICU qualified

and non ICU qualified groups of nurses. Thus the nurses' level of competence regarding ARDS lung pathology was not congruent with optimizing the ventilator settings and strategies required for the ARDS lung. Inappropriate settings can lead to VILI and exacerbation of the underlying pathology, prolonging ventilation days, with a risk of increased mortality and morbidity (Gattinoni, et al.2003). The ARDSNet study (2000) and subsequent studies (Galvin,et al.,2004; Gattioni, et al., 2006; Slutsky, et al., 2004;) show unequivocally that ventilator settings for the ARDS lung are crucial to the recovery of the ARDS lung and prevention of VILI.

The ICU students again demonstrated the highest level of competence obtaining a mean score of 64% as opposed to the ICU qualified nurses of 58%.with regard to mechanical ventilation of the patient with ARDS lung pathology.

The enrolled nurses demonstrated they had virtually no understanding or knowledge of caring for the patient who has ARDS, achieving a score of 17%. Such a severe lack of competence places the patient in an invidious, vulnerable, and helpless position which may threaten the progression of the patient to liberation from the ventilator, and may significantly increase the patients risk of increased morbidity and mortality.

Thus the competence levels of the nurses with regard to mechanically ventilating the patient with ARDS lung pathology were poor with the exception of the ICU students who scored 64%.

It is crucial that ventilator settings for the patient with ARDS are optimized to prevent further damage to the lungs and the release of cytokines which are thought to contribute to MSOF (Frank & Matthay, 2004). A specialist knowledge of mechanical ventilation is pivotal to ensuring competency amongst nurses and to progessing the patient towards recovery (Burns 2005; Williams & Schmollgruber, 2006)

5.3.3 Vignette three: nurses' level of competence in mechanical ventilation of the patient with obstructive outflow (asthma) lung pathology

The scenario for vignette three related to the patient with acute exacerbation of asthma and the ventilation strategies and settings required for the patient with obstructive outflow. The basics of ventilating the patient with COPD is to ensure that the expiratory time is set to prevent stacking of the breaths (auto-PEEP). The COPD patient also requires a slower mandatory ventilation rate, and is often ventilated in volume control. The consequence of incorrect ventilator settings on the ventilator, for the asthmatic patient, especially with regard to the I:E ratio and mandatory breath rate, is auto-PEEP, which if not diagnosed timeously can be quickly

fatal. It is essential that nurses who care for mechanically ventilated patients understand that different lung pathologies require different settings and strategies.
Neither the ICU qualified nurses nor the non- ICU qualified nurses achieved the CI of 75% with regard to their level of competence to mechanically ventilate the patient with obstructive outflow pathology of the lungs.

Both the ICU qualified nurses and non- ICU qualified nurses level of competence in mechanical ventilation of the COPD lung was poor (37% and 21% respectively). In terms of the competency levels demonstrated in vignette three it is suggested that neither the ICU qualified nurses nor the non-ICU qualified nurses have the specialist knowledge required to understand that the COPD lung requires different ventilator settings and strategies from the normal lung or the ARDS lung.

The overall poor competence levels as determined by three clinical vignettes for both the ICU qualified and non- ICU qualified nurses is not unique to this study. International and local studies, which evaluated other aspects of ICU nurses competency, found ICU nurses knowledge to be below the competency indictors set for the respective studies. Whilst no studies were found locally or internationally with regard to nurses' competence in mechanical ventilation, a similar international study was found. Cox (2003) compared the knowledge of mechanical ventilation of doctors, nurses and respiratory therapists and found the nurses' scores to be below the competency level set for the study.

Results of a local study undertaken by Scribante, Schmollgruber, Nel, (2004) showed that poor competency (knowledge) amongst ICU registered nurses in S.A. is more common than expected. Perrie & Schmollgruber, (2006) and Windsor (2005) further qualified the findings of Scribante et al (2004) in two studies.The two studies examined the knowledge of nurses in ICU in South Africa with regard to weaning patients from the ventilator (Perrie & Schmollgruber 2006), and interpretation of the ventilator graphics (Winslow, 2005) respectively. Results in each of the studies found the knowledge level of the nurses in the ICU to be below the set competency. A further study undertaken by Van Huyssteen & Botha, (2004), which focused on the knowledge of recovery room nurses with regard to airway emergencies in the recovery room revealed a level of knowledge below the set competence, amongst the nurses sampled.

Botha (2009) reviewed 11 studies which reported on critical care nurses' knowledge of various critical care topics e.g. haemodynamic monitoring, ventilator graphics, aortic balloon pump. Competency Indictors (CI) for the 11 studies ranged between 60% -85%. Overall 565 nurses participated in the studies. Results revealed that only 10.5% of the nurses achieved the set competency level, whilst the vast majority (90.5%) did not. It was concluded that critical care

nurses required to be updated and were not competent. Further the results of this study which found minimal difference between the knowledge levels of ICU qualified and non ICU qualified nurses is supported by Winslow, (2005) and Perrie & Schmollgruber, (2006),who found both ICU qualified and non-ICU qualified nurses levels of competency to be below the set competencies for the respective studies.

5.4 NURSES PERCEPTIONS OF THEIR LEVEL OF COMPETENCE IN MECHANICAL VENTILATION

The nurses (n=138) were asked four questions related to how they perceived their own level of competence in mechanical ventilation, their position held in the unit, and autonomous changes to ventilator settings. Their responses were quantified as percentages according to a grading scale and compared with mean vignette scores obtained by the nurses who answered the questions for three vignettes e.g. if the nurse responded that she/he perceived that her/his knowledge of mechanical ventilation was excellent, the grading scale score for “excellent” as a percentage is >75% compared to the actual mean score achieved by the nurses for three clinical vignettes.

The results of the study suggest there is a misperception amongst the nurses as to their level of competence in mechanical ventilation when compared to the scores achieved by the nurses for the three clinical vignettes.
The scores of the non-qualified ICU nurses of 31%, 36% and 31% who felt they had excellent to good knowledge of mechanical ventilation bare testimony to the nurses’ perception being totally misplaced. In spite of these misperceptions regarding their own knowledge levels, the nurses were changing ventilator settings autonomously 49% (n=33) of the ICU qualified nurses and 48% (n=31) of the non ICU qualified staff responded that they change ventilator settings autonomously. These nurses whose perception of their knowledge levels is shown to be significantly misplaced are also leading shifts, acting as clinical facilitators, and are required to make life and death decisions. The level of competence of the nurses as determined by the three clinical vignettes is not congruent with the specialist knowledge required,(WFCCN 2005) and the responsibility of making autonomous changes to the ventilator settings, and shows a lack of insight by both ICU qualified and non-ICU qualified nurses with regard to their level of competency in mechanical ventilation

The implications for this misplaced perception of nurses’ with regard to their own level of competence with regard to mechanical ventilation may put the patient at risk, increase the length of stay in the ICU, and ultimately lead to increased mortality and morbidity. The

phenomenon of nurses having a misperception of their knowledge levels is not unique to this study. The misperception of nurses with regard to their own competence has been shown by newly registered nurses in a study conducted by Moeti, Van Niekerk, Van Velden, (2004). In this study 89.4% of the newly registered nurses felt they were competent on completion of their training. Expert nurses were asked to evaluate the competency of the newly registered nurses. 71.5% of the expert nurses did not think the newly registered nurses were competent on completion of their training. Moeti, et al.(2004) postulates that the newly registered nurses did not realise their lack of performance due to lack of experience. They did not know they didn't know. Mollerup & Mortenson (2004), in their study of nurses own perceptions of their competency which was undertaken in the ICU, also comment that some of the nurses studied had very little professional self awareness of their individual competency.
The evidence from Moeti, et al.(2004) and Mollerup & Mortenson,(2004), leads the researcher to suggest that both the ICU qualified and non ICU qualified nurses in this study had misperceptions of their own individual levels of competence with regard to mechanical ventilation. They did not know that they didn't know.

