ROLES OF SPECIALIST INTENSIVE CARE NURSES IN MECHANICAL VENTILATION

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DECLARATION

I, Chinwe Jacinta Ladipo declare that this research report is my own work. It is being submitted for the degree of Master of Science (in Nursing) at the University of the Witwatersrand, Johannesburg. It has not previously been submitted for any degree or examination at this or any other university.

Signature …………………………………………….

………………………………day of ………………… 2017

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Father, you have been with me all the way, and I appreciate you God Almighty for your ever abiding presence, never would I have made it without you.

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I am very grateful.

ABSTRACT

The purpose of this study was to describe the role of specialist nurses in mechanical ventilation management. The intention of the study was also to make recommendations for clinical practice and education of intensive care nurses. The setting of the study was ten (n = 10) adult intensive care units of two public hospitals in the Gauteng province. Included were trauma ICUs, cardiothoracic ICU, coronary care ICUs, major burns ICU, major injuries ICU, neurosurgery ICU and multidisciplinary ICUs.

A non-experimental, descriptive, quantitative and cross-sectional survey design was used to describe the specialist nurses role in ventilation management. The final sample comprised 110 (out of 165) respondents, which yielded a response rate of 66.6% for the study. Data were collected from specialist intensive care nurses using a validated questionnaire developed by Rose et al. (2011). Data was analysed using descriptive (frequencies, means and standard deviation) and comparative statistical tests using t-tests and Chi-square analysis. Testing was done at the 0.05 level of significance.

Of the 165 surveys distributed, 110 were returned (response rate 66.6%). Ninety-seven percent stated that a 1:1 ratio was used for patients receiving mechanical ventilation. Eighty-nine percent reported ventilation education for nurses was provided during ICU orientation, and 86.4% indicated ICUs provided opportunities for on-going ventilation education. Eighty-six percent of nurses reported that they had not worked in ICUs with automated weaning modes. Fifty-nine percent stated that weaning protocols were present in ICUs, and 56.4% reported the presence of protocols for weaning failure.

Most nurses agreed that nurses and doctors collaborated in key ventilation decisions, but not when decisions to extubate and initial ventilation settings are made. This study showed a marginal (2%) number of nursing autonomous input made in key ventilator decisions. Seventy percent of nurses in this study agreed that responsibility for ventilation decisions lies at the level of senior registrars and above, and in their absence, only senior nurses (>80%) were perceived to be responsible for key ventilator decisions.

Regarding independent titrations of ventilator settings, without medical consultation, findings showed that nurses in this study reported a frequency of >50% of the time for titration of respiratory rate, tidal volume, decreasing pressure support, increasing pressure support, titration of inspiratory pressure and ventilation mode changes. The self-perceived nursing autonomy and influence in decision making revealed a median score of 7 out of 10 points, respectively. Nurses with higher levels of autonomy, influence in decision making and years of experience scores, frequently (>50% of the time) made independent changes to ventilation settings ($p<0.05$). Conversely, nurses with fewer years of experience scores, infrequently (<50% of the time) made independent changes to ventilation settings without first checking with the doctor.

The study concludes that nurses to re-evaluate their role in ventilation management and focus on key ventilation settings, nurses could strengthen their contribution in the collaboration of key ventilator settings. Recommendations are made for clinical practice and education of specialist nurses.

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LIST OF ABBREVIATIONS

The following is a list of abbreviations used in the study:

ASV	Adaptive Support Ventilation
CPAP	Continuous Positive Airway Pressure
ETT	Endotracheal Tube
FiO_2	Fraction of inspired oxygen
GCS	Glasgow Coma Scale
ICU	Intensive Care Unit
MMV	Mandatory Minute Ventilation
$PaCO_2$	Partial pressure of carbon dioxide in arterial blood
PaO_2	Partial pressure of oxygen in arterial blood
PAV	Proportional Assist Ventilation
PSV	Pressure Support Ventilation
PEEP	Positive End Expiratory Pressure
T piece	Thermovent
RSBI	Rapid Shallow Breathing Index
SaO_2	Arterial oxygen saturation
SBT	Spontaneous Breathing Trial
SIMV	Synchronized Intermittent Mechanical Ventilation

CHAPTER ONE

OVERVIEW OF THE STUDY

1.0 INTRODUCTION

This chapter presents an overview of the study. The background of the study, problem statement and purpose of the study, objectives and significance of the study are described. The researcher's assumptions and operational definitions are stated. A brief overview of the research methods, ethical considerations and the validity and reliability of the study will be described.

1.1 BACKGROUND OF THE STUDY

Critically ill patients are admitted to the intensive care units, where they receive ongoing surveillance and intense treatment. The use of highly sophisticated and advanced technological devices forms a major part of the intensive care environment (Elliott, Aitken & Chaboyer, 2013). Mechanical ventilation is the most commonly used treatment intervention in the care of critically ill patients (Rose, 2010; Spieth, Koch & de Abreu, 2014). McLean, Jensen, Schroeder, Gibney and Skjodt (2006) reported that worldwide more than 90% of adult patients are mechanically ventilated during a period of critical illness.

There are many clinical reasons for initiating mechanical ventilation. Oh, Soni and Bersten (2008) categorised these, as the need to maintain adequate oxygenation and removal of carbon dioxide, the management of Type I and Type II respiratory failure, cardiac arrest and central nervous system dysfunction. Esteban, Frutos-Vivar, Muriel, Ferguson, *et al.* (2013) found in their study, that the most common reasons for mechanical ventilation were community acquired pneumonia (66%). Followed by hospital-acquired pneumonia (34%), hemorrhagic stroke (30%), postoperative (21%), brain trauma (19%), metabolic disorders (17%), overdose or intoxication (13%), sepsis (9%), trauma (6%), congestive cardiac failure (6%) and cardiac arrest (5%) (Esteban *et al.*, 2013).

Mechanical ventilation is required when a patient is unable to maintain an adequate level of oxygenation and ventilation by natural means. The patient is intubated into trachea using an endotracheal tube, which is a hollow plastic tube used to create an artificial airway (Elliott, *et al.,* 2013). Either the oral route or nasal route is used for endotracheal intubation. An artificial airway bypasses the body's natural defence system and, thereby posing an increased risk of infections for the patient. (Craven, Lei, Ruthazer, Sarwar & Hudcova, 2013; Grap, Munro, Ashanti & Bryant, 2003).

Mechanical ventilation is a life-saving intervention. However, it can become a costly treatment when associated with iatrogenic complications such as ventilator-induced lung injury (VILI), which can trigger an inflammatory response and lead to the development of Acute Respiratory Distress Syndrome (ARDS) (Rose, 2010; Spieth, *et al.*, 2014). A further problem is the development of ventilator-associated pneumonia (VAP), which has become a central challenge in intensive care units (Alvarez-Lerma, Sanchez-Garcia, Lorente, Gordo, *et. al.,* 2014; Craven, *et al.,* 2013; Lorente. Blot & Rello, 2010). According to Cason, Tyner, Saunders and Broome (2007) and Craven *et al.* (2013) ventilator-associated pneumonia accounts for up to 47% of all infections in intensive care units. It can lead to complications in about 8% to 38% of mechanically ventilated patients and result in a mortality rate of 24% to 50% (Grap *et al.,* 2003).

When the patient's condition has stabilised or begins to resolve, attention is shifted to the process to liberate the patient from mechanical ventilation. El-Khatib and Bou Khalil (2008:221) defined "weaning as an abrupt or gradual withdrawal of mechanical ventilation and resumption of spontaneous breathing". The weaning process can occur abruptly by rapid withdrawal of mechanical ventilation after a short trial period of spontaneous breathing or gradually by reduction of ventilatory support over a period (Rose & Nelson, 2006).

Several weaning indexes have been developed to predict successful weaning from mechanical ventilation. Burns, Fisher, Tribbel, Lewis, *et al.* (2010) developed the Burns Weaning Assessment Programme (BWAP) as a continuum to track and assess patient's readiness for weaning. Over 20 BWAP factors have been found to have high predictive value for successful weaning outcome (Burns, Fisher, Sidenia, Tribble, *et al.,* 2012). Grap, Stricklund, Tormey, Keane, *et al.* (2003) found the Rapid Shallow Breathing Index (RSBI) to be an accurate predictor of weaning success in their study.

The use of weaning protocols has advantages that are suggested to play a role in achieving successful weaning (Crocker, 2002; Grap *et al.*, 2003). Tonnelier, Prat, Le Gal, Gut-Gobert *et al.* (2005) found that protocol-directed weaning led by nurses resulted in a decrease in the duration of mechanical ventilation. These authors reported on adverse effects and found no increase in patient re-intubation rates. These weaning protocols utilise a daily nurse screening test, followed by a single spontaneous breathing trial (SBT) of 90-minute duration and physician approval before extubation (Tonnelier, *et al.*, 2005).

Weaning protocols are associated with a 25% shorter period of mechanical ventilation, 78% shorter weaning period, and 10% shorter stay in the intensive care unit (Blackwood, Alderice, Burns, Cardwell *et al.*, 2011). Esteban *et al.* (2013) observed that the mortality rate is proportional to the duration of mechanical ventilation. Grap *et al.* (2003) and Ouellette *et al.* (2017) also predicted that the rapid shallow breathing index was the most accurate predictor of weaning success. Crocker (2002) concurred that nurses could expedite weaning from mechanical ventilation.

Conversely, Price (2001) noted that it is not clear whether the protocol or the increased role of the nurse leads to a shorter weaning period. By their professional scope of practice specialist nurses are expected "to understand patient data, to identify and diagnose actual or potential problems, and to enhance resolutions to solve problems to improve patient outcomes" (Elliott *et al.*, 2013:13). Many studies have demonstrated that increased nursing autonomy in decision making brings about better outcomes for critically ill patients (Rose, Nelson, Johnston & Presneill, 2007). However, there is a limited amount of data both, in South Africa and Internationally that explored intensive care nurse's role in decision making related to mechanical ventilation, this study, therefore, intended to investigate specialist nurses role in the management of mechanical ventilation in South Africa.

1.3 PROBLEM STATEMENT

Studies conducted internationally suggest that ventilation management is fundamentally a collaborative effort between doctors and specialist nurses. It is so because of the perceptions and opinions of nurse managers in these studies, and not the viewpoints of individual nurses themselves. It does raise a concern because this may not be an accurate reflection of what individual nurses do. If these nurses are to gain credibility in advanced practice, they need to have a clear understanding of what they are expected to do.

The South African nurse's scope of practice does not clearly define the expanded functions of specialist nurses. Studies to-date are limited in the South Africa context that focuses in particular on the nurse's role in decision making related to ventilation management. To ensure the specialist nurse's role is not under- or over- represented in actual practice this South African study, therefore, intended to describe the role of these nurses in the management of mechanical ventilation.

The study attempted to answer the following research question?

- What is the role of the specialist nurse in the management of the patient during mechanical ventilation?

1.4 PURPOSE OF THE STUDY

The purpose of the study is to describe the role of specialist nurses in the management of mechanical ventilation. The study also intended to make recommendations for clinical practice and education of specialist nurses.

1.5 OBJECTIVES

The objectives of the study were:

- To describe specialist nurses collaborative practices in key ventilator decisions and acting independently in titrating ventilator settings.
- To relate the association of specialist nurses autonomy and influence in decision making to independent titrations of ventilator settings.
- To identify specialist nurse's level of independent decision making in oxygen and positive end-expiratory pressure titrations.

1.6 SIGNIFICANCE OF THE STUDY

This study intended to obtain information about the role of the specialist nurse in the management of mechanical ventilation. This information is important to clarify the expected role functions and responsibilities of specialist nurses regarding advanced practice. Acknowledgement of the specialist nurse's role in the multi-disciplinary team will lead to enhanced teamwork and improved patient outcomes, and may even strengthen collaborative relationships between doctors and specialist nurses. It is hoped that this clarification will assist specialist nurses to differentiate their practices from other nurses who may work in the intensive care setting without formal intensive care training. Obtaining this clarification may be helpful to the South African Nursing Council to define the role functions and establish boundaries for these specialist nurses.

1.6 RESEARCHER'S ASSUMPTIONS

1.6.1 Meta-theoretical Assumptions

Chinn and Kramer (2008:53) state that the meta-theoretical assumptions in nursing usually "reflect the central concepts of the discipline of nursing, which includes the person, environment, health and nursing".

1.6.1.1 Person

The person in this study is the patient in the intensive care unit. This patient has physical, psychological, social and spiritual needs experienced in the health and illness continuum. The nurses' understanding of the patient as an individual, and application of the knowledge of respiratory physiology for mechanical ventilation management to minimise complications.

1.6.1.2 Environment

Man's environment constitutes internal and external factors which can influence him physiologically, psychologically, spiritually and socio-culturally. Body, mind and spirit are central to man's internal environment while the intensive care unit and all the equipment especially mechanical ventilation is an external factor. Early weaning of these patients minimises the risks and complications associated with mechanical ventilation.

1.6.1.3 Nursing

The specialist nurse integrates all skills, knowledge and competence to assess the patient, adjust the ventilator setting, recognise readiness to wean and extubate mechanically ventilated patient so as to minimise complications. It is based on the application of advanced respiratory knowledge and an individualised patient centred approach. The role of specialist intensive care nurse in mechanical ventilation management is to understand the constant change, adjustment, adaptation and individual response during mechanical ventilation and minimise complication associated with this life-saving intervention in the attempt to restore health. According to AACN Synergy Model Patient Care, when patients and families characteristic, match nurses competencies the best patient outcomes will be achieved (Alspach, 2006).

1.6.1.4 Health

The World Health Organisation (WHO) defines health not only as a state of well-being but also an absence of disease (WHO, 1948). Because individuals can understand the notion of health in many different ways, the researcher has chosen to adopt a more comprehensive approach that incorporates health as both illness and disease and the promotion of well-being. It would be in line with the current Primary Health Care (PHC) approach adopted in the provisions of the South African Healthcare System.

1.6.2 Theoretical Assumptions

Theoretical assumptions are inclusive of concepts and theories used as a point of departure in a study. It also includes the operational definitions used in a study.

1.6.2.1 Operational definitions

Definitions for the purpose of the study are as follows:

- **Critically ill patient**

A critically ill patient is a person who has a manifest or potential life threatening illness or injury, and complications thereof (Elliott *et al.,* 2013). More critically ill patients are characterised by vulnerability, instability and complexity (Alspach, 2006), and require intensive and vigilant nursing care in an intensive care unit.

- **Specialist intensive care nurse**

An intensive care nurse is a specialist nurse who functions at an advanced practice level (SANC, 2014). This nurse has undergone an advanced education and training programme in intensive care nursing and registered with the South African Nursing Council (SANC) as an intensive care specialist nurse (SANC, 2014). This nurse carried the responsibility for the care of mechanically ventilated patients in intensive care units and referred to as the specialist nurse in the study.

- **Intensive care unit**

An intensive care unit is a highly technological unit, highly sophisticated unit of a hospital, dynamic, complex, stressful and challenging environment. These units are specialised units where all efforts are the care of patients are concentrated in one location in the hospital because they are likely to need specialised techniques administered by a team of skilled personnel (Oh *et al.,* 2008).

- **Mechanical ventilation**

Mechanical ventilation is part of treatment for intensive care patients. Mechanical ventilation describes the process of application of positive and negative pressure breaths using invasive and non-invasive techniques (Rose *et al.,* 2007). It incorporates the process of putting the patient on mechanical ventilation and taking them off it.

- **Weaning**

Weaning is the process of discontinuing mechanical ventilation or liberating the patient from mechanical ventilatory support (Blackwood, 2000; Hess, 2001). It comprises of a plan that directs a series of coordinated steps and can occur rapidly or gradually. The weaning process should commence as soon as the mechanically ventilated patient is capable of breathing independently.

- **Roles**

The acknowledged function or position of an individual. For the purpose of this study, the roles of specialist nurses in mechanical ventilation management will be determined by using a questionnaire developed by Rose *et al*. (2011).

- **Titration of Positive End Expiratory Pressure (PEEP)**

This is a small adjustment of pressure at the end of expiration (to enhance alveoli stability, prevent alveoli collapse and promote gas exchange). It is titrated to control pressure while maintaining the pressure set on the mechanical ventilation circuit

- **Titration of Fraction of Inspired Oxygen (FiO^2)**

This is the adjustment of the flow of oxygen to minimise complications during mechanical ventilation such as acute lung injury, e.g. to low settings will lead to hypoxia and to high can cause oxygen toxicity.

1.6.3 Methodological Assumptions

Methodological assumptions not only assist to give shape to the research context but also influence a researcher's decisions about the research design. A quantitative, non-experimental descriptive survey design was chosen as the most appropriate approach to obtain information required in this study. The study was conducted to explore the role of specialist nurses in mechanical ventilation management to assist in clarifying the level of function expected of these specialist nurses in clinical practice.

1.7 OVERVIEW OF THE RESEARCH METHODOLOGY

A non-experimental, descriptive quantitative survey and cross-sectional design were used to achieve the study objectives. The study took place in intensive care units of two public hospitals in the Gauteng province. Ten adult, intensive care units was chosen because they are categorised as Level-III intensive care units in terms of the South African Society of Anaesthesiologists (SASA) practice guidelines.

