CHAPTER ONE

OVERVIEW OF THE STUDY

1.0 INTRODUCTION

This chapter presents an outline of the study. The problem statement, purpose of the study, research objectives and the significance of the study will be described, the assumptions of the researcher will be discussed and operational terms defined. A brief overview, which will be discussed in greater detail in Chapter Three, will be given of the research methodology, validity and reliability of the study and the ethical procedures adhered to.

Mechanical ventilation is one of the most common forms of therapy administered to patients in the Intensive Care Unit (ICU) and is applicable for approximately one third of patient's in ICU's worldwide (Wang Chunyan & Wang, 2008: 183). Critical illness is a sudden and traumatic experience affecting both patient and family. Patients' suffer discomfort and stress, as a result of hospitalisation and illness and when intubated with an artificial airway, cannot speak or communicate their feelings and needs, effectively being rendered helpless. The alienating ICU environment can have far reaching psychological and physiological repercussions for these patients (Wang, et al, 2008:183).

Care of ventilated patients is considered high risk and high cost (Kollef, Ahrens, Schaiff et al, 1997:567; Grap, Strickland, Tormey et al, 2013:454) consequently, weaning has been identified as an important research priority in order to reduce the duration of mechanical ventilation, the duration of weaning and patient stay in the ICU (Rose & Nelson, 2006:74; Blackwood, Alderdice, Burns et al, 2009:957). Patients may require either short-term or long-term mechanical ventilation (three days or less or more than three days, respectively) (Morton & Fontaine, 2013:544). Weaning implies the gradual withdrawal of mechanical ventilation and resumption of spontaneous breathing (El-Khatib & Bou Khalil, 2008; Ely, Meade, Haponik et al, 2001:454S). This may be rapid, with the patient having a short trial of spontaneous breathing then being extubated, or it may be gradual with slow reductions in support given by the ventilator (Rose & Nelson, 2006: 74).

A review of literature does not suggest one scientific weaning method is superior to another, nor is there agreement amongst experts about when to start weaning (Penuelas, Frutas-Vivar, Fernandez et al, 2011:430; Rose et al, 2007: 435). However, weaning protocols are considered useful in reducing the length of the weaning process (Crocker, 2009:185; Twibell, Siela & Mahmoodi, 2013:101). Weaning protocols are associated with 25% reduction in the duration of mechanical ventilation time, a 78% reduction in weaning duration and 10% reduction for length of stay in ICU (Blackwood et al, 2011:9). Some experts believe successful weaning is as a result of the use of a weaning protocol, rather than specific methods of weaning (Grap et al, 2003:455). Level one (grade A) evidence shows positive outcomes for patients managed with non-physician driven protocols (MacIntyre, 2001: 384-385s). Weaning patients off the ventilator is complex as the nurse needs to discontinue ventilation whilst providing continuous care and patient-focused, individualised weaning care plans, highlighting the expanding role of the ICU nurse (Lavelle & Dowling, 2011: 244).

1.1 BACKGROUND OF THE STUDY

Critical care nurses have a role to play in identifying prerequisites for successful weaning. Firstly, the reason for the patient's admission needs to be resolved, e.g. recovery from sepsis or renal failure, then a systematic assessment of the patient's physical and psychological status is done against guidelines or predictors. The Burns Weaning Assessment Programme (BWAP) was an early continuum developed in order to assess and track predictors for safe weaning (Burns, Fisher, Tribble et al, 2010:437; Crocker & Scholes, 2009:289); others are the rapid shallow breathing index (RSBI - frequency of breaths divided by tidal volume) and ratio of required percentage of oxygen and partial pressure of oxygen ($Fi0_2/Pa0_2$) ratio (Crocker, 2009:186). Crocker describes weaning as both "art and science" and nurses use both objective (physiological) and subjective (psychological) criteria when weaning patients off the ventilator (Crocker & Kinnear, 2007:187). Psychological factors like anxiety, fear and stress are regarded as important non-respiratory predictors leading to unsuccessful weaning and nurses without knowledge or experience may miss these predictors (El-Khatib & Bou-Khalil, 2008: 5; Crocker, 2009: 187; Blackwood et al, 2004:30).

There is global variation in nurses' roles with regard to weaning practice. In ICU's in Australia and New Zealand, it is within the nursing scope of practice to adjust the ventilator according to physiological parameters, usually without protocols (Rose et al, 2011: e14); in the UK, nurses are allowed to extubate, as legislated in 1992. In fact, weaning is increasingly being recognised as an expanded nursing practice role, especially in cardiothoracic ICUs where it is a simple process for a mostly homogenous group of patients (Rose & Nelson, 2006:82). A 2009 study by Eckerblad, Eriksson, Karner et al., found ICU nurses in Sweden are responsible for weaning, but many feel uncertain about it (Pettersson, Melaniuk-Bose & Edell-Gustafsson, 2011:169).

According to literature, nurses are influenced by their relationship with the doctor, experience, knowledge and skill, as well as the autonomy to make decisions and collaborate with other nurses (Villa, Manara & Palese, 2011:42). In Italy, an ethnographic study in 2008 on nurses in a cardiac unit revealed that expert nurses would collect data, share information with other nurses and then suggest decisions, which still needed to be authorised by doctors (Villa et al, 2011: 41).

Providing care, based on the best available clinical and cost-effective evidence, has become part of the national strategy for healthcare in the UK (Taylor, 2003:45). Similarly in South Africa, a national drive by the Department of Health, prescribes that those working in Critical Care need to ensure their practice is evidence-based and of top quality (Health Act 61 of 2003), in accordance with the National Core Standards of Health and patient's right to safety (Sacket, Richardson, Rosenberg et al, 2000).

Experts agree the value of protocols is to improve quality of care and patient satisfaction as well as minimise variations in care delivery. Inherent to the success of weaning protocols is the skill and expertise of the intensive care nurse and ability to accept this level of responsibility (Crocker, 2009: 185). However, critics of protocols believe they restrict critical thinking and individualised care (Hansen & Severinsson, 2007:197).