Men are four:
He who knows, and knows that he knows.
He is wise, follow him.
He who knows and knows not that he knows.
He is asleep, wake him.
He who knows not, and knows that he knows not.
He is a child, teach him
He who knows not, and knows not that he knows not.
He is a fool, shun him
ARABIAN PROVERB as quoted by Dr David Klatzow in his book "Steeped in Blood" 2010

5.5 MAIN FINDINGS

- Results showed both the ICU qualified and non- ICU qualified nurses demonstrated poor levels of competence as determined by scores for three clinical vignettes A significant difference (p=0.039) was found between the competence levels of the ICU qualified and non- ICU qualified nurses, with regard to mechanical .ventilation. However, in spite of the statistical result implying that that ICU qualified nurses had superior knowledge to the non-ICU qualified nurses, neither group of nurses were found to be competent. In spite of the statistical difference found in the levels of competency between the ICU qualified and non-ICU qualified, all the nurses

showed poor competency levels in mechanical ventilation, the clinical significance of which cannot be overlooked.The levels of competence achieved by both groups of nurses were well below the CI 75% thus suggesting a poor level of competence amongst the nurses which is likely to impact negatively on the patient who is mechanically ventilated.

- The results suggest that an ICU certification did not translate into superior knowledge amongst the ICU qualified nurses as would be expected.

- Years of experience and age of the nurses had no significant influence on the levels of competency in either the ICU qualified or non -ICU qualified nurse groups. This implies that there may not be sufficient attention being given to ongoing development of the staff working in the ICUs, and nurses do not appear to be taking responsibility for their own knowledge development.

- In spite of the poor competency levels determined in this study, nurses are taking charge of ICU units and autonomously changing ventilator settings.

- The study revealed that nurses have a misperception of their own competency levels with regard to mechanical ventilation, when compared to the scores they achieved on the three vignettes. It appears that the nurses studied do not know that they don't know.

5.6 LIMITATIONS OF THE STUDY

The following were identified as limitations to this study.

- This study cannot be generalized to the nurse population, as the study was conducted in only two hospitals, in one province of SA, and included only public sector hospitals.

- Whilst content and instrument validity was confirmed by the expert group, reliability of the questionnaire was not tested. Thus refinement and additional testing will be required for any further studies using the instrument

- The instrument was seen as a “test” by some of the participants and as such may have been threatening to them. This may have influenced how they answered the vignettes e.g. some of the participants handed back a blank questionnaire saying they didn’t want anybody to know if they scored badly.

- The scope of this study was limited by the nature of the study which was completed in partial fulfillment of the requirements of the degree MSc. (Nursing). As such it is a first level descriptive study and no hypothesis was tested.

5.7 RECOMMENDATIONS

The results of this study raise concern regarding the competence of nurses in ICU with regard to mechanical ventilation. As a result the patient may experience failure to progress, failure to be rescued, prolonged stay in the ICU, and increased morbidity and mortality. Therefore the following recommendations are made:

5.7.1 Clinical Practice

- Sub category nurses e.g. enrolled nurses should not deliver direct care to the mechanically ventilated patient, but only assist a registered nurse in the care of the patient.

- Guidelines for practice be developed and implemented

- Nurses who care for the mechanically ventilated patient 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.

- Patient acuity levels are considered and a nurse with congruent knowledge and skills allocated to the patient.

- ICU qualified nurses do more of the bedside nursing and supervise and teach non-ICU qualified nurses.

- Educational programs specific to mechanical ventilation are introduced into the clinical ICU environment

The Department of Health reconsiders its stance on using enrolled nurses in the ICU to combat the staff shortage.

5.7.2 Nursing Management

- Nurses in a management position must ensure their own competence in mechanical ventilation by attending courses, congresses, in-service in order that they remain up to date with new technologies and ventilation strategies, and are able to convey the information to junior staff

- Ensure proper supervision of the nurses caring for the mechanically ventilated patient, and be cognisant of acuity levels and skill mix when allocating staff.
- Ensure ongoing clinical and theoretical development of staff by ensuring staff attend In service programmes, at the bedside clinical teaching takes place and there is supervision of junior staff by more experienced staff.

5.7.3 Nursing Education

- ICU lecturers must be up to date with current clinical practice and ventilator technology.eg teach ventilator graphics in the ICU curriculum.

- ICU facilitators must be ICU qualified and their competency evaluated prior to be appointed to the post of ICU facilitator.

- Competency Indicators for nurses undertaking their practical assessment may need to be re evaluated and made more stringent.

- Continuing Professional Development should be instituted as a matter of urgency. The tutors and managers do not have to wait for the SANC to institute such a system. The system can be developed as a hospital based program and be linked to a reward structure as is the case in the private sector.

5.7.4 Further Research

- The instrument used in this study requires to be further developed to improve validity and confirm reliability.

- This study may be expanded to a greater number of the nursing population within ICUs in SA.

- A two tailed study undertaken whereby the same instrument is used for doctors and nurses in the ICU and the results compared.

- A Pre- post research design which implements a six month mechanical ventilation course.

5.8 CONCLUSIONS

- The level of competence of 136 ICU nurses (68 ICU qualified and 68 Non- ICU qualified) in mechanical ventilation, from two tertiary healthcare institutions in Gauteng was determined using three clinical vignettes and found to be below the set CI of 75%.

- Age and experience had minimal influence on levels of competency amongst the nurses

- Nurses' perceptions of their own level of competence with regard to mechanical ventilation was found to be misplaced.

- There was minimal difference in the levels of competency regarding mechanical ventilation, between the ICU qualified and non-ICU qualified nurses.

- The study has contributed to the body of knowledge currently available both locally and internationally, regarding the competence of nurses in ICU with regard to mechanical ventilation. The findings of the study have implications for the safety of the patient who undergoes mechanical ventilation, and may indicate a need for changes in how the nurses are trained and assessed prior to being allocated to care for the mechanically ventilated patient.

"It is the patients' constitutional right within the South African National Healthcare System to receive quality nursing from competent nurses.
However, it is unfortunate that this right is often violated by incompetent members of the nursing profession.
Society expects and rightfully should demand safe, high quality nursing care from its nurses." **(Morolong & Chabelli 2005)**

This chapter provided a discussion of the results, a presentation of the main findings of the study, limitations of the study, recommendations for clinical practice, nursing management and further research.

6.0 REFERENCES

Almerud, S. 2008. The meaning of technology in intensive care. The World of Critical Care Nursing 6(3):39-43.

Amitai, A. & Mosenifar, Z. 2011. Ventilator Management. Medscape Reference. http://emedicine.medscape.com/article/810126-overview#aw2aab6b7 Accessed 20/12/2011

Alphonso. A., Quinones, M., Mishra, A. et al. 2004. A study to evaluate the competency of ICU personnel in mechanical ventilation. Respiratory Clinical Study www.foocus.com/pdfs/Articles/summer2004/AlphonsoQuinones/pdf Accessed 5/7/2006

American Association of Critical Care Nurses. 2003. Safeguarding the Patient and the Profession: The Value of Critical Care Nurse Certification. American Journal of Critical Care. March 12(2):154-164.

Benner, P. 1982. From novice to expert. 1st Edition. Addison-Wesley, California.

.

Binnekade, J. M., Vroom, M.B., de Mol, B.A. et al. 2003. The quality of Intensive Care Nursing before, during, and after the introduction of nurses without ICU training. Heart and Lung 32(3):190-196.

Botha, A. 2009. Knowledge of Critical Care Nurses: The evidence. Department of Health Studies. University of South Africa. Presented at Critical Care Congress 2009.