The target population was all specialist nurses practising in the ten adult intensive care units at the selected study sites. A non-probability, a convenience sample was used to select the total sample of study participants (N = 165) after consultation with a biomedical statistician.
Before commencement of the study, ethical clearance and permission to conduct the study were obtained from the hospital management on behalf of the Gauteng Department of Health. Also, permission was obtained from the respective nurse unit managers to conduct the study. Data was collected using a self-administered questionnaire developed by Rose *et al.* (2011), and used to describe the role of the specialist nurses in ventilation management.

Descriptive statistics were used to analyse the sample demographics and study variables. Independent sample t-tests were applied to analyse the mean scores of nurse's level of autonomy and influence in decision making. The Chi-square analysis and two-by-two cross tables were used to proportionate relationships on independent titration in ventilation settings and the presence of ventilation protocols. Statistical tests at the 0.05 ($p<0.05$) level of significance was used, and the statistical software package Statistica ™ version 13.2 used for the data analysis.

1.8 ETHICAL CONSIDERATIONS

The following ethical requirements were taken into consideration.

- The research protocol was submitted to the Department of Nursing Education to assess the feasibility of the study.
- The research protocol and procedures were submitted to the Postgraduate Committee in the School of Therapeutics, Faculty of Health Sciences for permission to conduct the study.
- Ethical clearance to conduct research was obtained from the Committee for Research on Human Subjects of the University of the Witwatersrand.
- Permission to conduct the study at the selected study sites was obtained from Hospital Management on behalf of the Department of Health in the Gauteng province.
- Written permission to use the research questionnaire (Rose *et al.*, 2011) was obtained from Professor Louise Rose.
- To ensure confidentiality and anonymity of respondents code numbers were used for data analysis and reporting.
- Respondents were informed that participation in the study was voluntary and they could decide to withdraw their participation from the study at any time without incurred penalty.

1.9 OUTLAY OF THE REPORT

The research report will be presented as follows:

Chapter One:	Overview of the study
Chapter Two:	Literature review
Chapter Three:	Research design and methods
Chapter Four:	Data analysis and results
Chapter Five:	Summary, main findings, limitations, recommendations and conclusions

1.10 SUMMARY

In this chapter, an outline of the study has been presented. The background of the study, problem statement and purpose of the study, objectives and significance of the study discussed. The researcher’s assumptions described and operational definitions defined. An overview of the research methods provided, validity and reliability and ethical considerations about the study.

In the next chapter, the literature reviewed will be discussed in greater detail.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter presents the literature reviewed about the topic under study. The purpose of undertaking a literature review was to scrutinise past research and to show how the current study is linked to it. The literature review provides a "framework of enquiry and identifies the area of knowledge that the study intended to expand on" (De Vos *et al.,* 2011:135). This chapter provides an overview of mechanical ventilation, weaning from mechanical ventilation, the role of the nurse, use of protocols, interdisciplinary collaboration and use of automated ventilator modes.

The search was conducted using electronic databases available through the University of Witwatersrand Academic Library – CINAHL (Cumulative Index to Nursing and Allied Health Literature) with SCOPUS, EBSCO HOST and MEDLINE (Medical Literature on Line accessed through PUBMED). To search PUBMED the MeSH (Medical Subject Headings) were used. Journal articles were hand searched in respected national journals and books.

2.2 OVERVIEW OF MECHANICAL VENTILATION

Mechanical ventilation is a treatment intended to provide support for normal breathing. It can be achieved with a specialised machine often referred to as a ventilator. It is used more often during a period of critical illness in intensive care units. McLean *et al.* (2006) reported that worldwide mechanical ventilation is used in more than 90% of patients in intensive care units. A period of more than 21 days is defined as prolonged mechanical ventilation (Esteban *et al.,* 2013). It is estimated that 6% patients require a prolonged period of mechanical ventilation, with corresponding costs exceeding 37% of total ICU expenditure (Boles, Bion, Connors, Herridge, *et al.,* 2007; Tonnelier, A., Tonnellier, J., Nowak, Gut-Gobert, *et al.,* 2011).

The goals of the mechanical ventilator are to provide oxygen, reduce the patient's work of breathing (WOB), protect the airways from injury, promote patient comfort and correct acid-base balance (Blackwood & Wilson-Barnett, 2007; Branson, 2012; Haas & Loik, 2012; Hess, 2012; Spieth *et al.,* 2014; Lavelle & Dowling, 2011; Rose, 2010).

The indications for mechanical ventilation are vast and varied, but in most situations, it is a life-saving intervention when the patient's breathing is insufficient to sustain life (Blackwood, 2000). The following is a list of clinical indications for mechanical ventilation:

- "Hypoxemia
- Acute respiratory acidosis
- Reversal of ventilatory muscle fatigue
- To allow sedation and neuromuscular blockade
- Reduce systemic and myocardial oxygen consumption
- Reduce intracranial pressure
- To stabilise the chest wall."

(Alspach, 2006:106)

Although mechanical ventilation is an intervention used to provide life-saving support, there are several complications associated with its use, such as ventilator-induced lung injury (VILI) and ventilator-associated pneumonia (VAP) being the most significant. The estimates of which, vary from between 22% to 40% of patients in intensive care units (Esteban *et al.,* 2013; Spieth, *et al.,* 2014). Consequently, this can lead to increased mechanical ventilation days, increased length of stay in the intensive care unit, increased hospitalisation costs, and ultimately result in increased mortality and morbidity (Esteban, *et al.,* 2013; Hess, 2011; Spieth, *et al.,* 2014). As such, there is a consensus agreement that institution of mechanical ventilation includes a plan for the process of weaning.

2.3 WEANING

2.3.1 Definitions

Ventilator weaning refers to the process of liberating the patient from mechanical ventilation. Its aim is to allow the patient to assume a greater portion of the respiratory workload by decreasing ventilator support (Hess, 2001). Weaning is defined as "assisting the patient in breathing spontaneously without mechanical ventilation support" (Crocker, 2002:272). Blackwood (2000) acknowledges that the patient commences weaning from the onset of ventilation support, while also cautioning the harmful effects of prolonged ventilation and the dangers of withdrawing ventilatory support too early.

Experts agree that weaning encompasses the removal of mechanical support and the endotracheal tube (Boles, *et al.*, 2007). Esteban *et al.* (1995) and Hess (2001) observed that the process of ventilator withdrawal could consume up to 40% of the total period of ventilation time. Blackwood (2000), Crocker (2002) and Rose (2010) concurred that all mechanically ventilated patients should start weaning from the onset of mechanical ventilation.

The process of weaning has been conceptualised in three different phases. Knebel, Shelkelton, Burns, Chlochesy, Hanneman and Ingersoll (1994) proposes the application of weaning comprising three consecutive stages. The first stage is *pre-weaning*. No weaning takes place during this period because the patient's condition has not yet stabilised. *Actual weaning* starts in the second stage when the patient's condition has stabilised, and the final stage is the *outcome stage*. The following is a list of possible exit level outcomes:

- "spontaneous breathing without an endotracheal tube;
- spontaneous breathing with an endotracheal tube for 24 hours;
- incomplete weaning where the patient is dependent on the partial ventilatory support;
- non-reversible dependence on the full ventilatory support; or
- death"

(Burns, S., Ryan, & Burns, J., 2000:2259).

Another model proposes the application of the physical stages of the process, which is different from that of Knebel *et al.* (1994). The first stage is the gradual reduction in ventilatory support. During the second stage a trial period of spontaneous breathing is undertaken, and in the third stage the endotracheal tube is removed (Meade, Guyatt, Cook, Griffith, *et al.*, 2000). However, this model has a limitation because the gradual withdrawal of ventilatory support is required in as few as 20 to 30% of patients (Rose & Nelson, 2006).

2.3.2 Categorisation of Patients

Evidence-based guidelines on weaning from mechanical ventilation have been developed by Boles et al. (2007). These guidelines propose that patients are categorised according to three groups to predict the complexity of weaning. The three groups are:

- **Group 1:** This group of patients represented 69% of mechanically ventilated patients and classified as simple weaning. This group proceed to successful weaning on the first attempt of spontaneous breathing trial. Prognosis of this group of patients is good with a 5% mortality rate in the intensive care unit.

- **Group 2:** Patients in group two account for 16% of all mechanically ventilated patients. This group are classified as difficult because they require three spontaneous breathing trials. These patients can take up to 7 days to achieve successful weaning.

- **Group 3:** An estimated 15% of patients categorised into the prolonged weaning group. They require more than seven days of weaning and usually fail at least three spontaneous breathing trial attempts.

These guidelines allow clinicians to not only evaluate weaning readiness but also to initiate much earlier a suitable weaning plan of the patient based on the complexity of their weaning needs.

2.3.3 Methods of Discontinuing Mechanical Ventilation

The main techniques of discontinuing mechanical ventilation are spontaneous breathing with a T piece, Synchronised Intermittent Mandatory Ventilation (SIMV) and Pressure Support Ventilation (PSV). Each of these will be briefly discussed in the next section.

- **T-piece**

The T-piece is a special configuration that connects to the endotracheal tube and allows the patient to breathe spontaneously, while also receiving an additional oxygen supply. The short trial period of spontaneous breathing allows for the rapid withdrawal of mechanical ventilation (Hess, 2001). It can also be used to gradually increase spontaneous breathing periods through the T-piece by gradually reducing rest periods on the mechanical ventilator (Blackwood, 2000). The main advantage of this method is that extubation readiness can be assessed objectively with the endotracheal tube still in place (Boles et al., 2007).

- **Synchronised Intermittent Mandatory Ventilation (SIMV)**

Synchronised Intermittent Mandatory Ventilation (SIMV) is a gradual approach to the withdrawal of mechanical ventilation. It allows a gradual reduction of positive pressure, and in turn, a gradual increase in patients' work of breathing. The machine breaths can be flow or pressure cycled, and the spontaneous breaths enhanced with pressure support ventilation (PSV). This method has several advantages because it prevents patient ventilator dysynchrony, decreases inspiratory muscle exhaustion and expedite weaning (Esteban *et al.,* 1995).

- **Pressure Support Ventilation (PSV)**

Pressure Support Ventilation (PSV) is used to stabilise the resistance to respiratory work imposed by the endotracheal tube. It allows the medical doctor to set the pressure-volume controlled breaths, which allows the patient to take spontaneous breaths in between the machine breaths (Hess, 2001). The main advantage of this method is that it provides positive pressure for the patient effort which helps to reduce the work of breathing (Boles *et al.,* 2007).

2.3.4 Comparison of Weaning Modes

Comparison of the different weaning techniques remains a continuously debated issue (Blackwood, 2000; Rose & Nelson, 2006). Two experimental studies were conducted earlier to clarify the debate. The first large study was commissioned by the Spanish

Collaborative Group in Lung Failure and aimed to develop a standardised weaning approach. Patients who developed respiratory distress during a two-hour spontaneous breathing trial were randomly assigned to undergo one of four standardised weaning techniques developed by Esteban *et al.* (1995). The four techniques included Synchronized Intermittent Mandatory Ventilation (SIMV), Pressure Support Ventilation (PSV) and spontaneous breathing trials. The results of the study demonstrated that a daily trial of spontaneous breathing led to extubation much quicker than Synchronized Intermittent Mandatory Ventilation (SIMV) and Pressure Support Ventilation (PSV) (Esteban *et al.* 1995).

In the second study, Brochard, Rauss, Benito, Conti *et al.* (1994) conducted an experimental weaning trial in three Italian intensive care units. The study selected patients who had failed a 2-hour spontaneous breathing trial, and randomly assigned them to groups to be weaned with T-piece trials, with Synchronized Intermittent Mandatory Ventilation (SIMV) or with Pressure Support Ventilation (PSV). The results of this study revealed that the method of weaning influenced the outcome, and Pressure Support Ventilation (PSV) resulted in significant improvement when compared with, T piece or Synchronised Intermittent Mandatory Ventilation (SIMV).

According to Boles *et al.* (2007:1033) the current evidence-based recommendations for weaning from mechanical ventilation are summarised as follows:

- "Weaning should be considered as early as possible.
- A spontaneous breathing trial is considered the major diagnostic test to determine whether patients could be successfully extubated. The initial spontaneous breathing trial should last at least 30 minutes and consist of T-piece breathing or low levels of Pressure Support Ventilation. Pressure support assist/control ventilation should be favoured in patients failing an initial trial/trials, which include the difficult to wean or prolonged weaning patient categories.
- Non-invasive ventilation techniques are considered in selected patients, such as those classified to the prolonged weaning category, to shorten the duration of intubation but not used as a tool for extubation failure".

2.3.5 Criteria for Determining Weaning Readiness

There is a general agreement that prediction of weaning readiness based on clinical judgment is inaccurate. It is helpful to screen patients who are on mechanical ventilation for the possibility of weaning on a daily basis (Tonnelier *et al.*, 2005). There is a consensus amongst experts that both, objective and subjective clinical criteria be used when making judgements about the patient's readiness for weaning from mechanical ventilation (Boyles et al., 2007; Ouellette *et al.*, 2017). **Table 2.1** displays these criteria for assessment.

Table 2.1 Criteria for assessing readiness to wean

Criteria	Assessment
"Clinical assessment	• Adequate cough • Absence of excessive tracheobronchial secretions • Resolution of disease acute phase for which the patient was intubated
Objective measurements	Cardiovascular stability • Heart rate <140 beats/minutes • Systolic blood pressure 90-160 mmHg • No or minimal vasopressors • Stable metabolic status
	Adequate oxygenation • Pulse oximetry >90% • FiO_2 <0.4 • PaO_2 /FiO_2 ratio >150 mmHg • PEEP <8 cm H_2O
	Adequate pulmonary function • Respiratory rate < 35 breaths per minute • Mean Inspiratory Pressure <20 to 25 cm H_2O • Tidal volume >5 ml/kg body weight • Vital Capacity >10 ml per kg body weight • RSBI <105 breath per minute

	• No significant respiratory acidosis
	Adequate mentation • No sedation or adequate mentation on sedation (or stable neurologic patient)”

Key: RSBI = Rapid Spontaneous Breathing Index

Source: Boles *et al.,* 2007:1040; Ouellette *et al.,* 2017

According to Boles *et al.* (2007) and Ouellette *et al.* (2017) patients who met the criteria listed in **Table 2.1** are to be weaned as soon as possible to prevent complications associated with mechanical ventilation or delay weaning and re-intubation. These criteria are meant to serve as a guide for the weaning process and therefore, should not be rigid or strictly adhere to for all ventilated patients. Some patients can be successfully weaned and extubated without meeting all the listed criteria, such as patients in the simple weaning group. Therefore ventilated patients who do not meet all the criteria can be monitored to determine readiness to wean and extubate.

An acceptable respiratory pattern, patient’s ability to maintain adequate gas exchange and haemodynamic status of the patient are criteria to passing spontaneous breathing trial, weaning and extubation (Boles *et al.* 2007; Ouellette *et al.,* 2017).

2.3.6 Weaning Failure

Several criteria need to be assessed to recognise weaning failure, as this may lead to cardiac and respiratory compromise. **Table 2.2** displays failure of weaning criteria.

Table 2.2 Failure of weaning criteria

Criteria	Assessment
"Clinical and subjective assessment	Agitation and anxiety Depressed mental status Diaphoresis Cyanosis Evidence of increasing effort • Increased accessory muscle activity • Facial signs of distress • Dyspnoea
Objective measurements	Arterial oxygen tension (PaO_2) <50-60 mmHg Pulse Oximetry (SaO_2) <90% Arterial carbon dioxide tension ($PaCO_2$) >50 mmHg pH <7.32 or a decrease in pH >0.07 pH units RSBI <105 breaths per minute Respiratory rate >35 breaths per minute or increase by 50% Heart rate >140 beats per minute or increased by >20% Systolic blood pressure > 180 mmHg or increased > 20% Systolic BP <90 mmHg Cardiac arrhythmias"

Key: RSBI = Rapid spontaneous breathing index

Source: Boles *et al.*, 2007:1041

The specialist intensive care nurse should monitor the patient to identify reversible weaning failure criteria and work collaboratively with the physician to reverse or treat the aetiological cause(s) of criteria before considering spontaneous breathing. Boles *et al.* (2007) refer to these criteria as "reversible etiologies for failure", meaning that when these criteria are identified and the cause treated the risk of re-intubation is minimised.

2.3.7 Extubation

The aim of extubation is the removal of the endotracheal tube. After weaning readiness is established and the patient has passed the spontaneous breathing trial they are considered ready for extubation (Tonnelier *et al.*, 2005; Ouellette *et al.,* 2017). Before extubation, the endotracheal tube should be suctioned to remove secretions but also to ensure that the airway is clear. Then the endotracheal tube cuff is deflated and the patient is asked to cough.

Extubation can be considered if a cough was subjectively considered efficient, or inspiratory and expiratory air leaks are observed after deflation of the cuff, which is often referred to as positive leak test (Tonnelier *et al.,* 2005; Ouellette *et al.*, 2017). An oxygen mask is applied to the patient's face delivering the equivalent amount of oxygen before extubation.