An NHS led initiative in the UK found that nurse-led weaning improves decision-making, autonomy and job satisfaction (Crocker & Kinnear, 2007:185). A care bundle approach was introduced to enable nurses to wean the patient in stages (pre-weaning and weaning) by following a series of steps which included screening for factors causing ventilator dependence. It was found that even with these care bundles in place, barriers to weaning still occurred and some of the reasons cited were experience of the staff, available equipment and motivation of the patient (Crocker & Kinnear, 2007: 185).

Ventilator decisions in the USA are often made by a respiratory therapist, not a physician or nurse and the nurse may disagree with decisions made. Decisions in the USA are different about mechanical ventilation and weaning compared to Australia where up to 75% of nurses hold a critical care qualification, with a nurse to patient ratio of 1:1, in contrast to the USA with a nurse to patient ratio of 1:2 and respiratory therapists 1:8 (Rose et al. 2007: 441).

In South Africa, a physiotherapist led initiative researched the use of weaning protocols in the trauma unit of a private healthcare facility, using a non-randomised experimental trial. In comparing a prospective cohort of patient's weaned using a physiotherapist and nurse led protocol matched with a retrospective cohort of patients weaned using a physician led protocol, it was found there was a low re-intubation rate for patients on whom weaning protocols had been used by the former (Plani, Becker et al, 2012:211). Nurses and physiotherapists were well situated to provide screening for weaning and to correct any underlying pathologies. The use of a nurse and physiotherapist led protocol was found to be safe and led to similar results found by physicians using physician led protocols. It was suggested the role of nurses and physiotherapists could be greatly expanded in ICU's in South Africa (Plani, Becker et al, 2012:217).

While weaning practices, weaning readiness assessment predictors and methods of weaning are controversial, it is unanimously agreed in literature that nurse-led protocols for weaning improve patient outcomes by avoiding unnecessary delay in withdrawing mechanical ventilation, reducing increased costs, helping to recognise the best time to wean patients from mechanical ventilation and minimising problems such as VAP, patient discomfort and ventilator-induced lung injury (McIntyre, 2004:830; Rose & Nelson, 2006:73).

Providing "safe" and error-free" healthcare is an important priority for healthcare professionals. Guidelines and protocols have been created to help reduce variations in care and provide quality of care. As many as 50% of patients receive mechanical ventilation in

ICU and nearly 40% of this time is spent weaning, therefore it is important for nurses to have professional knowledge in order to safely and timeously wean patients from ventilator support. (Hansen & Severinsson, 2007:196-197).

1.2 PROBLEM STATEMENT

By following EBP guidelines and protocols for weaning, the incidence of LTMV and associated complications, including VAP, increased risk of airway trauma, over sedation, increased length of stay, increased costs and increased mortality, would be reduced. However, little is known about ICU nurses' knowledge and understanding of EBP and implementation in clinical practice. Therefore it is important to evaluate nurses' knowledge and identify any barriers to EBP regarding weaning mechanically ventilated patients. Globally, physicians and clinicians cannot agree on formalised or standardised weaning protocols, affording ICU nurses the opportunity to close the gap between evidence based research and evidence based practice as they are at the bedside 24/7. Nurses are already making treatment decisions and are in the best position to assess and report on the patient's changing condition and act according to patient and family needs.

The study will attempt to answer the following research questions:

- Do nurses have knowledge regarding EBP guidelines for weaning the mechanically ventilated patient?
- Are EBP guidelines for weaning the mechanically ventilated patient being practiced as protocols in Intensive Care Units and what are the reasons for lack of adherence to the guidelines?
- Does training and years of experience of ICU nurses correlate with levels of knowledge?

1.3 PURPOSE OF THE STUDY

To evaluate and describe Intensive Care nurses' knowledge of EBP guidelines with regard to weaning the mechanically ventilated patient in general Intensive Care Units in public hospitals in Gauteng in order to determine barriers to evidence based practice.

1.4 RESEARCH OBJECTIVES

The objectives for the study are:

- To evaluate ICU nurses' knowledge of EBP regarding weaning the mechanically ventilated patient through the use of an instrument (self-administered questionnaire) to a sample of Intensive Care trained nurses (with different levels of experience) in public hospitals in Gauteng.

- To determine whether ICU nurses' level of knowledge of EBP is based on experience as well as education. Research has shown nurse-led evidence based weaning protocols improve patient outcomes.

- To identify opportunities for further use of evidence based weaning protocols in ICU in order to enhance nursing education and improve patient outcomes including reducing patient mortality and the cost of long term mechanical ventilation.

1.5 SIGNIFICANCE

Mechanical ventilation and its associated complications (ventilator induced lung injury (VILI), ventilator associated pneumonia (VAP), increased length of ICU and hospital stay and increased cost of care) have a major influence on patient outcomes, weaning protocols however significantly reduce the length of weaning and mechanical ventilation. EBP guidelines have been created to prevent unnecessary LTMV and to enable it to be stopped as soon as possible, therefore ICU nurses' adherence to these guidelines is extremely important for increasing positive patient outcomes. A gap between best evidence and best practice was identified in literature (Hansen & Severinsson, 2007: 196-197).

1.6 RESEARCHER'S ASSUMPTIONS

The research was based on the following meta-theoretical, theoretical and methodological assumptions:

1.6.1 Meta- theoretical assumptions

These are related to the four main constructs of nursing, namely person, environment, nursing and health. Conceptual models were created as a foundation for nursing research, in turn having an impact on nursing education and clinical practice (Polit & Beck, 2010:220). According to literature, these theories provide a framework, which give qualitative studies a theoretical base (Polit & Beck, 2010:206).