Briggs, L., Brown, H., Keston, K. et al. 2006. Certification. A benchmark for critical care nursing excellence. Critical Care Nurse 26:47-53

Brower, R. G., Larkin, P.N., MacIntyre, N. 2004. Higher vs. lower positive end expiratory pressure in patients with ARDS. N. England Journal of Medicine 351:227-336.

Brown, M. K. 2002. Lung Protective Strategies for Acute Severe Asthma. RT for Decision Makers in Respiratory Care Feb/March:1-12

Bruce, J. C., Langley, G. C., Tjale, A. A. 2008. The use of experts and their judgments in nursing research: An overview. Curationis 31(4):57-61

Brunner, J. 2002. History and principles of closed loop control applied to mechanical ventilation. Vereniging voor Int Care 6(4):6-9

Burns, N. & Grove, S.K. 2003. Understanding Nursing Research. 4th Edition. W. B. Saunders, Philadelphia

Burns, S.M. 2003. Working With Respiratory Waveforms. AACN Clinical Issues 14(2):133-144

Burns, S.M. 2005. Mechanical ventilation of patients with acute respiratory distress syndrome and patients requiring weaning. Critical Care Nurse August. 25(4):14-23

Byrd, R.P. & Roy, T.M. Updated July 6 2006 .Ventilation, mechanical. http://www.emedicine.com/med/topics3370.htm Accessed 28/8/2006

Byrd,R.P., Kosseifi, S.G., Roy, T.M. 2009. Mechanical Ventilation. E-medicine Pulmonology. http://emedicine.medscape.com/article/304068 Accessed 8/11/2011

Byrd, R.P. & Mosenifar, Z. 2010. Ventilation, Mechanical. MedScape Reference. http://emedicine.medscape.com/article/304068-overview#aw2aab6b7 Accessed 11/12/2011

Canadian Association of Critical Care Nurses, 1999. Position Statement. The Use of Non Regulated Personnel in Critical Care. Canadian Association of Critical Care Nurses (CACCN) 1997. Non-regulated health personnel in critical care areas. Available at www.caccn.ca/position. Accessed January 9, 2006.

CCSSA. 2004.National Audit of Critical Care in South Africa: report. Presented at 26th Annual Conference of the Critical Care society of Southern Africa, Durban. August, 2004

Chatburn, R. 2006. Mechanical Ventilation: A tutorial for pharmacists. www.medscape.com/viewarticle/552178). Accessed 5/8/2007

Chatburn, R. 2007. Classification of ventilator and modes: Update and proposal for implementation. Respiratory Care 52(3):301-325

Cox, C., Shannon, S., Carson, E. et al. 2003. Effectiveness of medical resident education in mechanical ventilation. American Journal of Respiratory and Critical Care Medicine 167:32-38

Dasta, J.F., McLaughlin, T.P., Mody, S.H. et al. 2005. Daily cost of an intensive care unit day: the contribution of mechanical ventilation. Critical Care Medicine 33(6):1266-1271

De Beer, J.Brysiewiez, P. Bengu, B.R. 2011. South African Journal of Critical Care 27(1):1-4

Department of Health (DOH). 2003. Strategic Framework for the modernisation of tertiary hospital Services. http://www.doh.gov.za/mts/reports/criticalcare-sup.html
Accessed 20 /8/ 2006

Emery, M. 2005. University School of Medicine Atlanta Georgia from ask the experts about general critical care. Medscape Critical Care. www.medscape.com/ Critical Care/ask the experts/ventilating the patient with ARDS. Accessed 2/2/2006

Endacott, R. & Botti, M. 2005. Clinical research 3: sample selection. Intensive and Critical care Nursing, 21:51-55.

Engelbrecht, A. & Tintinger, G.R. 2007. Mechanical ventilation in the emergency department. Journal of Continuing Medical Education 25(3):118-122

Esteban, K., Raymondos, C., Apezteguía,J. et al. 2010. Outcomes of Patients Ventilated with Intermittent Mandatory Ventilation with Pressure Support. A Comparative Propensity Score Study.Chest 137:1265

Faculty of Health Sciences.2000. Style Guide for Theses, Dissertations and Research Reports. 3rd Edition. University of the Witwatersrand, Johannesburg

Fouche, N. 2002. Fighting Losing Battles. Editorial. South African Journal of Critical Care 18(2): 36-38

Frank, J.A. & Matthay, M.A. 2003. Science review: mechanisms of VILI. Journal of Critical Care 7:233-241

Fulbrook, G.W., Schmollgruber, S., Alberto, L. 2006. Consensus Forum: Worldwide Guidelines on the Critical Care Nursing Workforce and Education Standards. Crit Care Clin 22:393-406

Galvin, I., Krishnamoothy, R., Saadia, R. 2004. Management of advanced ARDS complicated by bilateral pneumothoraces with HFO in the adult. British Journal of Anaesthesia 93(3):454-466

Gattinoni. L., Carlesso, E., Cadringher, P. et al. 2003. Physical and biological triggers of ventilator-induced lung injury and its prevention. European Respiratory Journal 22:1-25

Gattinoni, L., Caironi, P., Cressoni, M. et al. 2006. Lung Recruitment in Patients with the Acute Respiratory Distress Syndrome. New England Journal of Medicine 354(17): 775-1786

Gould, D. 1996. Using vignettes to collect data for nursing research studies:how valid are the findings? Journal of Clinical Nursing 5(4):207-212

Hager, D.N., Krishnan, J.A., Hayden, D.L. et al. 2005. For the ARDS Clinical Trials Network. American Journal of Respiratory and Critical Care Medicine 172:1241-1245

Hering, A. 2001. The effects of prone positioning on Intra abdominal pressure and cardiovascular and renal function in patients with acute lung injury. Anaesthesia and Analgesia 92:1226-1231

Hess, D. 2010. Ventilator modes: Where have we come from and where are we going? Chest 137:1256-1258

Keane, K., Lubin, S., Emerson, J., et al. 2003. Collaborative practice: development, implementation, and evaluation of a weaning protocol for patients receiving mechanical ventilation. American Journal of Critical Care 12:454-460

Khoza, L.B., & Ehlers,V.J. 1998.The Competencies of Newly Qualified Nurses as Viewed by Senior Professional Nurses. Curationis September:67-76

Klatzow, D. & Walker, S. 2010. .Steeped in Blood. Zebra Press.1st Edition. 2010 Cape Town

Lynn, M.R. 1986. Determination and quantification of content validity. Nursing Research 35(6): 382-385

Mah, M. & Acourt, G. 1999. Mechanical ventilation and the COPD Patient. RT for Decision Makers in Respiratory Care. http://www.rtmagazine.com/issues/articles/1999-08_04.asp accessed 16/06/2008

Melgaard, E. & Dam, L. 2000. Læring og kultur (Learning and culture) (2). Copenhagen: Udviklings og uddannelsesafdelingen (Department of Education and Development), Bispebjerg Hospital.