Post-extubation failure can occur in approximately 6.3% to 17.7% of cases and it is associated with a mortality rate of 25% to 50% (Boles *et al.*, 2007; Thile, Cortes-Puch & Esteban, 2013). Boles *et al.* (2007) and Ouellette *et al.* (2017) stated that post-extubation failure could be subjectively and objectively assessed. These are outlined as:

- Altered patient comfort level
- Respiratory rate >25 breaths per minute for 2 hours
- Heart rate of >140 beats per minute <20%
- Arterial oxygen saturation of <90%
- Arterial oxygen tension <80 mmHg
- Fraction of inspired oxygen >0.50
- Arterial carbon dioxide level >45 mmHg
- pH <7.33 units

Extubation failure can be defined as the need to consider re-intubation of the patient within hours or days after planned extubation. Thile *et al.* (2013) state that the time interval varies from 48 hours to 72 hours. According to Boles *et al.*, (2007) re-intubation, non-invasive ventilation or death within 48 hours after extubation are also considered as extubation failure. Failed extubation is associated with prolonged mechanical ventilation and carries a

25 to 50% mortality rate and often associated with neurological disorders (Boles *et al.*, 2007).

2.4 ROLE OF THE NURSE

Intensive care nursing can be broadly defined as the care provided for patients with life-threatening or potentially life-threatening illnesses or injury, and the complications thereof (Elliot *et al.*, 2013). It includes "responsibility for close monitoring of patients and the attached equipment, whereby they are expected to engage in the analysis of complex data based on anticipated problems" (Schmollgruber, 2015:38). Tingsvik, Johansson and Marternsson (2014) investigated nurses decisions related to weaning in four large intensive care unit in Sweden. This qualitative study used content analysis to bring to light the factors influencing nurse's decisions in weaning practices. The authors highlighted the complex nature of nursing, and the overall nurse's assessment was the main factor that influenced the decision-making process. Thus the individual assessment of the patient enables nursing care from a holistic perspective.

In the Australian study of Rose *et al.* (2008) they investigated the role of nurses in ventilation management. In this study, it was reported that nurses were involved in decisions related to ventilation management and weaning. Nurses were reported as mainly adjusting the fraction of inspired oxygen (FiO_2), pressure support ventilation (PSV) and ventilation rate, and less likely to adjust PEEP and ventilation modes independently. Mean autonomy was rated as high at seven out 10 points on a visual analogue scale. The results of this study established how nurses were involved in decision making in ventilation management and weaning. A limitation of the study was that the data was collected from nurse managers and not the nurses themselves.

Crocker and Scholes (2009) explored the concept variable described as "knowing the patient" over a period of six months in a large British intensive care unit. Overall, nurse's involvement in weaning supported their patient knowledge that improves patient outcomes. Nursing expertise and continuity of care were found to be important factors that supported "knowing the patient" (Crocker & Scholes, 2009). These findings are consistent with the nursing expertise and skilled clinical judgment model described by Tanner, Benner, Chesla and Gordon (1993) and Tanner (2006). Blackwood (2000) observed that knowing the patient was an important factor in weaning as nurses can read patient cues and detect signs of discomfort before physiological changes become evident.

In the study of Gelsthorpe and Crocker (2004) they explored the factors that influence the nurse's decision to start nurse-led weaning. Data were collected using interviews, and a clinical vignette was presented to participants. The study highlighted nurse's experience as one factor found to be important in the decision to wean the patient. The authors suggest that the use of a protocol-led weaning may not be helpful when making the decision to commence weaning. Rose *et al.* (2007) proposed in their study that the presence of experienced bedside nurses may render protocols unnecessary.

2.5 WEANING PROTOCOLS

Weaning protocols offer guidance to the process of weaning because they provide structure to limit inconsistencies in clinical decision making. The terms protocol and guidelines are used interchangeably, even though they are different (Hewitt-Taylor, 2004). The researcher has chosen not to differentiate between these terms and will refer to protocols, also meaning guidelines.

2.5.1 Nurses Perceptions of the Use of Protocols

The value of the use of weaning protocols takes up much debate in the literature about the nurse's role in ventilation management. While some nurses are of the opinion that protocols give nurses greater autonomy, others find them restrictive or unnecessary (Hansen & Severinsson, 2007; Gelsthorpe & Crocker, 2004; Rose, *et al.*, 2007).

In the study of Hansen and Severinsson (2007) they conducted a prospective case study in one intensive care unit in Norway. The aim of the study was to investigate nurse's perceptions of protocol-directed weaning. Data were collected using focus group interviews, and analysed by qualitative methods. The results of this study revealed that nurses perceived protocols useful because it allowed them to take action in the absence of a doctor, viewed as time-saving. Barriers for these participants were identified, when doctors failed to give clear instructions. This behaviour resulted in nurses either taking action or waiting for a doctor, thus giving weaning a low priority, which could have negative effects for the patient (Hansen & Severinsson, 2007).

Blackwood and Wilson-Barnett (2007) found in their study that weaning protocols improved the role perception, perceived knowledge and awareness of weaning among senior and junior nurses, and were considered helpful in providing safe guidance to junior staff.

2.5.2 Nurse-led weaning protocols

Protocols aim to reduce inconsistency of weaning in the belief that weaning times can be safely reduced (Blackwood *et al.,* 2011). Several experimental and randomised studies have demonstrated that non-physician weaning directed by protocols is equally safe and effective, when compared with, physician-directed weaning (Ely, Baker, Dunagan, Burke *et al.,* 1996; Kollef, Shapiro, Silver, St John, *et al.,* 1997; Crocker, 2002).

In the first study, an experimental study conducted by Ely *et al.* (1996) using a sample of respiratory therapists. These authors developed a two-step protocol based on a spontaneous breathing trial. The results of this study demonstrated a statistically significant reduction in the weaning time and complication rates when compared to physician management.

In another study, Kollef *et al.* (1997) randomised a sample of patients (n=357) in intensive care units (n=4) to receive protocol-directed or physician-directed weaning. The results of this study revealed that protocol-directed weaning resulted in a shorter period of mechanical ventilation when compared with physician-directed weaning (67 vs. 102 hours), respectively (Kollef *et al.,* 1997). The results of this study demonstrated that protocol-directed weaning by non-physicians was safe and effective.

Crocker (2002) demonstrated through a retrospective audit analysis, followed by an introduction of a weaning protocol that nurses can successfully implement weaning protocols, in the form of a nurse-led initiative that resulted in a shortening of weaning time. Although this study took place in one intensive care unit, other single centre studies conducted in other geographical areas have produced similar results.

In the literature, Blackwood *et al.* (2011:7238) observed that the main structure of weaning protocols comprised of criteria related to “readiness to wean, a method of weaning and determining readiness to extubate”. **“Figure 2.1** displays an example of a weaning protocol.

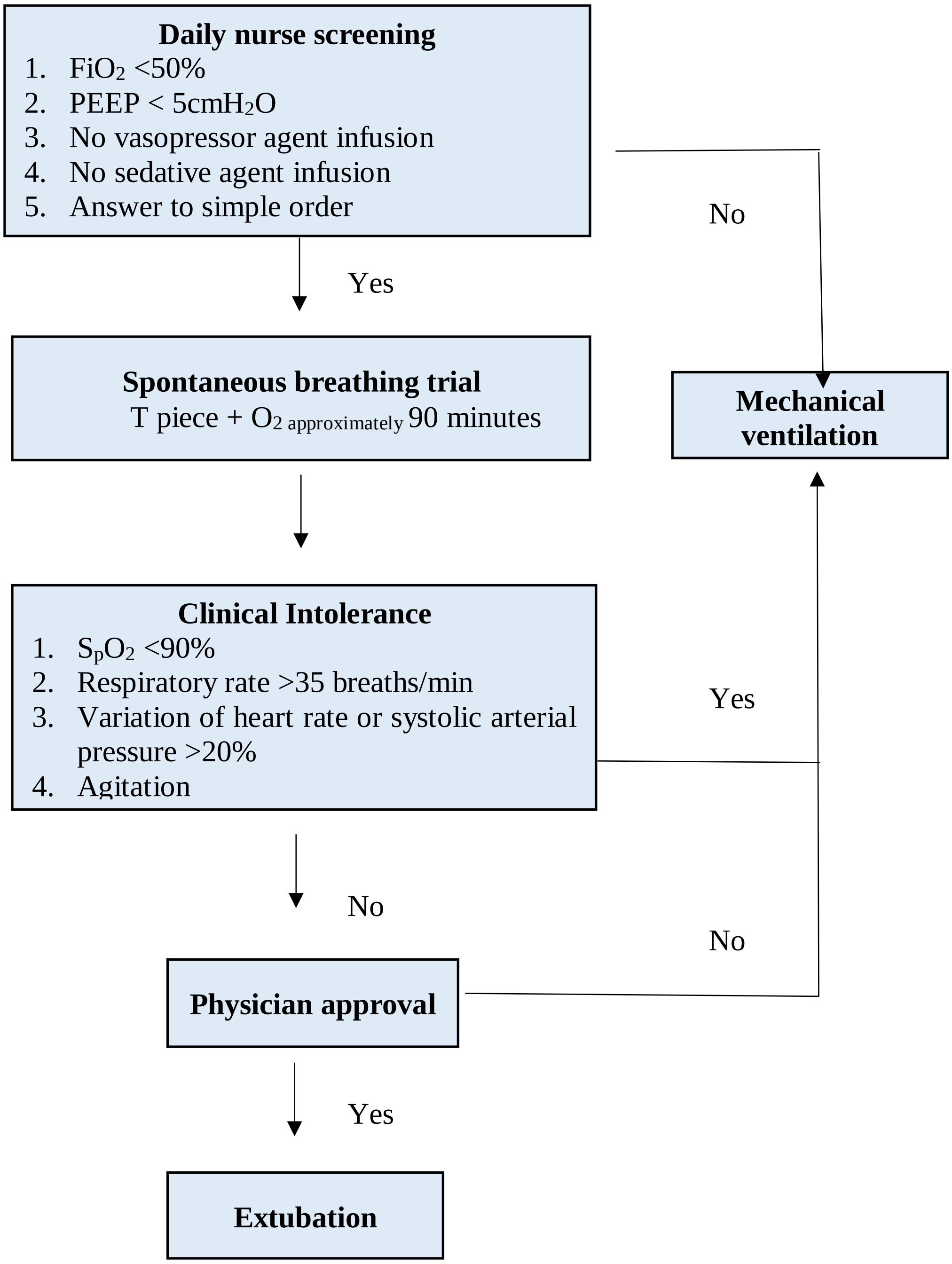

Figure 2.1 Mechanical ventilation weaning protocol”

Source: Tonnelier *et al.* (2005): Available at: http://ccforum.com/content/9/2/R83.

Blackwood *et al.* (2011) conducted a systematic review of the use of weaning protocols. It included a combined analysis of 11 clinical trials with a total of 1971 patients. Related to the protocol groups the pooled results demonstrated a shorter period of weaning time, the length of mechanical ventilation, and length of stay in the intensive care unit as 78%, 25% and 18%, respectively (Blackwell *et al.,* 2011). This study provides strong evidence in support of the use of standardised weaning protocols.

In the study by Tonnelier *et al.* (2005) they used a historically matched group and compared the results with an intervention group after the implementation of a weaning protocol. The control group matched the intervention group based on demographical data (age, sex, Simplified Acute Physiology Score version II) and admission diagnosis. After matching and exclusions 208 patients were included in the study, both groups consisting of 104 patients each (Tonnelier *et al.,* 2005). The results of this study demonstrated that a nurse-implemented weaning protocol reduced time spent on mechanical ventilation and overall intensive care unit stay without significant decreases in adverse events (Tonnelier *et al.,* 2005).

Roh Synn, Lim, Suh *et al.* (2012) compared the results of the intervention group after the implementation of a nurse-led weaning protocol and physician-led usual standard of care. Both groups were matched at baseline and consisted of 61 patients each (Roh *et al.*, 2012). Although the study found a similar number of successfully extubated patients in both groups, the weaning time was 25 hours in the nurse-led group versus 47 hours in the physician-led group (Roh *et al.*, 2012). The results of this study demonstrated that a nurse-led weaning protocol was safe and resulted in a shorter period of weaning time from mechanical ventilation (Roh, *et al.*, 2012).

In the study by Danckers *et al.* (2013) they used a historically matched group and compared the results with an intervention group after the implementation of a nurse-driven weaning protocol. After matching and exclusions 202 patients were included in the study, both groups consisting of 101 patients each (Danckers *et al.*, 2013). The results of this study revealed that a nurse-driven and physician driven weaning protocol resulted in a shorter period spent on mechanical ventilation (2 vs. 4 days); length of intensive care unit stay (5 vs. 7 days), and earlier extubation period (>2 hours) in the nurse-driven group (Danckers, et al., 2013). This study demonstrated that a nurse-driven weaning protocol shortened the period spent on mechanical ventilation and length of stay in the intensive care unit without adverse effects (Danckers, *et al.*, 2013).

Weaning protocols may be valuable in standardising the process of weaning. Protocol-directed screening coupled with trials of spontaneous breathing reduced the time required for extubation, decreased the length of stay and costs (Blackwood *et al.*, 2011). Duration of time for weaning is reduced from 80% to 5% (Blackwood *et al.*, 2011). The implementation of a nurse-driven weaning protocol can thus significantly expedite weaning and discontinuation of mechanical ventilation, over and above any specific weaning method used.

Despite an overwhelming amount of evidence supporting the implementation of nurse-directed weaning protocols, Price (2001) and Rose *et al.* (2007) suggest that is not clear whether the weaning protocol or the increased role of the nurse produced the change. Gelsthorpe and Crocker (2004) and Hewitt-Taylor (2004) observed that the implementation of weaning protocols is dependent on decisions made by a nurse.

2.5.3 Decision-making in weaning

Rose *et al.* (2007) investigated ventilation setting changes in one Australian intensive care unit. Data were collected over a period of three months, using patient records that resulted in ventilation changes. The results demonstrated that 3,986 decisions were documented, whereby 64% were made by nurses, when compared with, a lower 17% and 14% made by doctors alone and nurses and doctors together, respectively. Most of the decisions lead to changes in oxygen and ventilation settings. In this study, nurses were not involved in independent decisions for patients with respiratory disease or multiple organ failures. The results of this study demonstrated an autonomous group of nurses actively engaged in decision-making responsibilities.

In another study, Rose *et al.* (2011) conducted a multi-centre international study. Its aim was to profile decisional responsibility of nurses in ventilation management. Data were collected using a self-administered questionnaire, a total of 586 nurse unit managers from eight European countries participated. It yielded a response rate from 39% in the United Kingdom to 92% in Switzerland. Overall results, indicated that inter-professional collaboration was the main model of decision-making. Related to nursing autonomy and decisional responsibility, Swiss and UK nurses were found to have higher levels when compared to, lower levels in Greek and Italian nurses. Nurse autonomy was influenced by the allocation of the number of nurses to the number of patients and use of weaning protocols. More than half (55%) of intensive care units used automated weaning modes. The study revealed that nurses are best suited to make changes to ventilation settings, and failure to include nurses in decision making may lead to a longer weaning period for patients from mechanical ventilation (Rose *et al.*, 2011).

In a study by Haugdahl *et al.* (2013) they conducted a survey using the questionnaire developed by Rose *et al.* (2011). Data were collected from physician directors and nurse managers in Norwegian intensive care units. The results from perceptions of nurse managers for the nurse's autonomy, influence and collaborative interaction in ventilation were higher when compared with the perceptions of the physicians. The results of the study appear to suggest an over-representation of nurse's roles by nurse managers. A limitation of the study is that bedside nurses perceptions were not obtained.

Lavelle and Dowling (2011) explored nursing practices related to ventilator weaning in one intensive care unit in Ireland. Data was collected using interviews, and analysed by qualitative methods. The results of the study revealed not only a difficulty in finding a common definition but also the complexity of weaning. The authors reported the importance of the nurse's role by describing the blurred role boundaries. These findings are consistent with those found in the study of Hansen and Severinsson (2007) who also reported on the 'blurred roles' in ventilation management

2.6 INTER-PROFESSIONAL COLLABORATION

In the study by Rose and Presneill (2011), they conducted a cross-sectional survey in Australia. The aim was to obtain the perspective of medical personnel in the prediction of weaning practices. Data was collected using a questionnaire, whereby measurements were made on a visual analogue scale out of 10. Overall, the main predictions for weaning readiness were highest (M 8.0) for respiratory rate (M 8.0), compared with, a slightly lower mean of 7.3 (M 7.3) and 7.2 (M 7.2) for an effective cough and pressure support setting, respectively. The main predictions for extubation readiness were a higher (M 8.0) for respiratory rate, compared with, a slightly lower mean of 7.9 for an effective cough and Glasgow Coma Scale (M 7.9). In this study, the clinical judgment of a nurse as a contributing factor was only mentioned by one participant. This finding is contrasted with those of other similar studies that placed nurses as partners in decision making (Haugdahl *et al.,* 2013; Rose *et al.,* 2011).

In the study of Burns, Lellouche, Slutsky, Meret, *et al.* (2009) they conducted a cross-sectional survey in Canada. The study aimed to determine current practices about ventilator weaning. The study revealed pressure support ventilation (PSV) was the most frequently used weaning strategy. Most (96%) of the respondents screened patients on mechanical ventilation at least once, and more than one-third (36%) of respondents screened patients twice daily. Low dose vasopressors, inotropes, analgesics were considered acceptable (60.8%, 73.2%, 78.4% and 58.8% respectively), but the continuous infusion of sedatives-hypnotics was contraindicated when considering extubation. The limitation of this study is that the respondents were medical personnel and respiratory therapists, and the perspectives of nurses as partners in the team were not captured.