According to the World Federation of Critical Care Nurses (WFCCN), the role of the intensive care nurse is necessary to provide specialist knowledge and skill when caring for critically ill patients. The intensive care nurse brings knowledge and caring to provide holistic patient care in a highly technical environment and to do this, nurses need knowledge and skills over and above the basic nursing programmes of most countries (WFCCN published online 2005). The term "critically ill" defines patients according to their condition and the environment in which they are looked after, which provides staff and facilities above that normally found in a general ward (Williams, Chaboyer, Fulbrook al, 2011:73).

Furthermore, the position statement outlines that governing bodies overseeing the practice of nursing should support the dedicated specialised preparation of Critical Care nurses so as to ensure optimum health for their community. According to Roy's Adaptation Model (1999), the recipient of nursing care is a biopsychosocial and spiritual being, in constant interaction with the environment. Within the human systems are four subsystems including physiological/physical, self-concept/group identity, role function and interdependence. These systems constitute adaptive modes which provide mechanisms for coping with environmental stimuli and change. Nursing helps promote the patient adaptation during health and illness. Adaptive mechanisms of the individual are those that help someone cope mentally, socially, emotionally and spiritually (Polit & Beck, 2010:200). In weaning the mechanically ventilated patient, nurses increase, modify, remove and maintain stimuli that affect a patient's adaptation.

Another theory used in quantitative research is Pender's Health Promotion Model. A conjecture or presupposition from a theory can be a testing point for a theory's validity. From the theory, the researcher can develop a hypothesis about the way the variables would be interrelated if the theory were accurate. For example, if the HPM model is true the researcher could expect that ICU nurses with more knowledge about weaning the mechanically ventilated patient would be better able to implement evidence based practice (Polit & Beck, 2010:2007).

The underlying premise of the Synergy Model is that every patient and their family bring characteristics to a healthcare situation that will affect the nursing care needed to meet their specific needs. This theory proposes that when the needs of the patient and their family match the competence of the nurse, synergy results and better outcomes for patients can be anticipated (Kohr, Hickey & Curley: 421-422). Eight characteristics form the basis of the model including resiliency, vulnerability, stability, complexity, resource availability, participation in care, participation in decision making and predictability (Morton & Fontaine, 2010: 8). Nurse characteristics are also an important component of the model including clinical judgement, decision making and critical thinking, acquired by integrating formal and informal knowledge, including knowledge of evidence based practice and experience. The nurse also has to work as an advocate on behalf of the patient, which is relevant to weaning, as the nurse has to assess both physiological (objective) and psychological (subjective) parameters of the patient in order to determine weaning readiness and this will result in better outcomes for the patient – i.e. earlier liberation from mechanical ventilation and reduced costs for the family and healthcare facility (Blackwell, 2004:28).

In the seminal work of Patricia Benner and her adaptation of the Dreyfus Model of Skill Acquisition, the suggestion is that skilled performance in nursing is based on experience as well as education, clinical knowledge and career progression. The model outlines that whilst acquiring and developing skills, the nurse passes through five levels of proficiency: novice/beginner, advanced beginner, competent, proficient and expert. As the nurse passes through these levels they reflect changes: the use of abstract ideas to concrete experiences, from viewing a multiple faceted scenario to focusing on a holistic picture with relevant factors and movement from detached observer to active performer (Altmann, 2007:114). Benner’s work has been criticised for not being quantitative and the use of nurse intuition or “knowing” being seen as non-scientific (Altmann, 2007:117).

In 1998 Rolfe applied Benner's knowledge theory further by making the observation that knowing is as a result of theoretical and empirical knowledge based on scientific, experiential and personal knowledge. This is relevant to weaning the patient from mechanical ventilation, as nurses' know-how consists of different kinds of knowledge: practical (practical and experiential), knowing why (theoretical and empirical) and knowing what (pattern recognition). According to this theory, advancing practice from the nurses' perspective is concerned with knowledge acquisition and integration as opposed to skill and task acquisition alone (Christensen, 2009: 87).

1.6.2 Theoretical assumptions

A theory is an explanation of a phenomenon and the relationship between the variables are related to the phenomenon. It is also a way to link concepts together to describe or explain an aspect of reality and play a role in quantitative research (De Vos, Strydom, Fouche & Delport, 2005).

The operational definitions consistently used in this study are as follows:

Mechanical Ventilation

Mechanical ventilation is defined as a process by which gases move in and out of the lungs by means of a ventilator; a machine delivering a controlled flow of gas to a patient's airway (Withers, J, 2013: 55; Carlson, 2009:485).

Weaning

Weaning refers to a process of assisting patients to breathe spontaneously without mechanical support by reducing ventilator support over time, allowing patients to resume the work of breathing (Haas, 2012:1650).

Intensive Care Nurse

An Intensive Care nurse is a clinical nurse who is formally trained and functions at an advanced level of patient care in a multidisciplinary environment. According to the South African Nursing Council, an Intensive Care nurse is a registered nurse who obtains an additional qualification in advanced medical surgical nursing, critical care, at an approved learning facility (R212).

Intensive Care Unit

An adult Intensive Care Unit is a specifically staffed and equipped hospital unit. The management is dedicated to saving patients with life-threatening illnesses, injuries or complications (Bersten & Soni, 2003:3).

Knowledge

Self-knowledge is defined as the ability to understand and develop yourself within the realm of organizational challenges, interpersonal demands, and individual motivation (Dracup & Bryan-Brown, 2004: 450). In this study, knowledge is explored in respect of what the term weaning means, as well as different modalities. Another aspect explored is knowledge related to weaning parameters, weaning indexes and the factors that contribute to weaning.

Evidence based practice (EBP)

EBP is knowledge derived from research, experience and patient situation; this informs decision making in clinical practice. In clinical practice, critical thinking and clinical judgment result in decision making, translated into action (Sackett et al. 2000).