Moeti, M.R., Van Niekerk, S.E., Van Velden, C.E. 2004. Perceptions of the clinical competence of newly registered nurses in the North West province. Curationis August:72-84

Mollerup, A. & Mortenson, P.S. 2004. Nurses' perceptions of their own level of competence. Connect: The World of Critical Care Nursing 3(3):70-73

Morolong, B.G. & Chabeli, M.M. 2005. Competence of newly qualified registered nurses from a nursing college. Curationis, 28(2):38-50:

Noncini, B. 2004. Clinical vignettes and the measurement of physician performance. Annals of Internal Medicine 141:813-814

Nurses for a Healthier Tomorrow. 2006. Critical Care Nurse. http://www.nursesource.org/critical_care.html. Accessed 6/7/2007

Oddi, L. & Heurita, S. 1990. Which patient gets the critical care bed? Dimensions of Critical Care Nursing 9:288-295

Paolo, P., Paolo, S., Aspesi, M. et al. 2003. Non-invasive ventilation delivered by conventional interfaces and helmet in the emergency department. European Journal of Emergency Medicine10:79-86

Peabody, J.W., Luck, J., Glassman, P. et al. 2000. Comparison of vignettes, standardized patients and chart abstraction: A prospective validation study of three methods for measuring quality. Jama 283:1715-1722

Peabody, J.W., Tozija, F., Murioz, J.A. et al. 2004. Using vignettes to compare the quality of clinical care variation in economically divergent countries. Health Services Research, 39(62): 1951-1970

Perkal, M.F. Discontinuation of mechanical ventilation. Clinical paper. Published by permission of GASnet Inc ©2004-2005

Perrie, H. & Schmollgruber, S. 2010. Knowledge of Intensive Care Nurses in selected care areas commonly guided by protocols. Critical Care 14(suppl 1):446

Pierce, L.N.B. 2002. Traditional and Non Traditional Modes of Mechanical Ventilation. Critical Care Nurse 22 August:56-59

Pilcher, T., Odell, M., Bray, K. 2001. Nurse-patient ratios in critical care. Nursing in Critical Care, 6(2):59-61

Polit, D.F., Beck, C.T., & Hungler, B.P. 2001. Essentials of nursing research; Methods, appraisal and utilization. 5th Edition. pp.236. Lippincott. Philadelphia

Polit, D.F. & Beck, C. 2006., "The Content Validity Index: Are you sure you know what's being reported?" Research in Nursing and Health 29(5):489-497

Polit, D.F., Beck, C.T., Owen, S.V. 2007. Focus on research methods. Is the CVI an acceptable indicator of content validity? Appraisal and recommendations. Research in Nursing and Health 30:459-467

Pruitt, W. 2002. Ventilator Graphics Made Easy. RT for Decision Makers in Respiratory Care. http://www.rtmagazine.com/issues/articles/2002-02_04.asp accessed 9/11/2008

Rispel, L. Research on the State of Nursing ((RESON)2008. Exploring nursing policies, practice and management in South Africa. www.healthlink.org.za/uploads/files/resonDec08.pdf accessed 12th December 2010)

Robertson, S. 2007. Nesibopho best practice guideline on lung protection in mechanically ventilated patients in ICU. Nesibopho Healthcare (Pty) Ltd Endorsed by the Critical Care Society of Southern Africa.

Rodriques, P., Dojat, M., Brochard, L. 2005. Mechanical ventilation: Changing concepts. Indian Journal Critical Care Medicine 9:235-243

Schmollgruber, S. 2007. Organisation, strengths, and difficulties of South African intensive care nursing. Intensive and Critical Care Nursing, 23:247-248

Scribante, J. & Bhagwanjee, S. 2003. Working in a passionate nightmare. Presented at “DARE TO CARE” Combined congress of the South African Thoracic Society, The CCSSA, The Allergy Society of South Africa. Cape Town. August 2003

Scribante, J., Schmollgruber, S., Nel, E. 2004. Perspectives on critical care nursing: South Africa. The World of Critical Care Nursing 3(4):111-115

Scribante, J & Bhagwangee, S. 2007a. National audit of critical care resources in South Africa-nursing profile. South African Medical Journal 97(12):1315-1318

Scribante,J. & Bhagwangee, S. 2007b. ICU nurse allocation in cardiothoracic ICU: How many hands do we need? SAJCC November 23(2):66-69

Seckel, M. 2008. Ask the Experts. Critical Care Nurse 28(1):65-72

Sessler, C. N. 2009. Mechanical ventilatory support. ACCP Pulmonary Medical Board Review: 457-478

Sims, J. & Wright, C. 2002. Research in Health Care. Concepts Designs and Methods.1st Edition.Stanley, Cheltenham,UK

Slutsky, A.S. & Hudson, L.D. 2006. PEEP or No PEEP - Lung recruitment may be the solution. Editorial. New England Journal of Medicine 354(17):1839-1841

South Africa 1984 Regulations relating to the Scope of Practice of Persons who are Registered or Enrolled under the Nursing Act 1978. Pretoria: Government printer (Regulation R2598 1984 as amended)

South Africa 1985 Regulations relating to the Acts and Omissions in respect of which the Council may take disciplinary steps. Pretoria. Government Printer. Regulation R389 of 1985 (as amended)

Subirara, M. 2004. Which nursing issues need a European guideline? Proposal for respiratory management. Intensive and Critical Care Nursing 20:144-152

Sud, S., Sud, M., Friedrich, J.O. et al. 2008. Effect of mechanical ventilation in the prone position on clinical outcomes in patients with acute hypoxaemic respiratory failure: a systematic review and meta-analysis. Canadian Medical Association Journal 178(9):1153-1161

Teaching strategies for Outcomes Based Education. Edition 2 Juta and Company Ltd :368. http://www.ccmtutorials.com/rs/mv/page2.htm Accessed 4/2/2006

The Acute Respiratory Distress Syndrome Network 2000. Ventilation with lower tidal volumes as compared with traditional tidal volumes for acute lung injury and the acute respiratory distress syndrome. New England Journal of Medicine 342(18):1301-1308

Tobin, M.,Jubran, A., Laghi, F. 2001. Patient ventilator interaction. American Journal of Respiratory and Critical Care Medicine 163:1059-1063

Tobin, M.J. 2001. Advances in mechanical ventilation. New England Journal of Medicine 344 (26):1986-1996

Tobin, M.J. 2006. Principles and Practice of Mechanical Ventilation, 2nd Edition. New York: McGraw-Hill Medical Publishing Division

Toth, J.C. 2003. Comparing Basic Knowledge in Critical Care Nursing Between Nurses From the United States and Nurses From Other Countries. Am J Crit Care,12:41-46

Van Huyssteen, T. & Botha, A.D.H. 2004. Recovery nurses' knowledge regarding post operative airway emergencies in adults in private hospitals in Northern Gauteng, South Africa. South African Journal of Anaesthesia and Analgesia October 10(4): 9-13

Veloski, J., Tai, S., Evans, A.S. et al. 2005. Clinical Vignette based Surveys: A Tool for Assessing Physician Practice Variation. American Journal of Medical Quality 20(3):151-152

Windsor, S. 2005. An educational programme for critical care nurses on the interpretation of ventilator graphics.(dissertation)Pretoria: University of Pretoria

Williams, G. & Schmollgruber, S. 2006. Consensus Forum: Worldwide Guidelines on the Critical Care Nursing Workforce and Education Standards. Crit Clin Care, 22:393-406

World Federation of Critical Care Nurses. Position Statement on the Provision of Critical Care Nursing Workforce. Declaration of Buenos Aires, 2005

APPENDIX 1

Expert Group Consent Form

LEVEL OF NURSES' COMPETENCE IN MECHANICAL VENTILATION IN INTENSIVE CARE UNITS OF TWO TERTIARY HEALTHCARE INSTITUTIONS IN GAUTENG

EXPERT GROUP CONSENT FORM

I,_____(name), fully understand

the contents of the information letter. I have been offered the opportunity to ask questions and these have been answered to my satisfaction. I understand that I may withdraw from this verification process at any stage without penalty. I have been assured that my anonymity and confidentiality will be maintained.

I hereby give consent to participate as a member of the expert group for this study.