Petterson, Melanuik-Bose and Edell-Gustafsson (2012) and Eckerblad, Ericksson, Karner and Edell-Gustafsson (2009) highlighted findings in support of a multi-disciplinary holistic ICU quality of care in their Swedish study. These authors concluded that the choice of weaning strategy is flexible, individually adjustable, evidence-based and tailored for the responsibilities of the professional groups.

2.7 AUTOMATED WEANING

Automated weaning modes refer to more recently released ventilation strategies that automate medical reasoning with advanced closed loops (Spieth *et al.,* 2014). These include controlled modes or assisted modes, such as “Adaptive Support Ventilation (ASV), Intellivent-ASV ™ and SmartCare ™ “(Rose, 2010:74). The use of automated modes with advanced closed loops might simplify or reduce weaning from mechanical ventilation.

Rose, Schultz, Cardwell, Jouver, McAuley and Blackwood (2015) conducted a systematic review of the closed loop ventilation system. It included a combined analysis of 15 controlled and randomised studies with a total of 1173 patients. The results of the study revealed a 32% reduction in ventilation weaning time when compared to standardised practices (Rose *et al.,* 2015). The authors concluded that the current evidence is highly mixed as outcomes of standardised practices are dependent on the intensive care unit personnel (Rose *et al.*, 2015).

In the study by Rose *et al.* (2011), they reported that automated modes were used in 55% of European intensive care units. It may have implications for the nurse's role in ventilation management, but no studies to-date were found in the literature that explored this.

2.8 SUMMARY

This chapter summarised the various approaches to address the role of the nurse in ventilation management and weaning. An overview of mechanical ventilation, the definition of and methods of weaning, the role of the nurses, use of nurse-led protocols, inter-professional collaboration and automated weaning discussed.

The next chapter will outline the research methods and design used in the study.

CHAPTER THREE

RESEARCH DESIGN AND METHODS

3.1 INTRODUCTION

Chapter three describes the research design and methods used in this study. The design of the study was a non-experimental, descriptive, quantitative and cross-sectional survey. The research methods consist of the population, sampling, research instrument used in the study, data collection procedures and methods of data analysis. The ethical considerations, validity and reliability of the study are also described.

3.2 RESEARCH OBJECTIVES

For consistency, the objectives of the study are repeated.

- To describe specialist nurses collaborative practices in key ventilator decisions and acting independently in titrating ventilation settings.
- To relate the association of specialist nurses autonomy and influence in decision making to independent titrations of ventilator settings.
- To identify specialist nurse's level of independent decision making in oxygen and positive end-expiratory pressure titrations.

3.3 RESEARCH DESIGN

Research design refers to the researcher's overall plan for obtaining answers to the research questions and includes strategies and procedures to be implemented (Polit & Beck, 2012). The research design of the study was non-experimental, descriptive, quantitative and cross-sectional. Each aspect of the design is discussed in the following section.

3.3.1 Non-experimental

Non-experimental refers to a design where a researcher collects data without introducing an intervention. It enables a researcher to collect data as they naturally occur without intervening (Polit & Beck, 2012). According to Lobiondo-Wood and Haber (2010) even though the researcher does not actively manipulate the variables, the concept of control should be applied to prevent bias when reporting results.

During data collection no intervention was applied. Therefore the study was considered to be non-experimental. To allow control during data collection procedures the study used a structured questionnaire schedule developed by Rose, Nelson, Johnston and Presneill (2008).

3.3.2 Descriptive

Descriptive designs are used to obtain more information about an interesting field of study. It is achieved through the provision of a detailed account of the phenomenon as it naturally occurred. It could be used as a starting point for hypothesis or theory development (Polit & Beck, 2012).

This study was considered to be descriptive as it aimed to describe the roles of a specialist in mechanical ventilation management based on data collected from a sample of nurses using a structured questionnaire.

As this study was conducted on one occasion over a short period, as such it was considered as cross-sectional.

3.3.3 Quantitative

Quantitative as a design refers not only to a rigorously controlled design but also enables investigations that can be analysed regarding numbers and quantified or summarised (Polit & Beck, 2012). It allows a researcher to select a smaller sample that will allow generalisation of the results to a broader population.

In this study, a quantitative approach was applied as the researcher utilised a structured survey questionnaire to collect numerical data for analysis and interpretation through the application of statistical tests which allowed inferences for the broader population to be made. The study was considered a quantitative design.

3.4 RESEARCH SETTING

The study was carried out in ten (n=10) adult ICUs at two university-affiliated public hospitals in Johannesburg, Gauteng province. These are referral hospitals with adult intensive care units for critically ill and injured patients with different profiles, offering a comprehensive service for patients in Gauteng and other surrounding provinces.

The researcher considered these ten ICUs to be similar because they represent highly specialised public sector adult intensive care units, which admits critically ill and injured patients from medical, surgical and emergency disciplines. Five of the units accept patients from the trauma (n=2), major burns (n=1) and neurosurgical (n=2) specialities, two admits patients from the coronary care specialities (n=2), and one receives only patients from the cardiothoracic specialities (n=1). Another two units accept patients from all speciality disciplines (multidisciplinary) in the hospital (n=2).

These hospitals (n=2) have a combined 4,100 bed capacity with the official ICU beds ranging from seven to eighteen beds per unit. Patient care in the intensive care units is managed by the medical intensivist, who is specialised in anesthesiology or pulmonology and certified in intensive care medicine, or specialist doctors in emergency medicine or general surgery. Specialist nurses practising in these units have undergone advanced education and training in intensive care nursing.

3.5 RESEARCH METHODS

According to Burns and Grove (2009) and Polit and Beck (2012), the research methods refer to the steps, procedures and strategies for gathering and analysing data. **Figure 3.1** presents a plan to describe the research methods used in the study.

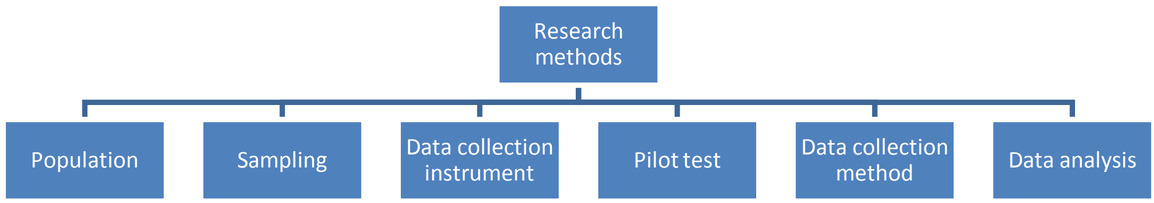

Figure 3.1 Plan to describe the research methods used in this study

3.5.1 Population

The research population refers to individuals who meet certain criteria for inclusion in a given setting. According to Burns and Grove (2009), the target population is the entire set of individuals who meet sampling criteria for a specific setting. The research population in this study refers to all nurses practising in intensive care units in the Gauteng province. The target population for this study refers to specialist nurses practising in ten adult intensive care units in two major public hospitals.

A preliminary record review, undertaken in January 2016, indicated that there were 165 specialist nurses practising in these units.

3.5.2 Sampling

Following the recommendations of the Postgraduate Assessor's Committee, a total sample was decided upon. The total sample (N = 165) would ensure a good representation of the population from which the sample was drawn. A non-probability convenience sampling method was utilised.

The inclusion criteria for prospective participants included:

- Registered by the South African Nursing Council (SANC) with an additional qualification in Intensive Care Nursing, or its equivalent Medical and Surgical Nursing: Critical Care in the category of intensive care nursing;
- In full-time employment in one of the adult intensive care units of the selected study sites;
- More than six months of clinical experience in the selected intensive care unit.

Registered professional nurses without formal intensive care training were excluded from the study, as they are not expected to have an advanced knowledge of ventilation management of critically ill patients.

3.5.3 Data Collection Instrument

In this study, a survey instrument developed by Rose, Nelson, Johnston and Presneill (2007; 2008) identified in literature and previously published studies (Haugdahl, Storli, Rose, Romild & Egerod, 2013; Rose, Blackwood, Egerod, Haugdahl, *et al.*, 2011). This was used to achieve the study objectives.

The self-administered questionnaire contains **three sections** (refer **Appendix A**). The *first section* collects participant demographics and ICU workplace data (*9 items*); *section two* employs dichotomous questions to assess decision-making responsibility for key ventilation decisions (*6 items and 12 sub-parts*), staffing ratios (2 items), nurse autonomy and influence (2 *items*). Key ventilation decisions included: “initial ventilation settings, evaluation and titration of ventilation settings, identification of patients readiness to wean, weaning method employed, identification of patient’s readiness for extubation, and identification of weaning and extubation failure”.

The *third section* asks respondents about “the type of ventilator setting titrations nurses made on independent decision making (*1 item and 10 sub-parts*) and the use of protocols for ventilation management (*3 items),* automated closed loop systems (*1 item and 4 sub-parts*) and nurse ventilation education (*2 items*). Independent ventilation changes included: “change of mode, titration of respiratory rate, titration of tidal volume, titration of inspiratory pressure, increase of pressure support, decrease of pressure support, increase of Positive End Expiratory Pressure (PEEP) and decrease of PEEP, increase of Fraction of Inspired Oxygen (FiO_2) and decrease of FiO_2“. Commercially available automated closed loop systems included “use of SmartCare PS (Drager Medical, Lubeck, Germany), Adaptive Support Ventilation (Hamilton Medical), Proportional Assist Ventilation (PAV) and Mandatory Minute Ventilation (MMV)”. Each statement is scored on a 5-point Likert-type scale ranging from 1 to 6, whereby 1 = never, 2 = seldom, 3 = frequently, 4 = often, 5 = routinely and 0 = uncertain.

The developers assessed face and content validity in the sample of the original study (Rose *et al.* 2008) and experts in ventilation management reviewed and rated the instruments for clarity. One subsequent international study (Rose, Blackwood, Egerod, Haugdahl, *et al.*,

2011) was found, which utilised this questionnaire on an independent sample of managers. However, these authors did not comment on the reliability of the instrument.

After verification by two local domain ICU experts, some questions were excluded while others were edited to fit the South African context:

- The section on ICU demographics (*6 items*) which included hospital type, a primary speciality of ICU, type of ICU, the number of ICU beds, and the number of beds staffed in the hospital and number of full-time equivalents of staff members was excluded as this study was only conducted in two major public hospitals.
- The last item related to nursing education which stated "*the number of nurses holding a postgraduate critical care speciality qualification*" was omitted as only intensive care nurses holding a speciality qualification were participants in this study.
- A section on the demographics of nurse participants (*5 items*), and developed by the researcher, was built into the instrument as a checklist. It included age, the highest level of nursing qualifications, years of ICU experience and ICU speciality workplace.
- An explanation of the term '*autonomy*' as defined by Rose *et al.* (2008) was included on the questionnaire.

3.5.4 Pilot Testing

A small pilot testing procedure was undertaken before the main study commenced. Its main purpose was to test the understanding of the statements used in the questionnaire in the South African context. Ten (n = 10) respondents who met the inclusion criteria of the study, participated in the pilot testing procedure. These results were not included in the main study.

The results of the pilot test showed that the statements on the questionnaire were easily understood. It was completed by the respondents in the estimated 15 to 20 minutes period. No major changes were made to the existing questionnaire or study procedures. The wording "*Physician*" was modified by the researcher after the pilot test was completed to read as "**Doctor**". These words are more easily understood in the South African context.

3.5.5 Data Collection Procedure

Once permission to conduct the research study had been obtained from the institutions (**Appendix D & E**), the researcher set up an appointment to meet with each respective intensive care nurse unit manager. The purpose of this meeting was to inform them about the study, its purpose and relevance to clinical practice, and to obtain their permission. After that the researcher visited the intensive care units (n=10) and observed the allocation lists for selection of potential participants. Those nurses who agreed to participate were given an information letter outlining the study and its procedures (**Appendix B**), and the questionnaire (**Appendix A**) to complete at their convenience. The researcher re-visited the intensive care unit the following day to see if the nurses had any questions related to the study and its procedures.

The respondent placed the completed questionnaire into an envelope and posted it in a sealed box in the respective intensive care unit. The researcher re-visited the intensive care unit on a weekly basis to remind the nurses to complete the questionnaire. At the end of the four-week data collection period the researcher collected all the boxes from the intensive care units. The researcher alone opened the boxes.

3.5.6 Data Analysis

Data analysis is the organisation and synthesis of research data. It allows a researcher to obtain an understanding and assigns meaning to the data obtained. The process of data analysis was achieved by using two levels of measurement in this study. Descriptive statistics was used to describe, display or summarise data in a meaningful manner, whereas inferential statistics were used to draw conclusions and make generalisations about the larger population (de Vos *et al.*, 2011; LoBiondo-Wood & Haber, 2010).

The statistical tests used in this study were as follows:

- Percentages, means and the standard deviation was used to describe the respondent's demographic data.
- Student t-tests were used to compare the group mean scores on nurses' level of autonomy and influence in decision-making, to determine whether the differences were significant or not (LoBiondo-Wood & Haber, 2010).

- The Chi-square test was used to compare the differences in mean scores and to determine whether this difference was statistically significant. It is a non-parametric test that is used “to determine whether the frequency found in each category is different from the frequency that would be expected” (LoBiondo-Wood & Haber, 2010:575).

3.6 ETHICAL CONSIDERATIONS

For a research study to be considered ethically sound not only must the human rights of participants be protected, but the researcher must also be honest and maintain the highest level of researcher integrity. As a student of this institution, the researcher is expected to adhere to the principles of ethics prescribed by the Declaration of Helsinki for the protection of human subjects, as well as the Singapore Declaration of research integrity. As a practising nurse, the researcher is expected to adhere to the risk to benefit ratio of a research study, regarding whether the risk to participants is commensurate with the benefit to society and nursing profession regarding the evidence produced (Polit & Beck, 2012). The ethical considerations as applied in this study is discussed in the next section.

3.6.1 Informed Consent

Informed consent refers to a procedure of ensuring participants have enough information about their participation in a research study (Grove, Burns & Gray, 2013). Participants in this study were given an information letter before participating in the study (**Appendix B**). After receiving the information, letter participants were given a reasonable amount of time (1 day) to decide whether they wanted to participant in the study. Written consent was not obtained because the returned questionnaire was considered as consent to participating in the study.

3.6.2 Permission to Conduct Research

Ethical clearance was obtained from the Committee for Research on Human Subjects of the University of the Witwatersrand (**Appendix F**). Written permission to conduct the study at the selected institutions was obtained from hospital management on behalf of the Department of Health in the Gauteng province (**Appendix D & E**). Written permission for the use of the data collection instrument was obtained from the authors (Rose *et al.,* 2011) (**Appendix G**).

3.6.3 Confidentiality

Confidentiality is a responsibility of the researcher to keep safe all data gathered in the study, from being exposed to individuals who have no involvement in the study (Burns & Grove, 2009). Confidentiality was maintained in this study, as the questionnaires were not coded and respondents sealed the returned questionnaire in an envelope that was placed in a sealed box in the respective intensive care unit. The researcher alone opened the boxes.

3.6.4 Anonymity

Anonymity is a responsibility of the researcher to keep participants "nameless" about their participation in the study (Burns & Grove, 2009). Anonymity was maintained in this study, as the questionnaires were not coded and respondents sealed the returned completed questionnaire in an envelope that was placed in a sealed box in the respective intensive care unit. Completed questionnaires will be stored for five years in a safe place before they are destroyed by shredding.

3.7 VALIDITY AND RELIABILITY OF THE STUDY

LoBiondo-Wood and Haber (2010:588) refer to validity as "the degree to which an instrument measures what it is intended to measure". Whereas, reliability is concerned with "consistency and accuracy of the data but also the researcher's ability to collect and record information accurately" (Cresswell, 2009:190-191).

The researcher used a valid and published instrument during data collection and adhered strictly to the guidelines provided by the principal developer (Rose *et al.,* 2008). As a prospective study, data collected during the study was analysed, and no variables were manipulated so that threats to internal validity could be prevented. A large sample (110 out of 165 potential participants) was achieved from the intensive care units to ensure external validity. Content and face validity of the instrument was achieved by a panel of experts in intensive care nursing. As such content validity for the study was established through a review of the literature, clinical experience and a small group of local domain experts in intensive care nursing.

Consistency and accurate recording of the data were done to ensure reliability. Data was collected by the researcher as participants returned the completed questionnaires in the boxes provided in a sealed envelope. The total sample was included to ensure representation of the larger population under study. Data analysis was guided by methods used by Rose *et al.* (2008; 2011), which allowed the researcher to compare the results in other similar studies.

3.8 SUMMARY

The chapter presented the research design and methods. It included the population, sampling, research instrument used in the study, data collection procedures and methods of data analysis. The ethical considerations, validity and reliability of the study has been described.

The next chapter will discuss data analysis and results of the study.

CHAPTER FOUR

DATA ANALYSIS AND RESULTS

4.1 INTRODUCTION

This chapter describes the specialist nurses' role in ventilation management in intensive care units with the intention of making recommendations for clinical practice and education of specialist nurses. It was achieved by a quantitative, descriptive, cross-sectional survey design. The population included all specialist nurses (N=165) practising in adult ICUs at two university-affiliated public hospitals in Johannesburg. A sample size of 110 (n=110) respondents, was obtained using convenience sampling. Data was collected using a data collection tool (**Appendix A**). Data were analysed using descriptive and comparative statistics. Statistical tests included independent sample t-tests and Chi-square analysis. Testing was done at the 0.05 level of significance and ensured a power of at least 95% accuracy on findings. Findings will be discussed on the scale, construct, and study group and item level.