Guidelines and Protocols

A guideline is a principle or criterion guiding or directing action. Clinical guidelines and care protocols are used interchangeably. Protocols are a set of directions, principles or decision support tools to assist the healthcare practitioner about diagnostic or clinical procedures. Protocols are viewed as “dynamic tools in evolution” which can be changed to accommodate new data or clinical practice (MacIntyre, 2001: 385s; Girard & Ely, 2008:242).

Critically ill patient

In this study, critically ill patients means those who are admitted to the Critical Care Unit to be supported with technology and treatment which requires intense monitoring, with the aim to prevent, or be rescued from complications that are life threatening.

Nurse-led initiative

By integrating best evidence based practice, knowledge, therapies and clinical skills of ventilator practice, nurses can play an expanded role and provide the respiratory patient with a high level of care. (Rose & Nelson, 2006:81).

1.6.3 Methodological assumptions

Methodological assumptions relevant to this study are quantitative research and evidence based research. In nursing, “best evidence” is a term applied to findings from research that is methodologically sound, relevant and appropriate for answering questions regarding the safety and efficacy of nursing interventions and how reliably the information is assessed. According to literature, support for the evidence is usually forthcoming when the research methods are compelling, where there are other similar studies replicating the study and where the evidence is systematically analysed and replicated. In this study, best evidence implies that all evidence about a clinical problem has been gathered and synthesised and conclusions made about effective practice (Polit & Beck, 2010: 38-39). Evidence based practice has also been considered as the “conscientious, explicit and judicious use of current evidence in making decisions about the care of individuals” (De Vos et al, 2011: 58).

The goal of quantitative research is to convey knowledge and findings in a scientifically based way and to make sure it is translatable and verifiable by finding causal relationships between variables (de Vos et al, 2011: 279). For example, results from the survey respondents of the sample will be applied to the wider population using robust sampling practices and statistical tests of significance, to ensure the results are meaningful and not by chance (de Vos et al, 274) and concepts are translated into operational definitions and results appear numerically and reported statistically. The research design is standardised and can be replaced. Data are obtained systematically. The steps involved in the research process included starting with a research problem, basing this on observable facts or data, confirming or rejecting the research hypothesis or problem on the basis of factual data and reaching a conclusion on the basis of what the data dictate or reveal. Finally, a conclusion will be reached to answer the research problem (de Vos et al, 2011: 62-66).

1.7 OVERVIEW OF RESEARCH METHODOLOGY

1.7.1 Research design

In this study, an observational, quantitative, non-experimental and contextual design was used. The dependent variable (evidence based practice) and independent variable (knowledge of ICU nurses) were suitable for observation and measurement using a rigorous and precise design (Creswell, 2009: 233). The study was quantitative and the researcher manipulated statistics and numeric data in order to describe phenomena and make inferences for how these phenomena were related (Burns & Grove, 2010: 565). The research was descriptive so as to portray the characteristics of persons, situations or groups in which the phenomena occurred (Burns & Grove, 2010: 552).

In this non-experimental design, which involves the accurate portrayal of a situation, data were collected without using an intervention (Polit & Beck, 2010: 234). The design was prospective and measured a presumed cause (knowledge) as well as presumed effects (evidence based practice). The design was contextual, being only relevant to the environment in which the research took place. It is necessary to provide a description and analysis of the environment and social context of the respondents, in this instance the general Intensive Care Units of two public health care facilities, the CMJAH and CHBAH.

1.7.2 Research methods

The research methods follow from the chosen design. Research methods are the techniques used to study, gather and analyse information in a methodical way (Burns & Grove, 2010:566).

1.7.3 Population

The population, from which a sample is drawn, is defined as the total number of persons, events, organisation units, case records or sampling units the researcher intends to study (de Vos et al, 2010:223). The target population in this study consisted of professional nurses, working in the general Intensive Care Units at the CMJAH and CHBAH. The population of Stage I of the study comprised trained ICU nurses (expert) working in

Intensive Care Units as well as specialist nurse educators and pulmonologists. The population of Stage II of the study comprised trained ICU nurses (novice to expert) of the general Intensive Care Units from the CMJAH and CHBAH. A preliminary audit undertaken in May 2013 indicated approximately 195 (N=195) Intensive Care registered professional nurses working in these units.

1.7.4 Sample and sampling

In literature, a sample is a subset of the population the researcher is interested in. It is also defined as taking a portion of the universe and considering it representative of the population (de Vos, 2010: 223).

A non-probability purposive sampling method was chosen because the odds of selecting a particular individual were not known (de Vos, 2010: 231). Each unit in the sample frame did not have an equal chance of being selected and purposive sampling was used.
Stage I: experts (n=6) were selected to validate the questionnaire to ensure applicability of the instrument to the South African context. Six specialists comprising ICU clinical nurse educators, ICU clinical nurse specialists and pulmonologists were invited to participate in a panel discussion for the instrument validation process.

Stage II: Following discussion with a statistician from the Medical Research Council (MRC) a sample size of 80 nurses (n=80) was decided upon to ensure good representation of the population from which the sample was drawn. A large sample is needed to ensure a confidence interval of 95% (Polit & Beck, 2012). A power analysis was used to determine the minimum or needed sample size. Power analysis refers to the probability that the test will find a statistically significant difference and that the null hypothesis will be rejected (and thus avoid a Type II error). Power analysis was used to ensure a sample large enough so that sampling error would be reasonably small (Polit & Beck, 2010: 564).

1.7.5 Data collection

Permission was obtained from hospital management and the unit managers at the CMJAH and CHBAH to conduct research in the general ICU's. Prior to respondents receiving their questionnaire, they needed to sign a consent form (**Appendix VI**). Respondents were informed about the purpose of the study and any possible risks explained to them. The data was collected at a single point in time (cross-sectional) (Burns & Grove, 2010:223). The study began with the antecedent that ICU nurses' knowledge of evidence based guidelines regarding weaning the mechanically ventilated patient results in evidence based practice, so it was done in a prospective fashion (Burns & Grove, 2010:223). The method will be discussed more extensively in Section 3.