_____

(Participant signature)

_____

(Date)

_____

(Researcher signature)

_____

(Date)

APPENDIX 2

Expert Focus Group Information Letter

LEVEL OF NURSES' COMPETENCE IN MECHANICAL VENTILATION IN INTENSIVE CARE UNITS OF TWO TERTIARY HEALTH CARE INSTITUTIONS IN GAUTENG

EXPERT FOCUS GROUP INFORMATION LETTER

Dear Colleague

My name is Lynn Botha. I am an Intensive Care Nurse and am currently registered to read for a Masters Degree in Nursing Science at the University of the Witwatersrand, Department of Nursing Education. As part of my course requirement I am expected to conduct clinical research under supervision. The title of my research is: "*Level of Nurses' Competence in Mechanical Ventilation within Intensive Care Units of Two Tertiary Healthcare Institutions in Gauteng,"* and I would like to invite you to participate in the study.

I have chosen to study the competence of ICU nurses with regard to mechanical ventilation of the adult patient, as recent research studies locally and internationally question the competence of both ICU qualified and non-ICU qualified nurses working in the intensive care environment. (Scribante, et al. 2003; Binnekade, 2004; Pilcher et al., 2000). The study is quantitative and will be conducted in two phases.

The first phase requires validating an instrument developed by the researcher. The instrument comprises three clinical vignettes (similar to case scenarios) relating to three lung pathologies, viz & the normal lung, ARDS lung pathology, and obstructive outflow as described by Engelbrecht & Tintinger, (2007). I have chosen expert focus groups using a modified Delphi technique as my method for validation of the instrument, with experts from the disciplines of nursing, medicine, and clinical engineering. I have identified you as an expert within your field, with regard to mechanical ventilation, and as such would hope that you will consent to participate in the focus group.

As a participant of the focus group, you will be required to study the three clinical vignettes which will be emailed to you, and record your grading of the questions and comment on, content, clarity etc of the 29 items of the vignettes. A group discussion will follow when I have received the individual corrected vignettes, the objective of which is for all participants of the group to agree on scores for each of the 29 items, and reach consensus on each item.
The focus groups dates times and venues are as follows:

FOCUS GROUP	VENUE	DATE	TIME
Nursing	Dept. Nursing Education, University of the Witwatersrand.	12th May	15h00-17h30
Clinical Engineers	As above	12th May	15h00-17h30
Intensive care Doctors	As above	12th May	15h00-17h30

I expect each focus group to last approximately 2.5 hours. Refreshments and lunch will be provided.

I appreciate that you will derive no benefit from participating in the focus group, and participation is voluntary, and you may withdraw from the study at any time. However I hope that the completed study will help clarify the educational and clinical needs of the ICU nurse caring for the mechanically ventilated patient.

I have applied to the Faculty of Medicine Post Graduate Committee, and the Committee for Research on Human Subjects of the University of the Witwatersrand for permission to conduct the study.

I would be most grateful if you could let me know if you are willing to participate and are able to attend the focus group. I would appreciate your reply by the 1st May. I can be contacted on the numbers and email listed below.

I thank you for giving of your time to read this information letter.

Yours truly,

Lynn Botha
Cell Phone : 072 220 4134
Home Phone : (011) 781 3887
E-mail : lynnbotha@telkomsa.net

APPENDIX 3

Instrument

- Demographic data Section I
- Demographic data Section 2
- Demographic data Section 3
- Clinical vignettes Section 4
    - Vignette one
    - Vignette two
    - Vignette three

LEVEL OF NURSES' COMPETENCE IN MECHANICAL VENTILATION IN INTENSIVE CARE UNITS OF TWO TERTIARY HEALTH CARE INSTITUTIONS IN GAUTENG

DEMOGRAPHIC DATA- ICU QUALIFIED NURSES ONLY

INSTRUCTIONS: SECTION ONE

- Please complete the demographic data prior to completing the three clinical vignettes (questionnaires). Please answer **ALL** the questions.

- This information is required to carry out the data analyses of the research study and is strictly confidential. Your name **MUST NOT** appear anywhere to ensure confidentiality.

- Thank you for agreeing to participate in this study

---

1 DEMOGRAPHIC DATA

SECTION ONE

Instructions:

ONLY nurses holding an ICU QUALIFICATION to complete SECTION ONE.

1. Do you hold and ICU Diploma/Degree recognized by the SANC?

Yes	
No	

2. Is your qualification in ICU nursing a:

Diploma	
Degree	
Masters degree	
PHD in ICU	

3. What year did you obtain your ICU qualification?

19_____

4. How long did you work in ICU prior to undertaking the ICU course/degree?

1-2 years	
3-5years	
6-8years	
9-11 years	
>11years	

5. How long have you worked in ICU since obtaining your ICU qualification?

1-2 years	
3-5years	
6-8years	
9-11 years	
>11years	

6. What is your age? (Mark the appropriate block)

<20yrs	
20-30yrs	
31-40yrs	
41-50yrs	
51-60yrs	
>60 yrs	

7. What is your position in the ICU unit?

Unit manager	
Shift Leader	
Clinical Facilitator	
Other (please state position)	

8. Do you work ONLY in ICU?

YES	
NO	
ICU and Wards	

9. Please state the ICU discipline where you have the MOST experience.

General ICU	Paediatric ICU
Surgical ICU	Neonatal ICU
Medical ICU	Trauma
Neuro ICU	Casualty
Cardiology	Other (please state)
Cardiothoracic	

LEVEL OF NURSES' COMPETENCE IN MECHANICAL VENTILATION IN INTENSIVE CARE UNITS OF TWO TERTIARY HEALTH CARE INSTITUTIONS IN GAUTENG

DEMOGRAPHIC DATA - NON ICU QUALIFIED NURSES ONLY

INSTRUCTIONS: SECTION TWO

- Please complete the demographic data prior to completing the three clinical vignettes (questionnaire). Please answer **ALL** the questions.

- This information is required to carry out the data analyses of the research study and is strictly confidential. Your name **MUST NOT** appear anywhere to ensure confidentiality.

- Thank you for agreeing to participate in this study

---

2 DEMOGRAPHIC DATA

SECTION TWO

Instructions:

ONLY nurses who DO NOT hold an ICU QUALIFICATION to complete SECTION TWO

1. Mark the qualification which applies to YOU at the time of participating in this research study in the empty block next to the qualification that pertains to YOU.

Registered ICU QUALIFIED nurse	
Registered NON ICU Qualified Nurse with experience of ICU	
Registered Nurse undertaking the ICU course.(STUDENT)	
Registered ENROLLED nurse with experience in ICU	
OTHER:	

2. What year did you obtain your General Nurse/ Enrolled Nurse qualification?

19_____

3. How long have you been working in ICU?

1-2 years	
3-5years	
6-8years	
9-11 years	
>11years	

4. Do you work ONLY in ICU?

Yes	
No	
Work in ICU and wards.	

5. What is your age?

<20yrs	
20-30yrs	
31-40yrs	
41-50yrs	
51-60yrs	
>60 yrs	

6. What is your position in the ICU unit?

Shift Leader	
Clinical Facilitator	
Other (please state position)	

7. How many years of general ward experience did you have prior to working in ICU?

0-1 yr	
2-4yrs	
5-7yrs	
8-10yrs	
>10yrs	

8. Please state the ICU discipline where you have the MOST experience.

General ICU	Paediatric ICU
Surgical ICU	Neonatal ICU
Medical ICU	Trauma
Neuro ICU	Casualty
Cardiology	Other (please state)
Cardiothoracic	

LEVEL OF NURSES' COMPETENCE IN MECHANICAL VENTILATION IN INTENSIVE CARE UNITS OF TWO TERTIARY HEALTH CARE INSTITUTIONS IN GAUTENG

DEMOGRAPHIC DATA – ALL NURSES TO ANSWER

INSTRUCTIONS: SECTION THREE

- Please complete the demographic data prior to completing the three clinical vignettes (questionnaire). Please answer **ALL** the questions.