4.2 APPROACH TO DATA ANALYSIS

Descriptive statistics were used to present the interpretation of the biographical and workplace data of nurses: age, academic qualifications, position in ICU, and years of clinical experience and workplace. Measures of frequency distributions were also used to summarise the questionnaire schedule. Frequency distribution and cross tables were used to present the data inclusive of key ventilation decisions, staffing ratios, nursing autonomy and influence, independent titration changes, use of protocols guidelines, automated weaning modes and ventilation education for nurses in ICU. The data mentioned above were then further explored by using bivariate analysis. Joint frequency and contingency tables were used to display associations between selected variables, and followed by comparative testing to determine statistically significant associations.

When testing for two samples of interest, the student t-test was used to compare nursing autonomy and independent titrations to ventilator settings. The student t-test was employed to clarify whether there was a significant difference in the scores of autonomy for these tests. When using the scores derived from in-dependent titrations in ventilator settings, two groups were created, whereby (1) = frequently (>50% of the time) and (2) = infrequently (<50% of the time) scores. The median score was used to make this distinction. Dichotomising the data is consistent with the methods used by Rose *et al.* (2011; 2008).

Further testing was done by using scores of nursing influence and experience of nurses. When testing for the relationships between the variables the t-tests was used to assign the test statistic. Cross tables were used to provide a representation of paired responses between selected variables and independent titrations to ventilator settings (frequently and infrequently). Also, the Chi-square test and two-by-two cross tables were used to proportionate relationships between selected variables and to assign the test statistic. Testing was applied on independent titrations to ventilator settings (frequently and infrequently) by item level and the presence of ventilation management protocols.

The level of significance for the statistical tests was set at the level of $p<0.05$. The data was analysed using the statistical package Statistica ™ version 13.2. The consultation was made with a biomedical statistician after the researcher attended some statistical short courses provided by the postgraduate office of research support in the Faculty of Health Sciences.

4.3 RESULTS AND FINDINGS

4.3.1 Descriptive Results

4.3.1.1 Sample

Specialist nurses (N = 165) practising in intensive care units who met the inclusion criteria were approached to participate. The sample size was 110 (n = 110). It represents a 66.6% response rate for the study.

4.3.1.2 Biographical and workplace data

This section of the questionnaire (see **Appendix A**) related to nurses biographical and workplace data which comprised of five items. Results of this process are summarised in **Table 4.1** for the total sample (n = 110).

Table 4.1 Biographical and workplace data for nurse respondents for the sample (n = 110)

Item	Category	Frequency	Percentage
Q1	"Age		
	20 to 29 years	11	10.0%
	30 to 39 years	23	20.9%
	40 to 49 years	42	38.2%
	50 to 59 years	32	29.1%
	>60 years	2	1.8%
Q2	Academic qualifications		
	Diploma	97	88.2%
	BSc Nursing	9	8.2%
	MSc Nursing	3	2.7%
	PhD	1	0.9%
Q3	Years of ICU experience		
	1 to 2 years	40	36.3%
	3 to 5 years	16	14.5%
	6 to 10 years	21	19.1%
	11 to 15 years	10	9.1%
	16 to 20 years	11	10.0%
	21 to 25 years	6	5.5%
	26 to 30 years	5	4.5%
	>41	1	0.9%
Q4	Position in ICU		
	ICU nurse	41	37.3%
	Shift leader	58	52.7%
	Unit Manager	11	10.0%
Q5	Speciality workplace area		
	Multidisciplinary	47	43.6%
	Cardiothoracic	22	20.0%
	Coronary care	2	1.8%
	Surgical	-	-
	Medical	-	-
	Trauma	18	16.4%
	Major Burns	3	2.7%
	Neurosurgery"	17	15.5%

Of the total sample (n = 110), the largest (38.2%; n = 42) group of nurse respondents was between the ages of 40 to 49 years, and 29.1% (n = 32) were in the 50 to 59 year age categories. Findings in this study indicate a slightly older (69.1% vs. 30.9%) age distribution than similar overseas studies, where Milutinovic, Repic and Arandelovic (2016) indicated 67% (n = 131) of their Serbian sample of nurses were under the age of 30 years, and 82% (n=75) was reported in a study conducted in the United Kingdom by Walker and Gillen (2006) in their sample. **Figure 4.1** presents these results.

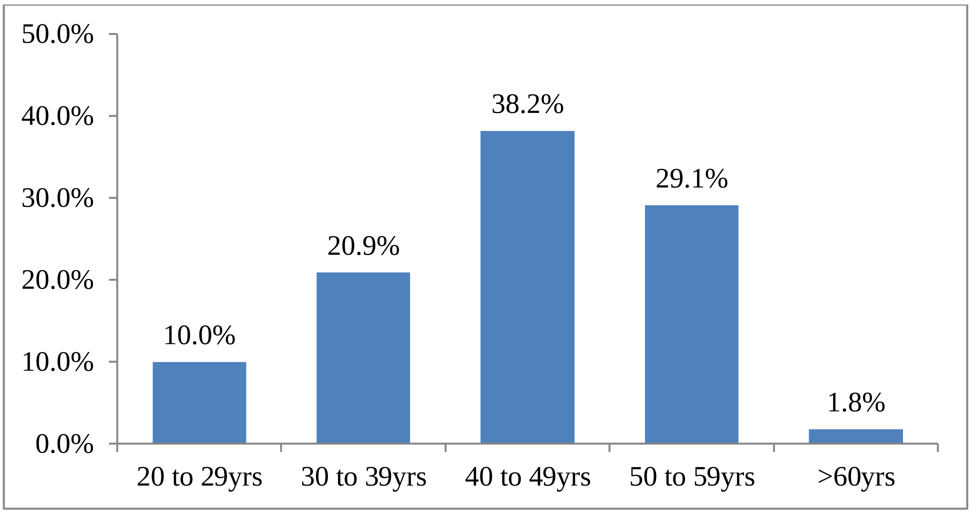

Figure 4.1 Age distribution of the respondents

In this study, the majority (88.2%; n = 97) of nurse respondents held a diploma as the highest level of nursing qualification, and only 12.8% (n = 13) had a degree level education. In this study, the level of diploma education is higher than similar studies conducted overseas. Where Rose, Haslam, Dale, Knechtel, Fraser, *et al.* (2011) reported 55.3% (n = 73) of their Canadian sample were diploma prepared nurses and indicated as 5.1% (n = 10) in the Serbian study of Milutinovic *et al.* (2016). The average length of respondents clinical experience in this study was 8.34 (SD 8.45), ranging from 1 to 41 years. Findings are similar to studies conducted in Serbia and New Zealand where Milutinovic *et al.* (2016) and Pirret (2007) where they reported average length of work experience in their sample of nurses as 8.5 (SD 7.6) and 8.9 (SD 6.8), respectively.

Most (36.3%; n = 40) of the nurse respondents in this study had less than 2 years of clinical experience, and only 14.5% (n = 16) and 19.1% (n = 21) had between 3 to 5 years and 6 to 10 years of ICU experience respectively, whilst a close one-third (30.1%; n = 33) had more than 10 years of ICU nursing experience. These current study findings are similar when compared to one Canadian study of Rose *et al.* (2011), but higher (36.3% vs. 16.2%) and lower (30.1% vs. 43.4%) in the categories of less than two years and more than ten years of clinical experience, respectively. It can be extrapolated from these findings that this is an older nursing population regarding age distribution, while a wide distribution of clinical nursing experience is noteworthy; the predominant group are less experienced in intensive care nursing. **Figure 4.2** presents these results.

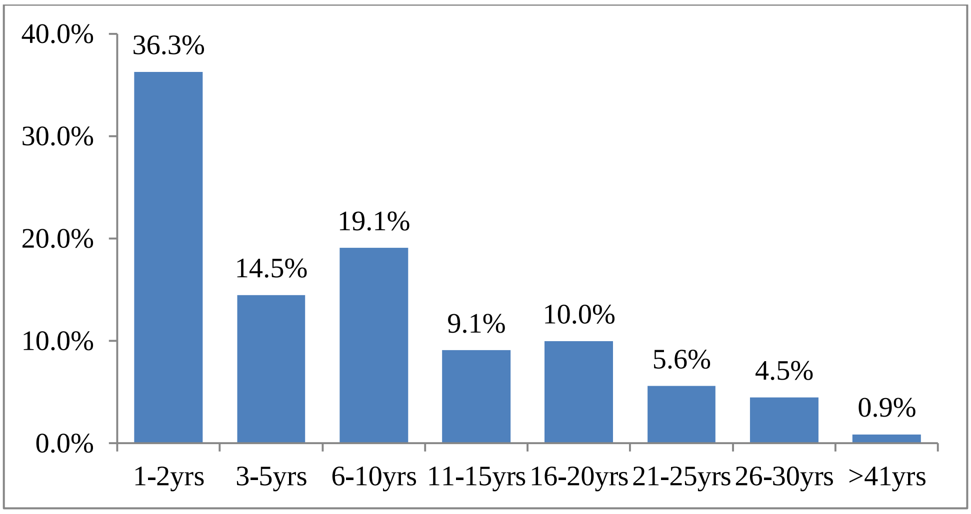

Figure 4.2 Distribution of ICU clinical nursing experience of the nurse respondents

The largest (52.7%; n =5 8) group of nurse respondents were shift leaders, and 37.3% (n = 41) and 10.0% (n = 11) were in the categories of ICU nurse and nurse unit manager, respectively. Of the total sample of nurses (n = 110), all (100.0%) the respondents were intensive care trained specialist nurses. The largest (43.6%; n = 47) group of nurse respondents practiced in a multidisciplinary unit, the next largest group was in the cardiothoracic unit (20.0%; n=22) and followed by a lower 16.4% (n = 22) and 15.5% (n = 17) in trauma ICU and neurosurgical ICU, respectively. **Figure 4.3** displays these results.

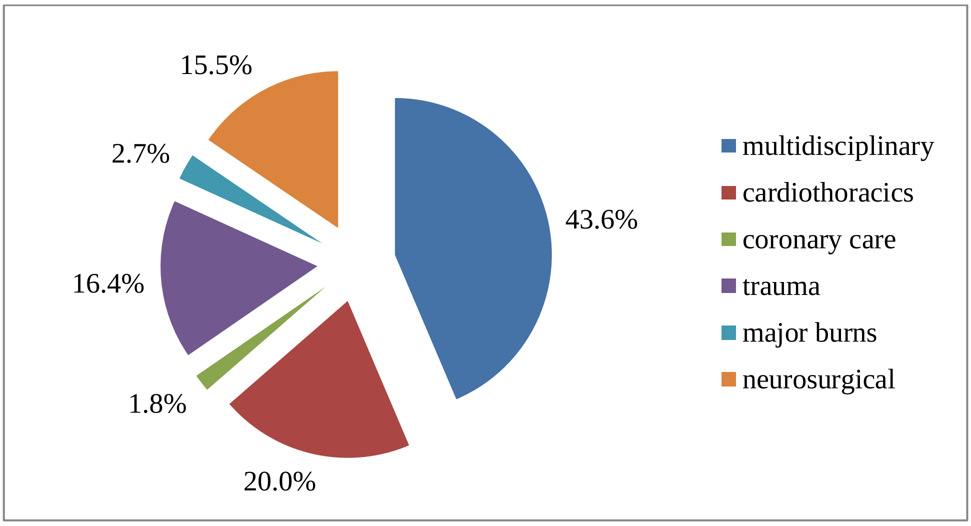

Figure 4.3 Distribution of respondents' ICU workplace

The distribution of workplace practices in this study is similar to the findings of two recent local published studies by Perrie, Schmollgruber, Bruce and Becker (2014) and Langley, Schmollgruber, Fulbrook, Albarran and Latour (2013). It can be extrapolated from these findings that the South African public sector, tertiary level III and academic ICUs are well represented in this study (South African Society of Anaesthesiology, 2013).

4.3.1.3 Key ventilation decisions

This section of the data collection instrument (see **Appendix A**) related to key ventilation decisions. Six items (including 18 sub-items) were included in this section. Results of this process are summarised in **Tables 4.2 to 4.4** for the total sample (n = 110).

Table 4.2 Inter-professional responsibilities for key ventilation decisions

Item	Statement	Doctors only		Nurses only		Doctors and nurses in collaboration		Other	
		n	%	n	%	n	%	n	%
Q1	"Who determines the initial ventilation settings?	35	31.8%	-	-	75	68.2%	-	-
Q2	Who evaluates the patient's response to ventilation and titrates' settings if required?	6	5.5%	1	0.9%	103	93.6%	-	-
Q3	Who decides when the patient is ready to wean?	8	7.3%	1	0.9%	101	91.8%	-	-
Q4	Who decides on the method of weaning from mechanical ventilation?	16	14.6%	2	1.8%	92	83.6%	-	-
Q5	Who decides when the patient is ready to extubate?	27	24.6%	-	-	82	74.6%	1	0.9%
Q6	Who decides when a patient is failing a weaning trial?"	9	8.2%	2	1.8%	99	90.0%	-	-

Items Q1 to Q6 on the data collection instrument inquired about collaboration between nurses and doctors for ventilation-related decisions. Most (93.6%; n = 103) of the respondents reported collaboration between nurses and doctors for decisions related to "patient evaluation and titration of ventilation settings" (item Q2), followed closely by a lower 91.8% (n = 101). 90.0% (n = 99) and 83.6% (n = 92) for "readiness for weaning" (item Q3), "determining failure of weaning" (item Q6) and "method of weaning" (item Q4).

Further, only a close three-quarters (74.6%; n = 82) of nurses reported collaboration between nurses and doctors for decisions "related to extubation" (item Q5), and 75 (68.2%) reported collaboration between nurses and doctors for decisions related to "initial ventilation settings" (item Q1). It can be extrapolated from these findings that nurses appear not to be involved in decisions "related to extubation" and "initial ventilation settings" as these decisions appear more likely to be made by the doctors.

Table 4.3 Seniority of doctors responsible for ventilation decisions

		Consultants only		Registrars and above		Residents and above		Other	
		n	%	n	%	n	%	n	%
Q1a	"Identify the seniority of doctors responsible for initial ventilation settings.	12	10.9%	77	70.0%	20	18.2%	1	0.9%
Q2a	Identify the seniority of doctors responsible for titration of ventilation settings.	13	11.8%	75	68.2%	21	19.1%	1	0.9%
Q3a	Identify the seniority of doctors responsible for determining weaning readiness.	13	11.8%	79	71.8%	16	14.6%	-	-
Q4a	Identify the seniority of doctors responsible for determining the method of weaning.	14	12.7%	83	75.5%	12	10.9%	1	0.9%
Q5a	Identify the seniority of doctors responsible for determining readiness for extubation.	19	17.3%	79	71.85	11	10.0%	1	0.9%
Q6a	Identify the seniority of doctors responsible for determining weaning failure".	13	11.8%	79	71.8%	16	14.6%	2	1.8%

Items Q1a to Q6a on the data collection instrument inquired about the seniority of doctors responsible for ventilation-related decisions. Most (75.5%; n = 83) of the respondents reported the category of registrars and above as the seniority of doctors responsible for ventilation decisions related to determining "the weaning method" (item Q4a), and a slightly lower 71.8% (n = 79) for "weaning readiness" (item Q3a), "weaning failure" (item Q6a) and "readiness for extubation" (item Q5a), respectively.

Similarly some (70.0%; n = 70) of the respondents also reported the category of registrars and above as the level of seniority of doctors responsible for "initial ventilation settings" (item Q1a), followed by a lower 68.2% (n = 75) of responses for "titration of ventilation settings" (item Q2a). It can be extrapolated from these findings that senior registrars and above are responsible for key ventilation decisions. However, as nurses carry sole responsibility for patient monitoring in ICU they are likely to carry more responsibility for decisions related to "titration of ventilation settings".

Table 4.4 Seniority of nurses responsible for ventilation decisions

		Senior nurses only		All nurses		Other	
		n	%	n	%	n	%
Q1b	"Identify the seniority of nurses responsible for initial ventilation settings.	88	80.0%	16	14.55%	3	4.6%
Q2b	Identify the seniority of nurses responsible for titration of ventilation settings.	95	86.4%	13	11.8%	2	1.8%
Q3b	Identify the seniority of nurses responsible for determining weaning readiness.	90	81.8%	18	16.4%	2	1.8%
Q4b	Identify the seniority of nurses responsible for determining the method of weaning.	95	86.6%	16	14.5%	1	0.9%
Q5b	Identify the seniority of nurses responsible for determining readiness for extubation.	87	79.8%	19	17.4%	1	0.9%
Q6b	Identify the seniority of nurses responsible for determining weaning failure".	82	74.6%	26	23.6%	2	1.8%

Items 1b to 6b on the data collection instrument inquired about the seniority of nurses responsible for ventilation-related decisions. Most (86.6%; n = 95) of the respondents reported the category of senior nurses responsible for ventilator-related decisions for determining "method of weaning" (item Q2b), followed closely by a lower 84.6% (n = 95), 81.8% (n = 90), and 80.0% (n = 88) for "titration of ventilation settings" (item Q4b), "weaning readiness" (item Q3b) and "initial ventilation settings" (item Q1b), respectively.