1.7.6 Instrument

A structured approach to collecting self-report data was used in the form of an instrument - a self-administered questionnaire was developed from a literature review and through the consultation of intensive care unit global clinical nurse specialists (Blackwood et al. 2011; Burns et al. 2010). These global nurse specialists were registered nurses with an expert knowledge base, complex decision-making skills and clinical expertise for advanced practice, the specifics of which are shaped by the context and/or country in which s/he is credentialed to practice. A master's degree is recommended for entry level (Canadian Nurses Association, 2012). To evaluate nurses' knowledge of weaning the mechanically ventilated patient, thirty five (35) questions relevant to nursing practice and known in the literature to result in better patient outcomes regarding weaning were collated (refer to **Appendix 1**). The questionnaire used a mix of questions and composite scales. Closed-ended questions were used for the sake of efficiency, anonymity and privacy for the respondent. Respondents were given response alternatives from which to choose (Burns & Grove, 2010: 354). Items were categorised and a scaling technique was used whereby respondents were asked to agree/disagree with a statement through the use of a Likert Scale (Burns & Grove, 2010:361).

1.8 VALIDITY AND RELIABILITY OF THE STUDY

A pilot study is a necessary part of the research process whereby the data collection process is done on a small scale in order to test and validate the instrument by administering it to a small group of respondents from the intended test population. The main purpose of the pilot study is to test the feasibility of the study and to test the measuring instrument (de Vos et al, 2010:237:73).

A sample of ICU nurses from the cardiac ICU at the CMJAH was used so as not to contaminate the sample. Validity scores were done to ensure feasibility of the study and detect possible flaws in the instrument used. Validity refers to the soundness of the evidence. It was ensured the evidence supported the inference that the method is really measuring the abstract concepts it is supposed to and that the finding are “cogent, convincing and grounded” (Polit & Beck, 2010: 115).

Content validity was achieved by having the data collection instrument reviewed by experts in ICU nursing. The Panel in Stage I addressed the following objectives: (a) whether or not the 35 items on the instrument are relevant for evaluating the knowledge of ICU nurses regarding weaning (b) if an item needs rewording and suggestions for the rewording, such as for language interpretation and consistency. Content validity for the instrument was established through a review of the literature, clinical experience and panels of experts in Critical Care nursing. Reliability was maintained by ensuring consistency and accuracy in recording of data. (Polit & Beck, 2010: 106). There was statistical reliability, when interpreting the results of statistical analysis - the same results can be obtained with a new sample of subjects and are a reflection of a wider population (Polit & Beck, 2010:106). Data collection was only done by the researcher.

An appropriate sample size was discussed with a statistician so as to be representative of the population of the study, taking into consideration possible refusal to participate. The internal consistency reliability of the instrument was measured using Cronbach’s coefficient alpha.

1.9 ETHICAL CONSIDERATIONS

Ethics is defined as a set of broadly accepted principles that outline rules and behavioural expectations for the most correct conduct towards subjects and respondents, employers, sponsors, researchers, assistants and students. Key issues are that no harm should come to subjects and respondents, prospective respondents need to give informed consent, the confidentiality and anonymity of the respondent should be respected, respondents should not be deceived and researchers need to be competent and professional. There is also a need for an ethics committee to consider research proposals and assist in ethical decision making (de Vos et al, 2011:129).

The following ethical requirements were taken into consideration during and prior to the study:

- Research proposal and protocols were submitted to the University Postgraduate Committee for permission to conduct the study
- Application for clearance to conduct research was submitted to the committee for Research on Human Subjects (Medical) of the University of the Witwatersrand
- Phase A validated/verified the instrument and any changes made were submitted in a new version to the secretariat of the Committee for Research on Human Subjects (Medical) of the University of the Witwatersrand
- Application for permission to conduct the study was obtained from Hospital Management
- To ensure confidentiality and anonymity of respondents no names were used during data collection and reporting
- Respondents were informed that respondents in the study were voluntary and respondents could decline to answer any questions or discontinue participation in the study at any time without incurring any penalty
- The data was stored and collected using coding and the data was translated into numeric form. This data was stored on computer files and protected with passwords known only to the researcher and statistician.

1.10 SUMMARY

In this chapter, the importance of weaning from mechanical ventilation was outlined, as well as reasons given as to why conducting this study is important. The objectives of the study have been stated and research methods discussed. The focus of the next chapter will be to refine the idea of mechanical weaning from mechanical ventilation through a comprehensive literature review. Following this, methodologies and data analysis will be discussed, a description and interpretation of research findings given, limitations of the study discussed, a summary of the findings given and conclusions and recommendations for further research provided.

CHAPTER TWO

LITERATURE REVIEW

2.0 INTRODUCTION

The previous chapter was written to provide background information concerning weaning from mechanical ventilation. In this chapter, the researcher aims to clarify this concept through a review of literature, theories and recent findings regarding weaning and mechanical ventilation will be discussed, previous research mentioned and gaps and contradictions explored (de Vos, Strydom, Fouche, & Delport, 2011: 109). The literature review provides a framework to support the significance of the study, compare the results with other similar findings (Creswell, 2009:25) and help the researcher interpret the findings (Polit & Beck, 2010: 170).

2.1 Key elements relating to mechanical ventilation will be provided as follows:

- Definition of weaning
- Pre-weaning
- Pathophysiology
- Physiological and psychological factors leading to ventilation failure
- Weaning Indexes
- Simple, difficult and prolonged weaning
- Modes of weaning
- Weaning Failure
- Extubation
- Sedation
- Protocols in weaning
- Nursing considerations

Finally, the researcher will conclude with the summary.

2.2 LITERATURE SEARCH

The search was conducted using electronic databases available online and through the Wits Academic Library - CINAHL (Cumulative Index to Nursing and Allied Health Literature) with EBSCO, SCOPUS, SA ePublications and MEDLINE (Medical Literature on Line accessed through PubMed, Cochrane Data base of Systematic Reviews). To search PubMed the researcher used MeSH (Medical Subject Headings) and WorldCat.org and ERIC (Educational Resources Information Centre) were accessed. Journal articles were sourced in respected national journals and books.