- This information is required to carry out the data analyses of the research study and is strictly confidential. Your name **MUST NOT** appear anywhere to ensure confidentiality.

- Thank you for agreeing to participate in this study

---

3 DEMOGRAPHIC DATA

SECTION THREE

Instructions: ALL nurses to answer SECTION THREE

1. Do you work in ICU?

Full time	
Part Time	
Agency only	
Combination of full time/partime and agency	

2. Are you a FULL TIME agency worker (are not employed by any hospital)?

Yes	
No	

3. Are you employed by a hospital but also do agency shifts?

Yes	
No	

4. At the time of participating in this research are you working as an agency staff member?

Yes	
No	

5. Are you required to take charge of the ICU on your shifts?

Yes	
No	
Sometimes	

6. If you are required to take charge is this on:

Day duty	
Night duty	
Both	

7. Do you rate your understanding of mechanical ventilation as?

Excellent	>75%
Very good	70-75%
Good	60-69%
Average	50-59%
Poor	40-49%

8. Are you required to make autonomous decisions regarding changes of ventilator settings?

Yes	
No	

9. ICU qualified staff who have been ICU qualified for 2 years or more have more knowledge about mechanical ventilation than ICU experienced staff who have worked in ICU for 2 years and don't have an ICU qualification.

Strongly agree	
Agree	
Disagree	

10. Are you of the opinion that you are competent to care for the mechanically ventilated patient?

Yes	
No	

11. Do you think you are up to date with new ventilator technology?

Yes	
No	

12. Are the majority of patients you care for in ICU mechanically ventilated?

Yes	
No	

13. Are you given adequate support and supervision by your senior nursing staff when caring for the ICU patient?

Yes	
No	

14. Are you given the opportunity to upgrade your knowledge and skills by attending congresses, going on courses, attending in service lectures, acquiring further qualifications?

Yes	
No	

15. If you have any comments you would like to make please write them in the space provided.

COMMENTS:

VIGNETTE ONE: NORMAL POST OPERATIVE PATIENT

Mr. Mbusi 48yrs old, weighing 70kg (ideal bodyweight 72kg) is admitted to the ICU post operatively having undergone major abdominal surgery. He has no history of lung pathology and the surgeon wants him ventilated only overnight, with a view to extubation 24hrs later. Soon after his admission to the ICU, Mr. Mbusi becomes agitated and restless. You do a blood gas which is normal.

QUESTION 1

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

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

QUESTION 2

Mr. Mbusi 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.

QUESTION 3

The doctor having assessed Mr. Mbusi asks you to increase the pressure support pressure from 10 cm/H20 to 15 cm/ H20. The PEEP is 5 cm/H20

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

a) PSV breaths always have the same tidal volume
b) PSV is not used when weaning patients from the ventilator
c) PSV breaths are triggered and cycled by the ventilator
d) PSV aids in ventilation and is adjusted in response to C02 levels.

e) Don't Know.

QUESTION 4

Later that night an arterial blood gas is done on Mr. Mbusi .Select the **ONE** Combination of diagnostic data that would best reflect oxygenation and ventilation from the choices given below.

a) Chest X-ray, $Sp0_2$

b) Heart rate, $ETC0_2$

c) Sa02 $ETC0_2$

d) Respiratory rate, $Sa0_2$

e) Don't know.

QUESTION 5

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

a) There is a leak in the ventilator circuit.

b) The ventilator was not calibrated with the humidification system in place

c) The exhaled tidal volume SHOULD be larger than the INSPIRATORY tidal volume

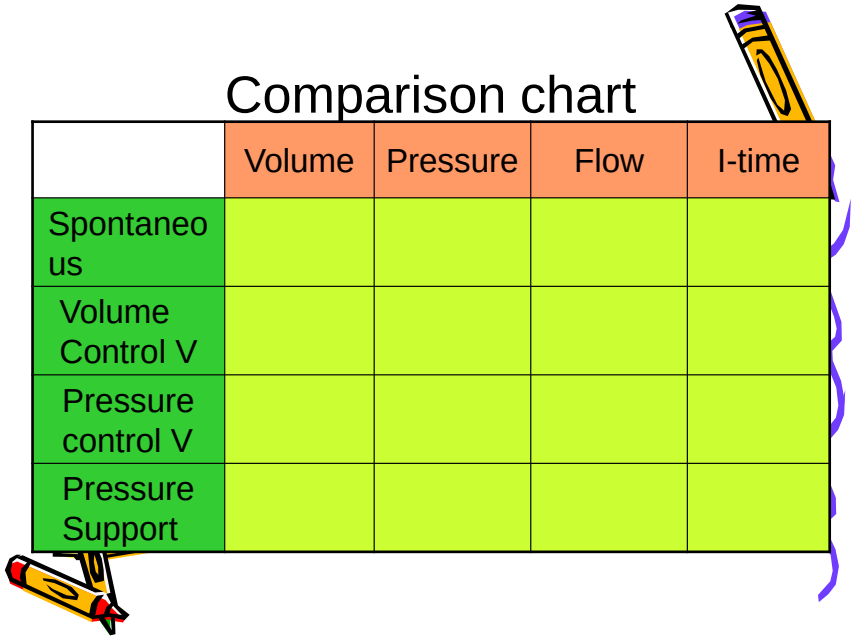
d) The ET tube cuff is leaking

e) Don't know

QUESTION 6

The nurse who is helping you with Mr. Mbusi is doing the ventilator observations for the hour, and asks you "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.



QUESTION 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.

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

QUESTION 8

The following morning an assessment is made by you and the doctor that Mr. Mbusi 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?

a) Patient still dependant on Inotropic support to maintain haemodynamic stability
b) RR rate > 10 and <30 breaths per min
c) Temp 36 degrees.
d) PC02 33-35mm/Hg
e) Don't Know

QUESTION 9

The decision to wean Mr. Mbusi 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?

a) 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.
b) CPAP /PEEP is decreased first, followed by reduction in pressure support, followed by reduction of 0_2 % followed by reduction of mandatory respiratory rate.
c) Pressure support reduced first, followed by reduction of mandatory respiratory rate, followed by reduction in 0_2% followed by reduction in PEEP/CPAP.
d) Rate reduced first, followed by reduction of 02% followed by reduction of pressure support, followed by reduction of PEEP/CPAP.
e) Don't Know

QUESTION 10

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

a) The oropharynx must be suctioned and then down the ET tube.
b) The cuff of the ET tube must be inflated to prevent aspiration on extubation
c) The patient is asked to cough
d) Post extubation the patient must be sitting up in bed and 40% 02 administered.
e) Don't Know

VIGNETTE TWO: ARDS

Mrs. Mayeke 48yrs 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 Acute Respiratory Distress Syndrome. (ARDS) as a result of fat embolus. She has a "white out" bilaterally on chest X-Ray and her lung compliance is decreased. The doctor says she must be ventilated using protective lung strategies.

QUESTION 1

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

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

QUESTION 2

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

QUESTION 3

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

a) P/C SIMV, 0_2 65%, Rate 20bpm, Pressure limit 30cm/H20, PEEP 12cm/H_2O, Pressure support 22cm/H20, Trig -2
b) 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
c) 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
d) V/C SIMV, 0_2 100% TV 450mls, Peak flow 40L rate 25bpm PEEP 5, Pressure support 5cm/H_20 trigger -2cm/H_2O
e) Don't Know

QUESTION 4

4 hrs later Mrs. Mayeke 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

QUESTION 5

Mrs. Mayeke improves after you have instituted the correct intervention.