Similarly, some (79.8%; n = 87) of the respondents reported the category of the senior nurse as responsible for determining "extubation readiness", and a lower 74.6% (n = 82) of responses for determining "weaning failure". It can be extrapolated from these findings that senior nurses are responsible for ventilation related decisions. However, as bedside nurses are responsible for monitoring patients they are more likely to carry responsibility for "recognising weaning failure".

4.3.1.4 Staffing ratios

This section of the data collection instrument (see **Appendix A**) related to staffing ratios. Two (items Q7 and Q8) items were included in this section. Results of this process are summarised in **Table 4.5** for the total sample.

Table 4.5 Staffing ratios for patients receiving invasive and non-invasive mechanical ventilation

Item	Statement	Frequency	Percentage
Q7	"What is the nurse to-patient ratio for patients receiving mechanical ventilation in your ICU?		
	-1:1 ratio	107	97.3%
	-1:2 ratio	2	1.8%
	-1:3 ratio	-	-
	-Other	1	0.9%
Q8	What is the nurse to-patient ratio for patients receiving non-invasive ventilation in your ICU?		
	-1:1 ratio	100	90.9%
	-1:2 ratio	9	8.2%
	-1:3 ratio	-	-
	-Other"	1	0.9%

Items Q7 and Q8 on the data collection instrument inquired about the nurse-to-patient ratio. An overwhelming majority (97.3%; n = 107) of nurses reported a 1:1 nurse-to-patient ratio for patients receiving invasive ventilation, whilst only a marginal 1.8% (n = 2) of nurses reported a 1:2 ratio.

Similarly, most (90.9%; n = 100) respondents reported a 1:1 nurse-to-patient ratio for non-invasively ventilated patients, whilst only a marginal 8.2% (n = 9) of responses were reported for a 1:2 ratio. It can be extrapolated from these findings that the nurse-to-patient ratio is exclusively 1:1 for both, invasive and non-invasively ventilated patients.

4.3.1.5 Nursing autonomy and influence

This section of the data collection instrument (see **Appendix A**) was related to nurse's autonomy and influence in ventilation decisions. Two (items Q9 and Q10) items were included in this section.

Nurse respondent's perception of the level of nursing autonomy in mechanical ventilation was established "by using a visual analogue scale (VAS) that ranged from 1 (low level) to 10 (high level)". In this study, responses ranged from 1 to 10 with a **median of 7.0** points. **Figure 4.4** presents these results.

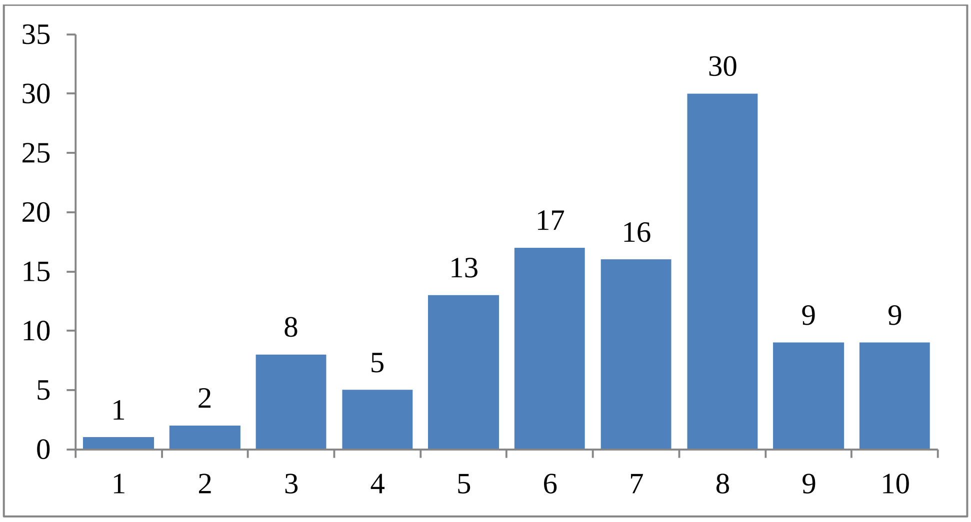

Figure 4.4 Perceptions of nursing autonomy

Similarly, nurse respondent's perception of the level of influence in decisions regarding mechanical ventilation was established by "using a visual analogue scale that ranged from 1 (low influence) to 10 (high influence)". Responses ranged from 2 to 10 with a **median of 7.0** points**. Figure 4.5** presents these results.

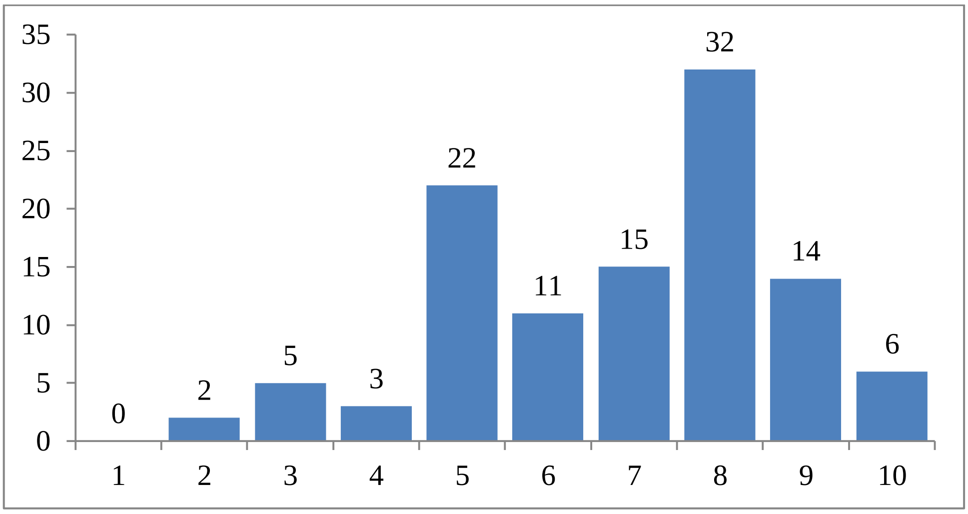

Figure 4.5 Perceptions of nursing influence

4.3.1.6 Independent titrations of ventilator settings

This section of the data collection questionnaire (see **Appendix A**) related to independent titrations of ventilation settings by nurses. One (item Q11) item is comprising 10 (sub-items Q11.1 to Q11.10) sub-items was included in this section.

Ventilator settings titrated independently by nurses are shown in **figure 4.6**.

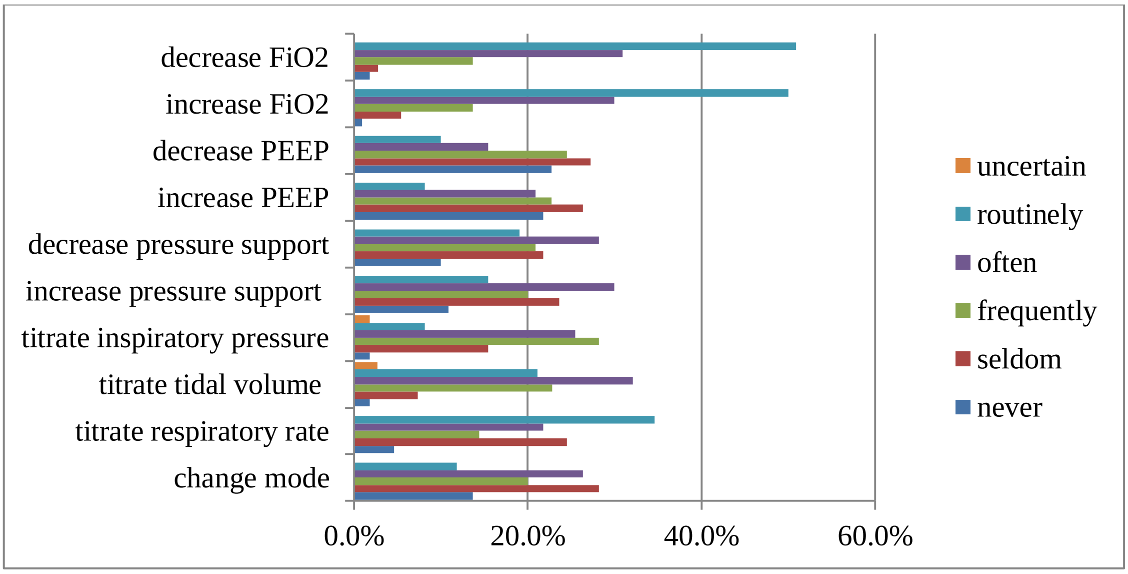

Figure 4.6 Titrations of ventilation settings by nurse respondents

The independent titration in ventilation settings scores was collapsed to create two groups, whereby (1) = frequently changed (>50% of the time) and (2) = infrequently (<50% of the time). **Figure 4.6** displays these results.

Table 4.6 Titrations of ventilation settings by nurse respondents

	Frequently >50% of the time		Infrequently <50% of the time	
	n	%	n	%
“Decrease FiO_2	90	81.8%	18	16.4%
Increase FiO_2	88	80.0%	21	19.1%
Titrate respiratory rate	62	56.4%	39	39.0%
Titrate tidal volume	58	53.2%	38	30.2%
Decrease pressure support	52	47.3%	48	42.7%
Increase pressure support	50	45.5%	47	43.6%
Change of mode	42	38.2%	53	48.2%
Titrate inspiratory pressure	49	33.6%	48	43.6%
Increase PEEP	32	29.1%	54	49.1%
Decrease PEEP”	28	25.5%	57	51.8%

Table 4.6 shows the titrations of ventilator settings in ranked order, with oxygen settings as the most frequently titrated setting, while positive end-expiratory pressure settings were the lowest titrated setting.

4.3.1.7 Protocols and Guidelines

This section of the data collection instrument (refer **Appendix A**) related to use of protocols and guidelines. Four (items Q12 to Q14) items were included in this section. **Table 4.7** presents these results.

Table 4.7 Use of protocols and guidelines

Item	Statement	Yes		No		Uncertain	
		n	%	n	%	n	%
Q12	"In your ICU, do you have guidelines/policy/protocol for management of mechanical ventilation?	70	63.6%	34	30.9%	6	5.2%
Q13	In your ICU, do you have a guideline/policy/protocol for weaning from mechanical ventilation?	65	59.1%	37	33.6%	8	7.3%
	If yes, does it contain information on management of patients failing weaning?	62	56.4%	15	13.6%	21	19.1%
Q14	In your ICU, do you have a guideline/policy/protocol for management of non-invasive ventilation?"	57	51.8%	44	40.0%	8	7.3%

In this study, a close two-thirds (63.6%; n=70) of the nurse's practice in ICUs in which there are protocols and guidelines for use in ventilation management. The majority (51.8%; n=57) have a "guideline for non-invasive ventilation". Of those who have protocols and guidelines, 59.1% (n=65) have "information on weaning" and 56.4% (n=62) who have "management of weaning failure".

4.3.1.8 Automated weaning

This section of the data collection instrument (see **Appendix A**) related to use of automated weaning. Four (items Q15.1 to Q15.4) items were included in this section. **Table 4.8** presents these results.

Table 4.8 Use of automated weaning

Item		Never /seldom		Frequently, often or routinely		Uncertain	
		n	%	n	%	n	%
Q15.1	"SmartCare PS^{tm}	90	81.8%	13	12.7%	5	4.7%
Q15.2	Adaptive Support Ventilation (ASV)	83	75.5%	6	5.5%	21	19.1%
Q15.3	Mandatory Minute Ventilation (MMV)	72	72.7%	17	15.5%	13	11.8%
Q15.4	Proportional Assist Ventilation (PAV)"	84	76.4%	8	7.3%	18	16.4%

The majority (81.8%; n=99) of the nurse respondents had not worked in units that have "SmartCare PS^{tm} (Drager Medical)" modes available. A close three-quarters of the nurse respondents had not worked in units that have "ASV (Hamilton Medical)" (75.5%; n=83), "PAV" (76.4%; n=84) and "MMV" (72.7%; n=72).

4.3.1.9 Ventilation management education

This final section of the data collection instrument (see **Appendix A**) related to ventilation education available to nurses in intensive care units. Two (items Q16.1 and Q16.2) items were included in this section. **Table 4.9** presents these results.

Table 4.9 Ventilation management education for nurses in intensive care units

Item	Statement	Yes		No		Uncertain	
		n	%	n	%	n	%
Q16.1	"Do nurses receive education on ventilation during ICU orientation?	98	89.1%	8	7.3%	4	3.6%
Q16.2	Are opportunities available for ICU on-going professional development related to mechanical ventilation?"	95	86.4%	8	7.3%	7	6.4%

Most (89.1%, n = 98) of the nurse respondents agreed that ventilation management education was provided during orientation in intensive care units, and 86.4% agreed that on-going professional development opportunities were available.

4.3.2 Comparative Results

In this study, the student t-tests were used to compare independent titrations in ventilator settings with nursing autonomy and influence in decision making, where the sample of nurses was divided into "*frequent*" (>50% of the time) and "*infrequent*" (<50% of the time) decision makers. Table 4.10 and Table 4.11 presents these results.

Table 4.10 Perceived nurse autonomy and independent titration in ventilator settings

Variable	n	Frequent		Infrequently		t-test	df	p-value
		M	SD	M	SD			
"Change of mode	110	7.52	1.85	6.22	2.05	-3.35	108	0.001*
Titration of respiratory rate	110	7.10	1.80	6.17	2.30	2.39	108	0.024*
Titration of Tidal volume	110	7.08	1.81	6.26	2.28	2.03	108	0.044*
Titration of inspiratory pressure	110	7.35	1.59	6.31	2.23	-2.59	108	0.011*
Increase of pressure support	110	7.18	1.89	6.33	2.14	-2.17	108	0.032*
Decrease of pressure support	110	7.00	1.95	6.46	2.15	-1.35	108	0.177
Increase of PEEP	110	6.70	2.04	6.59	2.19	1.73	108	0.086
Decrease of PEEP	110	7.17	1.86	6.56	2.12	-1.37	108	0.174
Increase of FiO_2	110	6.75	2.04	6.59	2.19	0.32	108	0.749
Decrease of FiO_2 "	110	6.87	2.01	6.00	2.20	1.73	108	0.086

Key: *=statistical significance

Findings indicated that of the ten independent titrations on nursing autonomy, only **five items were statistically (p<0.05) significant**. These included "change of mode, titration of respiratory rate, titration of tidal volume, titration of inspiratory pressure, an increase of pressure support". In above listed independent titrations in ventilator settings, the mean nursing autonomy scores were higher for more frequent (>50% of the time) decision makers. No significant difference was observed in the remaining independent titration items on nursing autonomy. Results of this process are summarised in **Table 4.10.**

Table 4.11 Perceived influence and independent titration in ventilator settings

Variable	n	Frequent		Infrequently		t-test	df	p-value
		M	SD	M	SD			
“Change of mode	110	8.00	1.39	6.14	1.83	-5.97	108	0.000*
Titration of respiratory rate	110	7.57	1.60	5.84	1.85	5.24	108	0.000*
Titration of Tidal volume	110	7.55	1.58	5.98	1.92	4.72	108	0.000*
Titration of inspiratory pressure	110	7.77	1.33	6.32	1.99	-4.56	108	0.000*
Increase of pressure support	110	7.78	1.41	6.08	1.92	-5.31	108	0.000*
Decrease of pressure support	110	7.76	1.46	6.03	1.89	-5.41	108	0.000*
Increase of PEEP	110	8.18	1.12	6.30	1.89	-6.44	108	0.000*
Decrease of PEEP	110	8.00	1.41	6.46	1.90	-4.52	108	0.000*
Increase of FiO_2	110	7.08	1.91	5.95	1.58	-2.54	108	0.013*
Decrease of FiO_2 “	110	7.03	1.76	6.05	1.89	2.12	108	0.036*

Key: *=statistical significance

Findings indicated that of the ten independent titrations, **all the items were statistically (p = 0.05) significantly different** when tested by nursing influence in decision making. In above listed independent titrations in ventilator settings, the mean nursing influence in decision making scores was higher for more frequent (>50% of the time) decision makers. Results of this process are summarised in **Table 4.11.**

The student t-tests were then used to compare the mean years of nursing experience and independent titrations of ventilation settings made frequently and infrequently. **Table 4.12** presents these results.

- Years of Experience and independent titration changes

Table 4.12 Years of Experience and independent titration in ventilator settings

Variable	n	Frequent		Infrequently		t-test	df	p-value
		M	SD	M	SD			
"Change of mode	110	8.12	7.79	8.47	8.89	0.21	108	0.833
Titration of respiratory rate	110	10.13	9.15	5.84	6.70	2.83	108	0.006*
Titration of Tidal volume	110	10.59	9.14	5.53	6.58	3.37	108	0.001*
Titration of inspiratory pressure	110	9.90	7.87	7.44	8.69	-1.47	108	0.143
Increase of pressure support	110	10.14	8.50	6.83	8.18	-2.07	108	0.041*
Decrease of pressure support	110	9.86	8.21	6.96	8.50	-1.81	108	0.072
Increase of PEEP	110	9.09	7.68	8.02	8.78	-0.60	108	0.550
Decrease of PEEP	110	9.32	7.64	8.00	8.73	-0.71	108	0.478
Increase of FiO_2	110	9.23	8.70	4.72	6.31	2.76	108	0.008*
Decrease of FiO_2 "	110	9.31	8.71	3.95	5.43	3.52	108	0.001*

Key: *=statistical significance

Findings indicated out of the ten independent titrations; only **five were statistically (p<0.05) significantly different when tested on years of nursing experience**. Included were: "titration of respiratory rate, titration of tidal volume, increase of pressure support, increase in oxygen and decrease in oxygen". In above listed independent titrations in ventilator settings, the mean years of nursing experience in decision making scores were higher for more frequent (>50% of the time) decision makers. Results of this process are summarised in **Table 4.12.**

- Presence of Ventilation Protocol

Also, a Chi-square test was used to compare "presence of a protocol (yes or no)" and "independent titrations in ventilation settings (frequently or infrequently)". Because the data is categorical or ordinal, frequencies and proportions used were two-by-two cross tables, comparing two categories with two variables.