2.3 OVERVIEW OF MECHANICAL VENTILATION

The process of mechanical ventilation was reviewed to provide clarity. Mechanical ventilation was not the main topic so only a broad summary was provided. According to evidence based guidelines, patients are normally intubated and placed on mechanical ventilators when their own ventilatory and gas exchange capabilities are compromised by disease. Mechanical ventilation may be needed when the patient has no respiratory drive to start breathing because of disease processes or drugs. As the conditions that led to the patient being ventilated resolve, the ventilator should be removed as quickly as possible. This process often is termed “ventilator weaning” (implying a gradual process), although there has been a change to the term “discontinuation” to more accurately describe when the patient is disconnected from the ventilator for a period of time (Martensson & Fridlund, 2002: 219; MacIntyre, 2001: 375S).

Whilst mechanical ventilation is a life-saving intervention commonly used in Critical Care, patients who require mechanical support for longer than three days are at risk of complications including increased length of stay in ICU, increased costs associated with hospitalisation, risk of nosocomial infections, VAP (ventilator associated pneumonia), increased risk of airway trauma, unnecessary sedation, increased mortality and morbidity (Burns, 2004:37; Kollef, 1997:567; MacIntyre, 2004: 830). Six percent of mechanically ventilated patients need prolonged ventilation with costs representing as much as 37% of ICU expenses (Tonnelier, Tonnelier & Nowak, 2011:583), therefore, it is important for nurses to expedite the liberation of the patient from the mechanical ventilator as soon as possible (Carlson, 2009: 469; Burns, 2004: 379).

Nurse-led weaning remains underutilised and it is important to identify whether nurses have the knowledge to make use of weaning opportunities (Hansen et al, 2008:1), as it has been shown to reduce the length of weaning time (Crocker, 2002:272).

Patients who need ventilator support are also at risk of mechanical injury to the throat and vocal cords, injury and infection in the lungs and complications of immobility such as clots in the lungs or legs and infections of the urinary tract (Blackwood et al, 2012: 2). Nurses need to recognise when patients can breathe on their own and liberate the patient from the mechanical ventilator as soon as possible, in order to avoid prolonged and expensive hospital stays and even death. Achieving this goal needs to be balanced with weaning too early, which in turn can cause problems such as establishing an airway, compromised gaseous exchange, nosocomial pneumonia and muscle weakness (Rose & Nelson, 2006: 74; Carlson, 2009: 469; Burns, 2004: 379).

Management with intubation and mechanical ventilation becomes a priority when a patient cannot maintain a patent airway and gaseous exchange is impaired. Mechanical ventilation is required when the patient's respiration is not maintained by arterial blood PH, $PaC0_2$ and $Pa0_2$. The objectives of mechanical ventilation are to relieve hypoxemia ($Pa0_2$ less than 60 mm Hg), respiratory acidosis, atelectasis, reduce systemic and myocardial oxygen consumption and stabilise the chest wall (Morton & Fontaine, 2013:524). An ETT (endotracheal tube) is inserted if the patient needs ventilation or to make sure the airway is protected from aspiration. (Morton & Fontaine, 2013: 514). During mechanical ventilation, a pressure gradient (greater than 760 mm Hg) is created between the upper airway and the alveoli. This flow of positive pressure increases thoracic pressure and decreases venous return when the patient inspires.

Complications from mechanical ventilation are numerous including unplanned extubation, endotracheal tube obstructions and ventilator associated lung injury (VALI) (Rose & Nelson, 2006: 74).

2.3.1 The Goal of Mechanical Ventilation

- To support pulmonary gas exchange by providing alveolar ventilation through arterial pressure of carbon dioxide ($PaC0_2$) and PH, arterial oxygenation, partial pressure of oxygen (PaO_2), arterial oxygen saturation (SaO_2) and oxygen content (CaO_2)

- To provide end inspiratory lung inflation and functional residual capacity
- To reduce or change the work of breathing (Alspach, 2006:106)

2.3.2 Clinical Indications for Mechanical Ventilation

- Hypoxemia
- Acute respiratory acidosis
- Atelectasis
- 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).

2.4 Definition of weaning

At the start of mechanical ventilation, plans are made to wean the patient from mechanical support (Rose & Nelson, 2005: 73). Ventilator withdrawal can comprise up to 40% of total ventilator time (Eckerblad et al, 2009: 225). Weaning refers to the transition from ventilator support to spontaneous breathing (Mancebo, 1996 cited in Rose & Nelson, 2006: 74). Weaning includes the process of "liberating" the patient from mechanical support and from the endotracheal tube (Boles et al, 2007:1033). Weaning has also been defined as "assisting the patient to breathe spontaneously without mechanical ventilator support" (Crocker, 2002: 272).

Experts agree it is not about the type of method used, but about how the method is used as no method of weaning has been proven to be superior. However, the use of a weaning protocol has proven more effective than without in reducing the duration of weaning (Crocker, 2002:272). Clinical trials have shown that hastening the weaning process is the best way to minimise the length of mechanical ventilation (Thille et al, 2013: 1300).

The goal of weaning is to reduce the support given by the ventilator and enable the patient to resume the work of breathing. This may be rapid, with the patient undergoing a short trial of spontaneous breathing and then being extubated, or it may be gradual with slow decrements in support given by the ventilator (Rose & Nelson, 2006: 74). Patients can be categorised into two groups – those needing short-term mechanical ventilation (three days or less) and those needing long term mechanical ventilation (more than three days) (Morton & Fontaine, 2013: 544).