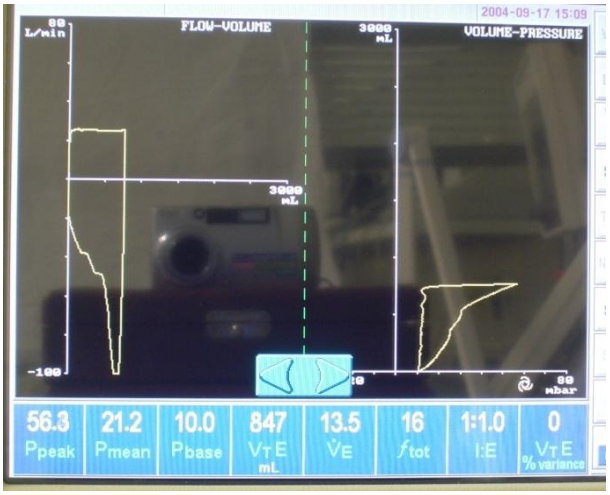
With regards to PEEP, what is the effect of optimal PEEP at alveolar level of the lungs? Select the **ONE CORRECT** statement.

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

QUESTION 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.



a) Shows the lung has normal compliance
b) The patient has significant increased work of breathing
c) The lungs are over distended
d) The PEEP level setting on the ventilator is 15cm/H20
e) Don't Know

THE END OF VIGNETTE 2

GO TO THE NEXT PAGE TO COMPLETE VIGNETTE NUMBER 3.

You are not finished yet!!

VIGNETTE THREE: CHRONIC OBSTRUCTIVE AIRWAYS DISEASE.

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 35breaths 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 arterial blood gas (ABG) drawn whilst Mrs.Smith is receiving 2 L of oxygen via nasal cannula shows:

Ph 7.3	
$PaCO_2$ 60mm/Hg (8 mm/L)	3.1.1
PaO_2 55mm/Hg (7.3mm/L)	3.1.2
BE -1	
SBC 24 mm/L	
SaO_2 90%	

QUESTION 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.

QUESTION 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

QUESTION 3

2 hrs 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

QUESTION 4

2 hrs 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?

a) 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
b) 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,
c) Spontaneous mode, PEEP 7.5cm/H_20 and Pressure support 25cm/H_20
d) Volume control SIMV, Peak Flow 40L Mandatory rate 10 bpm, Pressure support 15 Cm/H_20, PEEP 7.5 cm/H_20, 35% 0_2 IE 1:4
e) Don't Know

QUESTION 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.

a) Increase the respiratory rate

b) Decrease the respiratory rate

c) Increase the inspiratory time

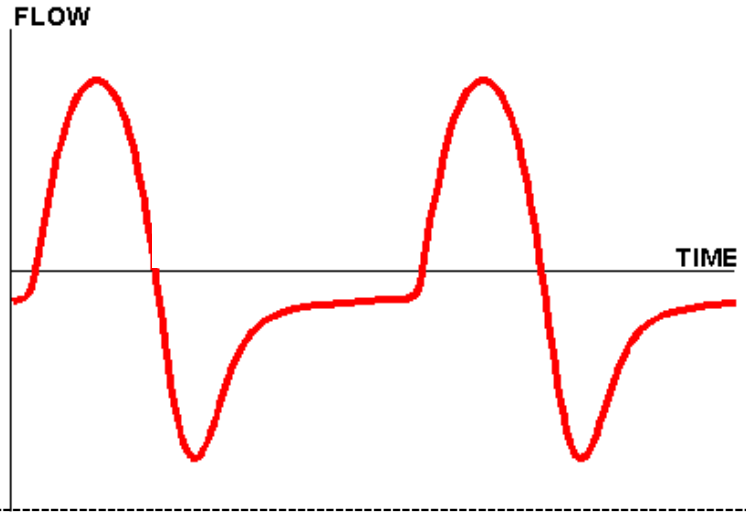
d) Decrease the expiratory time

e) Don't know

QUESTION 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:----------

THE END

Thank you for participating in my research. It is much appreciated. Please ensure that you have answered ALL 6 questions. If you don't know the answer mark e).

Your identity, score, and unit remain anonymous even to the researcher.

On completion of the vignette please place the completed vignette in the brown envelope provided and seal it, and hand it back to the researcher.

APPENDIX 4

Participant Consent Form

LEVEL OF NURSES' COMPETENCE IN MECHANICAL VENTILATION IN INTENSIVE CARE UNITS OF TWO TERTIARY HEALTH CARE INSTITUTIONS IN GAUTENG

PARTICIPANT CONSENT FORM

I,_____(name), fully understand

the contents of the information letter. I have been offered the opportunity to ask questions and these have been answered to my satisfaction. I understand that I may withdraw from this verification process at any stage without penalty. I have been assured that my anonymity and confidentiality will be maintained.

I hereby give consent to participate in this study.

_____

(Participant signature)

_____

(Date)

_____

(Researcher signature)

_____

(Date)

APPENDIX 5

Information Letter and Request for Participation in Research Study

LEVEL OF NURSES' COMPETENCE IN MECHANICAL VENTILATION IN INTENSIVE CARE UNITS OF TWO TERTIARY HEALTH CARE INSTITUTIONS IN GAUTENG

INFORMATION LETTER AND REQUEST FOR PARTICIPATION IN RESEARCH STUDY

Dear Colleague,

My name is Lynn Botha. I am an Intensive Care Nurse and am currently registered to read for a Masters Degree in Nursing Science at the University of the Witwatersrand, Department of Nursing Education. As part of my course requirement I am expected to conduct clinical research under supervision. The title of my research is: **"Level *of Nurses' competence in Mechanical Ventilation in Intensive Care Units of Two Tertiary Care Institutions in Gauteng,"*** and I would like to invite you to participate in the study.

The purpose of the study is to determine and describe the competence of nurses working in intensive care units within two tertiary healthcare institutions in Gauteng, with respect to the mechanically ventilated patient. The study participants will be ICU qualified and non-ICU qualified nurses with varying years of experience working in the ICU. The study will make recommendations for clinical practice, education of ICU nurses, and clinical guidelines currently being developed by the Nurses Forum of the Critical Care Society of Southern Africa.

Should you consent to participate in the study I will require that you sign a consent form. I will then ask that you complete three clinical vignettes. Vignettes consist of a clinical scenario, and you are required to answer questions in relation to the clinical scenarios. This process should take no longer than thirty to forty minutes. For the purpose of this research the clinical scenarios and questions will all relate to mechanical ventilation of the adult patient within the ICU environment. I will obtain permission from your Unit Manager to complete the questionnaire in "on duty" time, and will personally bring the questionnaire to you at a time when you are on duty. Completed questionnaires will be placed in a sealed unmarked envelope so as to ensure confidentiality and anonymity. Your name will not appear anywhere on the questionnaire.

Participation is entirely voluntary. You may choose not to participate or withdraw from the study at any time. Anonymity and confidentiality is guaranteed. I will personally analyze the questionnaire results once the study is completed. No names or any identifying information

regarding the hospital or the intensive care unit you are working in will be noted and a process of coding will be used to maintain anonymity. All completed questionnaires will be kept under lock and key and only my supervisor and I will have access to your completed questionnaire. Results of the questionnaire will be written in general terms and no personal information will be given. Results of the study will be made available to you if you so wish.

I appreciate that you will derive no direct benefit from participating in this study. However I hope that the completed study will help clarify the educational and clinical needs of nurses working in ICU with regard to mechanical ventilation.

I have applied to the Faculty of Medicine Post Graduate Committee and to the Ethics Committee of the University of the Witwatersrand to conduct the study. In addition I have also applied to the management of your Health Institution for permission to conduct the study.

Thank you for taking the time to read this information letter. I will be visiting your unit in March 2006 to begin my data collection. Should you wish to contact me, or require any further information you are welcome to contact me at the telephone numbers listed below.