Table 4.13 Presence of protocol and independent titration in ventilator settings

Variable	n	Frequently		Infrequently		X^2	df	p-value
		Yes	No	Yes	No			
“Change of mode	110	29	13	41	27	0.86	1	0.353
Titration of respiratory rate	110	43	21	27	19	0.83	1	0.361
Titration of tidal volume	110	43	18	27	22	2.78	1	0.095
Titration of inspiratory pressure	110	29	11	41	29	2.13	1	0.144
Increase of pressure support	110	36	14	34	26	2.77	1	0.096
Decrease of pressure support	110	36	16	34	24	1.33	1	0.248
Increase in PEEP	110	21	11	49	29	0.08	1	0.781
Decrease in PEEP	110	21	7	49	33	2.10	1	0.147
Increase of FiO_2	110	59	29	11	11	2.21	1	0.137
Decrease of FiO_2 “	110	60	30	10	10	1.96	1	0.161

Table 4.13 presents these results. Findings indicated out of the ten independent titrations in ventilator settings, no items were statistically ($p>0.05$) significantly different when tested on protocols.

4.4 OPEN ENDED RESPONSES

However, the study participants chose not to elaborate by providing additional information on the space provided on the questionnaire (Appendix A) for open comments.

4.5 DISCUSSION OF MAIN FINDINGS

The purpose of this study was to describe the role of specialist nurses in ventilation management in 10 adult ICUs at two academic hospitals in the Gauteng province. The study intention was also to make recommendations for clinical practice and education of specialist intensive care nurses.

The distribution of the sample revealed a majority (69.1%; n = 76) of nurses were between ages of 40 to 60 years, and 34 (30.9%) were between ages of 21 to 40 age categories. Most

(88.2%; n = 97) nurses held a diploma level education, and only 9 (8.2%) had a basic nursing degree. All nurses held a post basic specialisation in intensive care nursing. Also, a close majority (52.7%; n = 58) had additional responsibilities as shift leaders in their respective ICUs, 41 (37.3%) nurses were primary bedside nurses without additional responsibilities, and only 11 (10%) were unit managers. Most (69.9%; n = 77) nurses had less than ten years of ICU experience, and 33 (30.1%) nurses had more than ten years of ICU nursing experience. Slightly less than half (43.6%; n = 48) of the nurses practised in a multidisciplinary ICU, followed by one-fifth (20.0%; n = 22) in a cardiothoracic ICU. The distribution of the sample is similar to previously published studies by Rose *et al.* (2007; 2008), Haugdahl *et al.* (2013) and Milutinovic *et al.* (2016).

Regarding current workplace practices, most (97.3%; n = 107) of the nurses reported 1:1 nurse-to-patient ratio for patients receiving mechanical ventilation. These results are comparable with data from a survey in eight European countries, where Rose *et al.* (2011) reported more than half of the ICUs in four countries (United Kingdom, Switzerland, Norway and Denmark) reported a 1:1 ratio. Also, most (90.0%; n=100) of the nurses in this current study also reported a 1:1 nurse-to-patient ratio for non-invasively ventilated patients. These results are higher than 71% and 69% reported in the studies of Rose *et al.* (2008) and Rose *et al.* (2011), respectively.

With respect to self-reported use of protocols and guidelines, more than half of the sample of nurses in this current study reported that they practiced in intensive care units that had guidelines and protocols to guide nurses on weaning (59.1%; n = 65) and management of weaning failure (56.4%; n = 62). These results are higher than data from a survey from Australian and New Zealand intensive care units, whereby Rose *et al.* (2008) reported only 24% of 54 participating units had such a protocol. These results are comparable with data from a Norwegian survey (Haugdahl *et al.*, 2013), whereby 46% and 56% of participating units in respective university and community hospitals had a weaning protocol.

Regarding key ventilation decisions, most nurses in this study agreed that nurses and doctors collaborated on ventilation settings (93.6%), weaning readiness (91.8%), weaning failure (90.0%), and weaning methods (83.6%). These results are comparable with the study of Haugdahl *et al.* (2013), whereby nurse managers (n = 38) and physician directors (n = 38) respectively agreed that nurses and physicians collaborated on patient responses to ventilation changes (92% vs. 87%), recognising weaning failure (84% vs. 84%), recognizing weaning readiness (82% vs. 23%) and choosing the weaning method (70% vs. 42%). Also, nurses in this study agreed that nurses are less likely to collaborate with doctors in recognising readiness for extubation (74.6%) and selection of initial ventilation settings (68.2%). These results are comparable with the study of Rose et al. (2008) where it was reported that medical staff determined the weaning method and decisions to extubate.

While this current study revealed low (2%) numbers of nurses input in making independent key ventilator decisions. Most (>70%) of nurses in this study agreed that responsibility for ventilation decisions lies at the level of seniority of a registrar and above, and in their absence, only senior nurses (>80%) were perceived to be responsible for the adjustment of fundamental ventilation settings. These results share some similarities with the study conducted by Rose *et al.* (2008), whereby it was reported that the seniority of nurses related to increased autonomy.

Nursing autonomy, this study revealed nurse respondents perceptions of the level of autonomy ranged from 1 (low level of nursing autonomy) to 10 (high level of nursing autonomy), with a median score of 7.0. These results share similarities in the data from a descriptive survey by Rose *et al.* (2008), where participant perceptions of autonomy ranged from 0.8 to 10 with a median level of 7.0. Regarding nursing influence in ventilation management, findings in this current study ranged from 2 (low level of influence) to 10 (high level of influence) with a median score of 7.0. These results are lower than found in the studies of Rose *et al.* (2008) and Haugdahl *et al.* (2013) where a median score of 7.7 and 8.0 was reported for nursing influence in ventilation decisions by participating units in their respective studies. Similarly, in another European study, Rose *et al.* (2011) found nurse managers rated autonomy and influence for participating ICUs (n = 586) and resulted in a median score of 7.0 for both scales.

Regarding adjustments made to ventilation settings, most (>80%) nurses in this current study reported independent titrations with oxygen settings as the most frequently adjusted setting, while PEEP settings were the least (<30%) adjusted setting. These results are higher than found in data from a descriptive survey by Rose *et al.* (2011), whereby 67% and 68% of European nurses reported frequently increasing and decreasing oxygen settings, respectively, and a lower 25% and 28% for increasing and decreasing PEEP settings as the least adjusted settings. This issue was investigated in the study by Haugdahl *et al.* (2013). Of the respondents in Haugdahl *et al.* (2013) study, 58% and 60% reported increasing and decreasing oxygen settings respectively, as independent titrations made independently by nurses without direct medical consultation, and 18% agreed that PEEP was the least adjusted setting by nurses. In the study of Rose *et al.* (2008), 46% of the respondents identified that titration of positive end-expiratory pressure was the lowest titrated ventilator settings by nurses.

Out of the remaining independent titrations of ventilation settings, nurses in this study reported a frequency of >50 % of the time for: titration of respiratory rate (56.4%), titration of tidal volume (53.2%), decreasing pressure support (47.3%), increasing pressure support (45.5%), change mode (38.2%) and titration of inspiratory pressure (33.6%). This particular aspect was also investigated by Rose *et al.* (2011). Of these participants in the study of Rose *et al.* (2011) the >50 % of the time independent adjustments were reported as follows: increasing pressure support (55%, 95% CI 51 – 59,), decreasing pressure support (55%, 95% CI 51 - 59), titration of respiratory rate (50%, 95% CI 46 - 54), titration of tidal volume (44%, 95% CI 40 - 48), titration of inspiratory pressure (40%, 95 % CI 36 – 44) and change mode (40% 95% CI 36 - 44). These results are comparable with previously published studies (Rose *et al.*, 2008; Haugdahl *et al.* 2013). It may, therefore, seem that nurses have a greater involvement in ventilator decisions in these settings.

Related to use of automated weaning, revealed results in this current study that are lower than previously published studies (Rose *et al.* 2011). Of these modes, only 12.7% (n=13) of nurse respondents had worked in units that have frequent use of SmartCare PS ™ modes available, and 15.5% (n = 17), 5.5% (n = 6) and 7.3% (n = 8) had worked in units that have frequent use of MMV, ASV and PAV, respectively. Use of automated weaning modes was reported in European ICUs by Rose *et al.* (2011). Of the 586 participating ICUs, 319 (50 – 59, 55%) use a form of automated ventilation, where the most frequently used was ASV and SmartCare PS ™ at 15% and 12%, respectively (Rose *et al.*, 2011). It may, therefore, seem that more ICUs are using a closed loop system but in this setting few ICUs are using them routinely.

Most (89.1%; n = 98) of the nurses in this study, agreed that ventilation management education is provided during orientation, and 86.4 % (n = 95) are offered on-going education. This particular aspect was also investigated by Haugdahl *et al.* (2013). Of these participants in Haugdahl *et al.* (2013) study, 92% of their participating ICUs (35 out of 38) provided new nurses with ventilation management education on orientation to the intensive care units. These results are comparable with previously published studies in Europe (Rose *et al.*, 2011) and Australia (Rose *et al.*, 2008).

4.6 SUMMARY

This chapter discussed descriptive and comparative statistical tests that were used to describe and analyse the data collected. The data and interpretations of findings supported by literature discussion were presented. The following chapter will discuss the limitations of the study, summary of the research findings, conclusions and recommendations.

CHAPTER FIVE

SUMMARY OF STUDY, MAIN FINDINGS, RECOMMENDATIONS AND CONCLUSIONS

5.1 INTRODUCTION

The final chapter of the report presents a summary of the study and main findings. This will be followed by a discussion of the limitations of the study and recommendations for clinical practice, nursing education and further research. The chapter concludes with the conclusion from the main findings.

5.2 SUMMARY OF THE STUDY

5.2.1 Purpose of the Study

The purpose of the study was to describe the roles of specialist nurses in mechanical ventilation management in intensive care units of two academic hospitals in the Gauteng province, with the intention of making recommendations for clinical practice and education of such nurses.

5.2.2 Objectives of the Study

The objectives of the study were to:

- Describe specialist nurse's collaborative practices in key ventilator decisions and acting independently in titrating ventilation settings.
- Relate the association of specialist nurses autonomy and influence in decision making to independent titrations of ventilator settings.
- Identify specialist nurse's level of independent decision making in oxygen and positive end-expiratory pressure titrations.

5.2.3 Methodology

Ethical clearance was obtained from the Committee for Research on Human Subjects of the University of the Witwatersrand (refer Appendix C). The Postgraduate Committee of the School of Therapeutics in the Faculty of Health Science (refer Appendix F), and the Hospital Management of the selected study sites approved the study (refer Appendix D and E). Permission to use the questionnaire for data collection in the study was obtained from the developer (refer Appendix G).

Ten adult intensive care units at two public hospitals in the Gauteng Province were used to conduct the study. The target population was all specialist nurses practising in intensive care units (n = 10) at the selected study sites. Non-probability convenience sample was used to select the study participants. A biomedical statistician was consulted before data collection, and the total population (N = 165) was used for the study sample. The final sample was 110 (n = 110), which formed a response rate of 66.6% for the study.

To test the feasibility of the questionnaire a small pre-testing procedure was conducted with ten (n = 10) respondents who completed the self-administered questionnaire before the main study started. The questionnaire used in the study was developed by Rose *et al.* (2008; 2011). The questionnaire consisted of three sections. The first section collected demographic data, section two collected data for key ventilation decisions, staffing ratios, the level of nurse's autonomy and influence in decision making, while section three asked about independent ventilation titration changes, use of ventilator protocols, automated weaning and ventilation management education for nurses.

In order to meet the study objectives a non-experimental, descriptive, quantitative and cross-sectional survey design was used. Descriptive and comparative statistics were used to analyse the data which was done in consultation with a biomedical statistician in the postgraduate research office of the Faculty of Health Sciences.

5.3 SUMMARY OF MAIN FINDINGS

The purpose of this study was to describe the role of specialist nurses in mechanical ventilation management in two academic hospitals in Gauteng province, with the intention of making recommendations for clinical practice and education of specialist nurses.

The demographic data showed that the majority 69.1% of nurse respondents were between the ages of 40 to 60 years. All the nurse respondents had an additional specialist qualification in intensive care nursing. Fifty-two percent of the nurse respondents were shift leaders, and about 70.0% had less than ten years of experience in the respective intensive care unit. Forty-three percent of nurse practised in a multi-disciplinary unit.

The organisation and structure of the unit data showed that the majority 97.3% of nurses reported a 1:1 nurse-to-patient ratio for patients receiving mechanical ventilation, and similarly, 90.9% of nurses reported a 1:1 nurse to patient ratio for non-invasive mechanical ventilation. Eighty-nine percent of nurses reported that ventilation management education was provided during intensive care unit orientation, and 86.4% indicated that they were also offered on-going education. Eighty-six percent of nurses reported that they had not worked in units that used automated weaning protocols. Fifty-nine percent of nurses reported that weaning protocols were present in intensive care units, and similarly, 56.4% reported the presence of protocols for the management of weaning failure.

The *first objective* was to describe nurse’s collaborative practices in key ventilator decisions and acting independently in titrating ventilator settings.

Regarding key ventilator decisions, the findings showed that most nurses agreed that nurses and doctors collaborated on ventilation settings (93.6%), weaning readiness (91.8%), weaning failure (90.0%) and weaning methods (83.6%). Contrasted with, this, most nurses reported that doctors are not likely to collaborate with nurses when decisions to extubate the patient (74.6%) and selection of initial ventilation settings (68.2%) are made. This study observed a marginal (2%) number of nurses input in making key ventilator decisions. Seventy percent of nurses in this study agreed that responsibility for ventilation decisions lies at the level of seniority of a registrar and above, and in their absence, only senior nurses (>80%) were perceived to be responsible for key ventilator decisions.

In regard to the independent titrations of ventilator settings, without direct medical consultation, finding showed that nurses in this study reported a frequency of >50 % of the time for: titration of respiratory rate (56.4%), titration of tidal volume (53.2%), decreasing pressure support (47.3%), increasing pressure support (45.5%), change mode (38.2%) and titration of inspiratory pressure (33.6%).

The *second objective* was to relate the association of specialist nurses autonomy and influence in decision making to independent titrations of ventilator settings.

Relating to the level of nursing autonomy and influence in decision making, findings revealed a median score of 7.0 in nursing autonomy and influence in decision-making, respectively. It suggests nurse respondents in this study perceived themselves to have reasonable levels of autonomy and influence in decision making. In this study, nurses with higher levels of autonomy scores frequently (>50% of the time) titrate “respiratory rate, tidal volume, inspiratory pressure, increase pressure support and ventilation mode” ($p<0.05$).

Similarly, nurses with higher levels of influence in decision making scores frequently (>50% of the time) titrate “respiratory rate, tidal volume, inspiratory pressure, pressure support, *positive end-expiratory pressure* and ventilation mode” ($p<0.05$).

Nurses in the study with more years of experience, frequently (>50% of the time) titrate “respiratory rate, tidal volume, *increase positive end expiratory pressure, oxygen settings*” ($p<0.05$). Conversely, nurses in the study with fewer years of experience, infrequently (<50% of the time) titrate “respiratory rate, tidal volume and increase or decrease oxygen settings” ($p<0.05$).

In this study, there was no significant difference in the role of nurses who worked with weaning protocols, either in numbers of independent titrations ($p>0.05$) in all ten titrations, nor the perceived autonomy and influence in decision making.

The *third objective* was to identify specialist nurse's level of independent decision making in oxygen and positive end-expiratory pressure titrations.

Regarding independent titrations made to ventilation settings, eighty percent of nurses reported independent titrations with oxygen settings as the most frequently titrated setting, while positive end-expiratory pressure settings were the least (<30%) titrated setting. This difference may account for the fact that changes to oxygen settings are less complicated for a nurse to make that making changes to positive end-expiratory pressure settings.

Nurses with higher levels of influence in decision making and years of experience scores frequently (>50 % of the time) titrate "*positive end-expiratory pressure*" ($p<0.05$), whereas nurses with higher levels of years of experience scores frequently (>50% of the time) titrate oxygen settings ($p<0.05$).

5.4 LIMITATIONS OF THE STUDY

The following limitations of the study were identified:

- The investigation of the specialist nurses role in ventilation management by looking at the perceptions of specialist nurses without comparing same with medical doctor's opinions.
- The use of non-probability convenience sampling and a relatively small sample.
- The perceptions of the roles of specialist nurses in ventilation management may not be representative of actual patient care.

In consideration of these limitations, the findings of this study cannot be generalised unless replication of the study is carried out on a larger scale including adult intensive care units in other public hospitals.

5.5 RECOMMENDATIONS ARISING FROM THE STUDY

Based on the findings of the study the following recommendations for clinical practice, nursing education and further research are suggested.