Studies suggest that the point of effective weaning is to improve the condition that required mechanical ventilation. Routine surgery could lead to rapid weaning, whilst a patient intubated for respiratory failure may require a more gradual reduction in support. In 80% of patients, ventilator support can be stopped in a matter of hours. If the patient has normal lung function, a rapid wean is possible. Muscle atrophy begins 72 to 96 hours after ventilation begins and therefore an attempt to wean patients from the ventilator should begin as soon as their condition warrants (Newmarch, 2006: 56).

Whilst weaning implies the gradual withdrawal of mechanical ventilation and resumption of spontaneous breathing, experts argue this is unnecessary in most patients because it delays the extubation of patients who have recovered from respiratory failure (Khatib & Bou Khalil, 2008; Ely et al, 2001:454S). Literature shows when weaning is delayed the patient is exposed to discomfort and the risk of further complications, leading to increased cost of care. Time spent weaning can be as much as 40 to 50% of the total duration of mechanical ventilation (Boles et al, 2007:1034).

Many experts agree that weaning patients timeously from mechanical ventilation improves patient mortality and morbidity, but due to the complexity of the weaning process, it is difficult for them to agree on when and how to begin, how long it should take, methods, outcomes and whether or not a tracheostomy is required (Burns, 2004: 379). If the patient is weaned to too early this can delay the weaning process (Crocker, 2002:274).

Haste in removing the ventilator should be balanced against the chance that premature discontinuation can happen, which could lead to difficulty in re-establishing an airway and compromised gaseous exchange (McIntyre, 2001:375s). Other problems with early weaning include over sedation, the use of midazolam and morphine, especially in the elderly and those with renal impairment and delays with tracheostomy insertion. Other reasons include lack of knowledge of staff and lack of support of guidelines (Crocker, 2002: 272).

From the patient's perspective, weaning has been found to be stressful, frightening and frustrating. The patient's family is considered an important link for the nurse to get to know and understand the patient to reduce their level of anxiety According to a phenomenographic study cited in Eckerblad et al, the nurse can learn about the patient's psychological and physiological resources by working with the family and create a balance between resting periods and weaning periods. The patient's underlying emotional state can affect his/her ability to be weaned (Eckerblad et al, 2002: 226).

There are a number of key issues involved in the management of a mechanically ventilated patient whose disease process is stabilising or reversing. It is necessary to identify the reasons the patient requires mechanical ventilation, for example poor gaseous exchange, neuromuscular dysfunction or cardiac compromise. Secondly, the patient needs assessing for his/her ability to tolerate withdrawal of the ventilator; in this case, then the correct ventilator management strategies are required. Lastly for ventilator dependent patients, an extended management plan is needed (MacIntyre, 2004: 831).

2.5 PRE-WEANING

The intensive care nurse plays an important role in assessing the patient's ability to be weaned and implementing weaning trials. Once started, the process of weaning can be divided into three phases: pre-weaning, weaning and extubation.

Nurses play a key role in the weaning process. Weaning patients from mechanical ventilation presents a challenge to nurses, due of the large number of variables that influence successful weaning. Continuous assessment of the patient throughout weaning is essential to evaluate his or her response and progress and according to their response to the reduction of ventilatory support (Maclntyre, 2004).

During the pre-weaning phase, the decision to wean or not has to be made and physiological and psychological parameters are considered during the nursing assessment of the patient. There are a number of precipitating factors, which may indicate a potential difficulty and the nurse can play a role in helping to reverse these before weaning. Those patients' who may be difficult to wean have been found to present with underlying pathology and the nurse needs to help identify this. As an example, COPD patients may have an infection and as a result have increased secretions, fever or bronchospasm (Knebel, 1991:322), ventilation is reduced in the affected areas of the lung leading to ventilation/perfusion mismatching. The combination of increased secretions, limited breathing reserve, inability to clear secretions and ventilator mismatching can lead to ARDS (Knebel, 1991:323).

Prior to mechanical ventilation, the patient may present with problems with respiratory function that eventually leads to ventilator failure; after the respiratory disorder is resolved, the patient will then be weaned (Tobin et al, 2012, 2871). Ventilatory failure is defined as an increase in arterial carbon dioxide ($PaCO_2$) that exceeds the normal range. When the $PaCO_2$ is higher than 45mmHg, then the respiratory system has not succeeded in maintaining sufficient ventilation (Tobin et al, 2012: 2871). Patients with COPD are sensitive to the development of hypercapnia when given supplemental oxygen. Hypercapnia can arise due to several variables, namely a decrease in hypoxic ventilator response due to the administration of oxygen, an increase in dead space due to ventilation/perfusion relationships, due to hypoxic vasoconstriction and the Haldane effect. The Haldane effect is defined as when any given amount of CO_2 bound to haemoglobin, $PaCO_2$ is higher in the presence of a high vs low oxygen saturation (Tobin et al, 2012:2872).

Patient's needing mechanical ventilation may have normal arterial blood gases but clinically exhibit signs of distress including increased work of breathing, nasal flaring, activity of sternomastoid muscles, recession of the suprasternal, supraclavicular and intercostal spaces, uneven movement of the abdomen. Mechanical ventilation decreases the work of breathing for the patient by allowing oxygen stores to be routed from the respiratory muscles to other tissues.

2.6 PATHOPHYSIOLOGY

There are a number of underlying problems associated with breathing, some of the main ones cited in literature are:

2.6.1 Central alveolar hypoventilation

This is caused by the failure of the respiratory centres to activate the lower motor neurons and patients present with hypercapnia and marked increases in $PaCO_2$ despite normal levels of resistance and compliance (Tobin et al, 2012: 2873).

2.6.2 Neuromuscular disorders

When the inspiratory muscles become severely weak, there is decreased vital capacity, total lung capacity and functional residual capacity (FRC of the lung). Patients with respiratory muscle weakness take shallow, rapid breaths, likely caused by afferent signals in weakened muscles, intrapulmonary receptors or both (Tobin et al, 2012: 2874).