Yours sincerely

Lynn Botha
Cell Phone : 072 220 4134
Home Phone : (011) 781 3887
E-mail : lynnboth@telkomsa.net

APPENDIX 6

Research Consent Request Letters

- Charlotte Maxeke Johannesburg Academic Hospital (Formerly known as Johannesburg Academic Hospital) Letter of Consent
- Chris Hani Baragwanath Hospital

LEVEL OF NURSES' COMPETENCE IN MECHANICAL VENTILATION IN INTENSIVE CARE UNITS OF TWO TERTIARY HEALTHCARE INSTITUTIONS IN GAUTENG

76 Curvy Road
Blairgowrie
RANDBURG
2194

Dr Pillay
Chief Executive Officer
Charlotte Maxeke Hospital
Private Bag X39
Johannesburg 2000

Dear Dr Pillay

RESEARCH AT CHARLOTTE MAXEXE HOSPITAL

My name is Lynn Botha and I am presently registered as a MSc. Student at the University of the Witwatersrand, Department of Nursing Education. As part of the course requirement, I am expected to conduct clinical research under supervision. The title of my research is: "*Level of Nurses' Competence in Mechanical Ventilation within Intensive Care Units of Two Tertiary HealthCare Institutions in Gauteng*."

The significance of carrying out this research lies in the fact that intensive care units in South Africa are staffed mainly by non intensive care qualified staff, and it is of importance to determine if the nurses who care for the mechanically ventilated patient are competent and carry out their practice safely and efficiently. The outcomes of the research will be used to inform nursing education, clinical practice, and the need for further research.

I hope to profile intensive care nurses working at Johannesburg Hospital, within the Trauma ICU, Cardiothoracic ICU, Neurosurgical, and General ICU. I will obtain permission from the relevant heads of medical and nursing staff of these units.

I wish to assure you that the name of your institution and the personnel who consent to participate in the research study will not be divulged in the report, and my supervisor and myself ensure confidentiality of all questionnaires. Consent will be obtained from all the research participants.

I hereby apply for permission to undertake research at Johannesburg Hospital, within the above-mentioned ICU units, once the Post Graduate Committee and the Committee for Research on Human Subjects of the University of the Witwatersrand have approved my proposed study.

Yours sincerely

Lynn Botha (MSc Student)

LEVEL OF NURSES' COMPETENCE IN MECHANICAL VENTILATION IN INTENSIVE CARE UNITS OF TWO TERTIARY HEALTH CARE INSTITUTIONS IN GAUTENG

76 Curvy Road
Blairgowrie
RANDBURG
2194

Dr Manning
Chief Executive Officer
Chris Hani Baragwanath Hospital
Johannesburg 2000

Dear Dr Manning

RESEARCH AT CHRIS HANI BARAGWANTH HOSPITAL

My name is Lynn Botha and I am presently registered as a MSc. Student at the University of the Witwatersrand, Department of Nursing Education. As part of the course requirement, I am expected to conduct clinical research under supervision. The title of my research is: "*Level of Nurses' Competence in Mechanical Ventilation within Intensive Care Units of Two Tertiary HealthCare Institutions in Gauteng*."

The significance of carrying out this research lies in the fact that intensive care units in South Africa are staffed mainly by non intensive care qualified staff, and it is of importance to determine if the nurses who care for the mechanically ventilated patient are competent and carry out their practice safely and efficiently. The outcomes of the research will be used to inform nursing education, clinical practice, and the need for further research.

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I wish to assure you that the name of your institution and the personnel who consent to participate in the research study will not be divulged in the report, and my supervisor and myself ensure confidentiality of all questionnaires. Consent will be obtained from all the research participants.

I hereby apply for permission to undertake research at Johannesburg Hospital, within the above-mentioned ICU units, once the Post Graduate Committee and the Committee for Research on Human Subjects of the University of the Witwatersrand have approved my proposed study.

Yours sincerely

Lynn Botha (MSc Student)

Private bag X39, Johannesburg 2000, South Africa
Tel: +27 (0) 11 488 4911, Fax: +27 (0) 11 643 1612
www.johannesburghospital.org

Gauteng Department of Health

Enquiries: M. Motjelele
(011): 488-3785
(011) 488-3753

14 December 2006

Ms. Lynn Botha
76 Curvy Road
Blairgowrie
2194

Dear Ms. Botha

RE: Permission to Undertake Research on the Level of Nurses competency in mechanical ventilation within intensive care units

Permission is granted for you to conduct the above research as described in your request provided:

1. Johannesburg hospital will not in anyway incur or inherit costs as a result of the said study.
2. Your study shall not disrupt services at the study sites.
3. Strict confidentiality shall be observed at all times.
4. Informed consent shall be solicited from patients participating in your study.

Please liaise with the Head of Department and Unit Manager or Sister in Charge to agree on the dates and time that would suit all parties.

Kindly forward this office with the results of your study on completion of the research.

I wish you success in your studies.

Yours sincerely

Sagie Pillay
Chief Executive Officer

APPENDIX 7

Postgraduate Committee Approval

Faculty of Health Sciences
UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

7 York Road PARKTOWN Johannesburg 2193 Telegrams WITSMED Telex 4-24655.SA
FAX 643-4318 TELEPHONE 717-2075/2076
E-MAIL healthpg@health.wits.ac.za

MRS ML BOTHA
P O BOX 2511
PINEGOWRIE
2123

APPLICATION NUMBER 8805286V
STATUS (DEG 7) (MM042) PZZ

2006-06-09

Dear Mrs Botha

Approval of protocol entitled Level of nurses' competence in mechanical ventilation within intensive care units of two tertiary health care institutions in Gauteng

I should like to advise you that the protocol and title that you have submitted for the degree of Master Of Science In Medicine (Part-Time) have been approved by the Postgraduate Committee at its recent meeting. Please remember that any amendment to this title has to be endorsed by your Head of Department and formally approved by the Postgraduate Committee.

Ms. S Schmollgruber has/have been appointed as your supervisor/s. Please maintain regular contact with your supervisor who must be kept advised of your progress.

Please note that approval by the Postgraduate Committee is always given subject to permission from the relevant Ethics Committee, and a copy of your clearance certificate should be lodged with the Faculty Office as soon as possible, if this has not already been done.

Yours sincerely

S Benn (Mrs)
Faculty Registrar
Faculty of Health Sciences

Telephone 717-2075/2076

Copies - Head of Department____Supervisor/s

APPENDIX 8

- **Ethical Clearance**

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Botha

CLEARANCE CERTIFICATE	PROTOCOL NUMBER M060237
PROJECT	Level of Nurses' Competence in Mechanical Ventilation within Intensive Care Units of Three Tertiary Healthcare....
INVESTIGATORS	Ms ML Botha
DEPARTMENT	Dept of Nursing Education
DATE CONSIDERED	06.02.24
DECISION OF THE COMMITTEE*	Approved subject to informing volunteers that confidentiality cannot be guaranteed in a focus group discussion

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE 06.02.27 CHAIRPERSON .....
(Professor PE Cleaton-Jones)

*Guidelines for written 'informed consent' attached where applicable

cc: Supervisor : Dr S Schmollgruber

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10005, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

12-6-2006

APPENDIX 9

- **Department of Health Consent**

MSc PROPOSAL FOR MARGARET LYNN BOTHA

The MSc Proposal for Margaret Lynn Botha has been received at the Gauteng Health Department situated at the Bank of Lisbon Building, Cnr of Sauer and Market Street JHB, 16th Floor, office of Dr Rahman, by----------

on this day 12th July 2006

Time....9..A.M.....

Signed

Dr. A. RAHMAN

For the Gauteng Health Department

Acting Head: HEALTH

Signed