5.5.1 Recommendations for Clinical Practice

To achieve effective inter-professional collaboration in key decision making related to ventilation management, there must be teamwork. It can be enhanced by strengthening nurses input and contribution in decision making related to ventilation management. Experienced nurses need to guide and encourage lesser experienced nurses to become active participants when multi-disciplinary decisions are being made for their patients. It can be achieved by acting as positive role models and mentors, promoting good communication, respect and collegiality between team members.

It was observed in this study that automated weaning modes are not routinely used in these intensive care settings. This is despite the availability of these modes on the mechanical ventilators currently used in intensive care units. Therefore, ventilation management education during orientation of new nurses to the intensive care units must incorporate these automated modes. This can also be achieved through on-going education programmes.

5.5.2 Recommendations for Nursing Education

To enhance specialist nurses roles in decision making related to ventilation management, there must be clinical knowledge. It can be enhanced by emphasising the importance of fundamental respiratory pathophysiology and its application in decision-making related to mechanical ventilation in the curriculum. Therefore intensive care nurses should be encouraged to learn to integrate ventilation parameters and make clinical judgments to solve problems and identify patient needs.

Educators of intensive care nursing programmes should pay particular attention to the use of automated modes that are currently used in practice. This needs to be incorporated into the teaching of mechanical ventilation to enhance intensive care nurses knowledge base.

5.5.3 Recommendations for Further Research

The results of the study have shown that specialist nurses have a role in decision-making related to ventilation management, but there is a need to conduct a survey to identify and compare doctor’s perceptions and opinions to determine to what extent they would agree with the viewpoints of specialist nurses.

5.5 CONCLUSION

The researcher undertook this study with the aim of describing the specialist nurses role in ventilation management in the adult intensive care units of two public hospitals in Gauteng. While collaboration between nurses and doctors appears to be the model of key ventilator decision making, nurses have marginal independent input into key ventilator decision making. Doctors and nurses are more likely to collaborate on decisions made for ventilator settings, determining weaning readiness, identifying weaning failure and choice of weaning methods. Doctors are, however, not likely to collaborate with nurses when decisions are to be made on initial ventilation settings and extubation. Senior nurses have more inter-professional responsibilities than lesser experienced nurses in key decision making in the absence of the medical doctor.

Specialist nurses perceived themselves to have reasonable levels of autonomy and influence in decision making related to ventilator management. Nurses with more experience tend to make more independent ventilator setting changes without medical consultation. Lesser experienced nurses are not likely to make independent decisions without first consulting with a medical doctor. Nurses are more likely to make frequent changes to oxygen settings than titrating positive end-expiratory pressure settings for a patient. This difference may account for the fact that is easier to titrate oxygen settings than positive end expiratory pressure. The use of ventilation management protocols was not found to influence nurse’s level of autonomy and influence in decision making.

Acknowledging the role of the specialist intensive care nurse in initial ventilation settings and decisions leading to extubation of mechanically ventilated patients will improve their clinical decision-making ability, and most probably will also enhance inter-professional collaboration in intensive care units, nurse’s autonomy and credibility of specialist nursing practice.

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APPENDIX A

ROLES OF SPECIALIST INTENSIVE CARE NURSES IN MECHANICAL VENTILATION MANAGEMENT

DATA COLLECTION INSTRUMENT

Dear Colleague
You are being invited to take part in a research survey. I am surveying specialist intensive care nurses' roles and responsibilities for mechanical ventilation and weaning practices in an academic hospital in Johannesburg. I would appreciate if you take 15 to 20 minutes to complete the enclosed questionnaire. When completed please return the questionnaire in the envelope provided.
Thank you.

SECTION A: Biographical Data

1. What age group do you belong to:

20-29 years	
30-39 years	
40-49 years	
50-60 years	
>60 years	

2. Please list your academic qualifications

3. State the year you qualified as an intensive care nurse

4. Indicate your position in the ICU by ticking one of the following:

ICU nurse	Shift leader	Unit manager

5. Indicate your clinical area by ticking one of the following:

Multidisciplinary ICU	
Cardiothoracic	
Coronary Care	
Surgical	
Medical	
Trauma	
Major Burns	
Neurosurgery	

SECTION B: KEY VENTILATION DECISIONS, STAFFING RATIOS, AUTONOMY AND INFLUENCE

1. Who determines the initial selection of ventilator settings?

a	Doctors only	
b	Nurses only	
c	Doctors and nurses in collaboration	
d	Other	

If other, please specify ________________________________

1a. Identify the seniority of doctors responsible for initial selection of ventilator settings

a	Consultants only	
b	Registrars and above	
c	Residents and above	
d	Other	

If other, please specify ________________________________

1b. If applicable, the seniority of nurses responsible for initial selection of ventilator settings

a	Senior nurses only (eg clinical nurse specialists, nurse managers, educators	
b	All nursing staff (once orientated to the ICU environment	
c	Other	

If other, please specify ________________________________

2. Who evaluates the patient's response to mechanical ventilation and titrates settings if required?

a	Doctors only	
b	Nurses only	
c	Doctors and nurses in collaboration	
d	Other	

If other, please specify ________________________________

2a. Identify the seniority of doctors responsible for titration of ventilator settings

a	Consultants only	
b	Registrars and above	
c	Residents and above	
d	Other	

If other, please specify ________________________________

2b. If applicable, identity the seniority of nurses responsible for titration of ventilator settings

a	Senior nurses only (eg clinical nurse specialists, nurse managers, educators	
b	All nursing staff (once orientated to the ICU environment	
c	Other	

If other, please specify ________________________________

3. Who decides when a patient is ready to wean?

a	Doctors only	
b	Nurses only	
c	Doctors and nurses in collaboration	
d	Other	

If other, please specify ________________________________

3a. Identify the seniority of doctors responsible for determining weaning readiness

a	Consultants only	
b	Registrars and above	
c	Residents and above	
d	Other	

If other, please specify ________________________________

3b. If applicable, identify the seniority of nurses responsible for determining weaning readiness

a	Senior nurses only (eg clinical nurse specialists, nurse managers, educators	
b	All nursing staff (once orientated to the ICU environment	
c	Other	

If other, please specify ________________________________

4. Who decides the method of weaning from mechanical ventilation?

a	Doctors only	
b	Nurses only	
c	Doctors and nurses in collaboration	
d	Other	

If other, please specify ________________________________

4a. Identify the seniority of doctors responsible for determining the method of weaning

a	Consultants only	
b	Registrars and above	
c	Residents and above	
d	Other	

If other, please specify ________________________________

4b. If applicable, identify the seniority of nurses responsible for determining the method of weaning

a	Senior nurses only (eg clinical nurse specialists, nurse managers, educators	
b	All nursing staff (once orientated to the ICU environment	
c	Other	

If other, please specify ________________________________

5. Who decides when a patient is ready to extubate ?

a	Doctors only	
b	Nurses only	
c	Doctors and nurses in collaboration	
d	Other	

If other, please specify ___________________________________

5a. Identify the seniority of doctors responsible for determining readiness for extubation

a	Consultants only	
b	Registrars and above	
c	Residents and above	
d	Other	

If other, please specify ___________________________________

5b. If applicable, identify the seniority of nurses responsible for determining readiness for extubation

a	Senior nurses only (eg clinical nurse specialists, nurse managers, educators	
b	All nursing staff (once orientated to the ICU environment	
c	Other	

If other, please specify ___________________________________

6. Who decides when a patient is failing a weaning trial?

a	Doctors only	
b	Nurses only	
c	Doctors and nurses in collaboration	
d	Other	

If other, please specify ___________________________________

6a. Identify the seniority of physicians responsible for determining weaning failure

a	Consultants only	
b	Registrars and above	
c	Residents and above	
d	Other	

If other, please specify ___________________________________

6b. If applicable, identify the seniority of nurses responsible for determining weaning failure

a	Senior nurses only (eg clinical nurse specialists, nurse managers, educators	
b	All nursing staff (once orientated to the ICU environment	
d	Other	

If other, please specify ________________________________

7. What is the nurse-to-patient ratio for patients receiving mechanical ventilation in your ICU?

a	1:1 ratio	
b	1:2 ratio	
c	1:3 ratio	
d	Other	

If other, please specify ________________________________

8. What is the nurse-to-patient ratio for patients receiving non-invasive ventilation in your ICU?

a	1:1 ratio	
b	1:2 ratio	
c	1:3 ratio	
d	Other	

If other, please specify ________________________________

9. How would you rate nursing autonomy in regards to mechanical ventilation practices? Please circle the number on the scale below

1	2	3	4	5	6	7	8	9	10

10. How often to nursing contributions influence decisions made regarding mechanical ventilation? Please circle the number on the scale below

1	2	3	4	5	6	7	8	9	10

SECTION C: INDEPENDENT VENTILATION DECISIONS, PROTOCOLS, AUTOMATED WEANING AND NURSE EDUCATION

11. How often do nurses make and implement the following decisions independently (without direct consultation with a doctor):

	Never (0%)	Seldom (1-25%)	Frequently (26-50%)	Often (51-75%)	Routinely (>75%)	Uncertain
Change of mode						
Titration of respiratory rate						
Titration of respiratory rate						
Titration of inspiratory pressure						
Increase of pressure support						
Decrease of pressure support						
Increase of PEEP						
Decrease of PEEP						
Increase of FiO2						
Decrease of FiO2						

12. In your ICU, do you have guidelines/policy/protocol for management of mechanical ventilation?

Yes		No		Uncertain	

13. In your ICU, do you have a guideline/policy/protocol for weaning from mechanical ventilation?

Yes		No		Uncertain	

If yes, does it contain information on management of patients failing weaning?

Yes		No		Uncertain	

14. In your ICU, do you have a guideline/policy/protocol for management of non-invasive ventilation?

Yes		No		Uncertain	

15. Are any of the following automated weaning modes used in your ICU?

	Never (0%)	Seldom (1-25%)	Frequently (26-50%)	Often (51-75%)	Routinely (>75%)	Uncertain
SmartCare/PS						
Adaptive support ventilation (ASV)						
Mandatory minute ventilation (MMV)						
Proportional assist ventilation (PAV)						

16.1 Do nurses receive education on ventilation during ICU orientation?

Yes		No		Uncertain	

If YES please describe (optional)

16.2 Are opportunities available in your ICU for on-going professional development related to mechanical ventilation?

Yes		No		Uncertain	

If YES please describe (optional)

THANK YOU for taking the time to complete the questionnaire

APPENDIX B

ROLES OF SPECIALIST INTENSIVE CARE NURSES IN MECHANICAL VENTILATION MANAGEMENT

PARTICIPANTS' INFORMATION LETTER

Dear Colleague,

My name is Chinwe Jacinta Ladipo. I am a student at the University of the Witwatersrand, in the Department of Nursing, for the Master of Science degree in Nursing (intensive care). I hope to conduct a research project under the supervision of Dr Shelley Schmollgruber, and would like you to consent to my including you in my sample of nurses that I hope to study in the intensive care units.

The purpose of this study is to understand how intensive care specialist nurses describe their role in ventilation management in two academic hospital in Johannesburg.

I hereby invite you as an intensive care specialist nurse to please participate in a research study entitled "the role of intensive care specialist nurses in ventilation management in two academic hospitals in Johannesburg. Should you agree to participate in this study, you will be asked to sign a consent form to confirm your willingness to participate in the study. I will then ask you to rate 24 items independently on a predetermined questionnaire. This questionnaire will take 5-10 minutes to complete.

Participation in this study is voluntary. You may choose not to participate or withdraw from the study at any time, which will not affect the services you provide or your position in this institution. Anonymity and confidentiality will be ensured by using a code number instead of real name and no personal information will be reported in the study in order to protect your identity. No direct benefit will be derived from participating in this study. I do hope that the completed study will help to understand how specialist intensive care nurses describe their role in the management of mechanical ventilation. Result of the study will be given to you should you wish.

The appropriate people and research committee of the University of the Witwatersrand, Gauteng Department of Health and Charlotte Maxeke Johannesburg Academic Hospital (CMJAH) have approved the study and its procedures.

Thank you for taking your time to read to read this information letter. Should you require any more information regarding the study or your rights, you are free to contact me in the Department of Nursing Education, on the following telephone 0840302891 or email me using the following address chijacy@yahoo.com.

Yours sincerely
Chinwe Jacinta Ladipo
MSc Nursing Student

APPENDIX C

R14/49 Ms Chinwe Jacinta Ladipo

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M160551

NAME: (Principal Investigator)	Ms Chinwe Jacinta Ladipo
DEPARTMENT:	Nursing Education Charlotte Maxeke Johannesburg Academic Hospital Chris Hani Baragwanath Academic Hospital
PROJECT TITLE:	Roles of Specialist Intensive Care Nurses in Mechanical Ventilation Management
DATE CONSIDERED:	27/05/2016
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Dr Shelley Schmollgruber
APPROVED BY:	Professor P. Cleaton-Jones, Chairperson, HREC (Medical)
DATE OF APPROVAL:	07/07/2016

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary in Room 10004,10th floor, Senate House/2nd floor, Phillip Tobias Building, Parktown, University of the Witwatersrand. I/We fully understand the the conditions under which I am/we are authorised to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated,from the research protocol as approved, I/we undertake to resubmit to the Committee. **I agree to submit a yearly progress report**. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. in this case, the study was initially review in May and will therefore be due in the month of May each year.

Principal Investigator Signature ____________ Date ____________

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

APPENDIX D

GAUTENG PROVINCE

HEALTH
REPUBLIC OF SOUTH AFRICA

CHARLOTTE MAXEKE JOHANNESBURG ACADEMIC HOSPITAL

Enquiries:
Ms. G. Ngwenya
Office of the Nursing Director
Tell: (011): 488-4558
Fax: (011): 488-3786
06 May 2016

Chinwe Jacinta Ladipo
Department of Nursing Education
Faculty of Health Sciences
University of Witwatersrand

Dear Chinwe Jacinta Ladipo

RE: "Roles of Specialist Intensive Care Nurses' in Mechanical Ventilation Management"

Please note that permission to conduct the above mentioned study is provisional approved. Your study can only commence once ethics approval and supporting letter from Head of Department is obtained. Please forward a copy of your ethics clearance certificate as soon as the study is approved by the ethics committee for the CEO's office to give you the final approval to conduct the study.

Supported / ~~not supported~~

PP **Ms. M.M Pule**
Nursing Director
DATE:

Approved / not approved

Ms. G. Bogoshi
Chief Executive Officer
DATE: 11. 05. 2016

APPENDIX E

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

MEDICAL ADVISORY COMMITTEE
CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL

PERMISSION TO CONDUCT RESEARCH

Date: 27 June 2016

TITLE OF PROJECT: Roles of specialist intensive care nurses in mechanical ventilation management

UNIVERSITY: Witwatersrand

Principal Investigator: CJ Lapido

Department: Nursing Education

Supervisor (If relevant): S Schmollgruber

Permission Head Department (where research conducted): Not yet

Date of start of proposed study: June 2016
Date of completion of data collection: Dec 2017

The Medical Advisory Committee recommends that the said research be conducted at Chris Hani Baragwanath Hospital. The CEO /management of Chris Hani Baragwanath Hospital is accordingly informed and the study is subject to:-

- Permission having been granted by the Human Research Ethics Committee of the University of the Witwatersrand.
- the Hospital will not incur extra costs as a result of the research being conducted on its patients within the hospital
- the MAC will be informed of any serious adverse events as soon as they occur
- permission is granted for the duration of the Ethics Committee approval.

....
Recommended
(On behalf of the MAC)
Date: 27 June 2016

....
Approved/Not Approved
Hospital Management
Date: 2016/06/16

APPENDIX F

POSTGRADUATE COMMITTEE APPROVAL

Original letter to be inserted on final report.

APPENDIX G

Permission to use instrument

Dear Shelley
Of course your student can have my permission to use the tool. I would ask that we are acknowledged as the source in any presentations and publications. I would also love to receive a copy of her results.
Kind regards
Louise

From: Shelley Schmollgruber [mailto:schmoll@iafrica.com]
Sent: Thursday, March 16, 2017 4:18 AM
To: Louise Rose
Subject: Request for permission

Dear Professor Rose,
My name is Shelley Schmollgruber, I am the Postgraduate Research Coordinator in the Department of Nursing, University of the Witwatersrand in Johannesburg, South Africa. I am currently supervising a MSc student who has identified one of the instruments developed by you as suitable for her study design. The article is entitled: Decisional responsibility for mechanical ventilation and weaning: an international survey. Published in Critical Care, 2001: 15-R295. The student will be conducting the study in 10 intensive care units at two major university-affiliated public hospitals.

Our student has accessed the instrument used in this study from the additional files of the above-mentioned publication. However, as this student is undertaking formal studies, our University policies require that she obtain written permission from the developer of the instrument. Would you please be so kind and consider our request to use the instrument in her study. I anticipate the student would complete the study within the next three months. It is our university policy for the award of the degree that the student prepares a manuscript for consideration for publication.

A short email response from you will be sufficient for our purpose of having obtained permission.

Kind regards

Dr Shelley Schmollgruber
Senior Lecturer.
Specialisation: Intensive and Critical Care Nursing, Trauma and Emergency Nursing.
e-mail: shelley.schmollgruber@wits.ac.za
Tel: +27 (0) 11 488 4271
address: 7 York Road, Parktown, Johannesburg, South Africa, 2193.

Department of Nursing Education

WITS UNIVERSITY FACULTY OF HEALTH SCIENCES THERAPEUTIC Sciences