2.6.3 COPD (chronic obstructive pulmonary disease)

The development of ventilator failure in COPD is thought to result from a mechanical obstruction, namely an increase in resistance to airflow during expiration. The main problem is not an increase in airway resistance, but limitation of expiratory airflow caused by decreased resistance of the airways due to the rupture of elastic fibres. Expiratory air-flow is limited, which slows the lungs from emptying therefore inspiration starts before the lungs go back to their relaxation volume, termed "dynamic hyperinflation". COPD is diagnosed by airway obstruction and decreased airflow on expiration, whilst the mechanical problems occur on inspiration, consisting of an elastic load (on hyperinflation), a threshold load (due to auto PEEP) and weakness of the inspiratory muscles with a small increase in inspiratory airway obstruction (Tobin et al, 2012: 2874).

2.6.4 ARDS (Acute respiratory distress syndrome)

This is described in literature as non-cariogenic pulmonary oedema, resulting from alveolar injury. There is increased elastance and resistance in the lungs, a decrease in FRC, severe hypoxemia and pulmonary hypertension. Patients' present with dynamic hyperinflation and PEEP, loss of lung recoil and increased peripheral airway resistance. Breathing at low volumes can lead to airway closure and trapping of gas resulting from alveolar oedema and lack of surfactant (Tobin et al, 2012: 2878).

2.7. PHYSIOLOGICAL AND PSYCHOLOGICAL FACTORS LEADING TO VENTILATOR FAILURE

2.7.1 Infection

The nurses' role is to help treat the infection by administering antibiotics as prescribed for bacterial infections and give antipyretics, suction regularly and provide chest percussions to loosen secretions. Infection can lead to complications such as increased bronchoconstriction, which can exacerbate expiration in patients with compromised airways (Knebel, 1991:323).

2.7.2 Increased metabolic demand

Overfeeding with carbohydrates or giving too many calories can lead to increased carbon dioxide production and increased ventilator demand. Patients can also be malnourished because of increased metabolic demand, poor absorption from the gut and the inability to eat due to dyspnea. The combination of an increased breathing workload and decreased oxygen supply can lead to muscle fatigue and ARDS (Knebel, 1991:323).

2.7.3 Cardiovascular and hemodynamic stability

If a patient is unstable, the transport of gases to and from the tissues may be affected. In turn, this influences the transport of oxygen and cardiac output. If the patient has anemia, the oxygen content may be reduced and the nurse can assess this by looking at the Hb and Hct levels, which could precipitate weaning problems. Congestive heart failure can also be a precipitant to distress and the nurse can ensure the fluid balance is monitored and diuretics administered if needed. In addition, cardiovascular difficulties can precipitate poor weaning if the patient's cardiac output is affected, for example by heart rate, filling pressures and myocardial contractility (Knebel, 1991:323).

2.7.4 Neurological

The patient needs to be well rested with a good cough and gag reflex but according to literature, the patient does not have to be completely alert and awake to be weaned. Clinical judgment regarding sedation needs to be implemented as too little will leave the patient anxious and in pain, whilst over-sedation will suppress the patient's respiratory drive.

2.7.5 Renal

Renal function can be affected by changes in electrolytes including potassium, magnesium and phosphorus, which can lead to muscle weakness. The nurse needs to carry out a pulmonary assessment but this may be a poor predictor of weaning success and sometimes the ability of the patient to breathe spontaneously can be underestimated.

2.7.6. Pulmonary

Workload can be influenced by changes in compliance, abdominal distention, atelectasis, bronchospasm or muscle weakness. Nurses can assess the patient for increased rate of breathing; shallow breathing and asynchrony in the chest and abdomen may show the patient will struggle with spontaneous breathing (Knebel, 1991:324).

2.7.7 Psychological distress

Assessing psychological readiness is paramount, as fear, anxiety, anger and confusion have also been found to precipitate increased work of breathing leading to increased energy needs, the inability to meet metabolic demand, shortness of breath, dyspnea and in turn, weaning failure. It is the nurses' role to explain the weaning process and procedures to the patient (Knebel, 1991; 324-325).

2.7.8 Communication

Asking the patient simple questions and giving them time to respond is cited as helpful to alleviating patient anxiety. The nurse can assess non-verbal cues such as facial expressions, hand gestures, eye movement and body posture. In a randomised control study, patients using a communication board expressed more satisfaction with communication than the control group. During pre-weaning, the precursors to weaning failure should be reversed, the patient should be clinically stable and pulmonary/physiological and psychological parameters addressed. The weaning phase can then start with the patient ready to breathe spontaneously. Spontaneous ventilation is defined as the ability of the patient to do the necessary breathing work in order to maintain gaseous exchange (Knebel, 1991: 325).

2.8 WEANING INDEXES

Many weaning indexes have been used to predict weaning readiness. Some consider respiratory factors such as muscle strength and endurance (e.g. NIP negative inspiratory pressure) and rapid shallow breathing index as ratio of frequency to tidal volume (Morton & Fontaine, 2013:544). Clinicians disagree about which approach to weaning is best. Literature cites differing views on weaning with regard to whether it should be gradual or immediate. The thinking behind a gradual approach is that over time, the patient on partial ventilation experiences lower levels of pressure and volume, reducing the risk for complications and allowing the patient to perform the work of breathing, in turn reducing deconditioning and atrophy of the muscles used in respiration (Morton & Fontaine, 2013: 544). A multi-society, evidenced based task force recommended a weaning screen be used daily to identify patients on mechanical support who are ready to be weaned from the ventilator (Girard & Wesley, 2008). The main considerations are as follows:

- Resolution of disease for which the patient was intubated in the first place
- Cardiovascular stability, with no need for or minimal vasopressors
- No continuous sedation
- Adequate oxygenation $Pa0_2/Fi0_2$ ratio of at least 150 mmHg
- PEEP (positive end expiratory pressure) up to 8cm H_20 (Thille et al, 2013:57)

Table 2.1 Selected recommendations for weaning and ventilator discontinuation from the American College of Chest Physicians (ACCP) Taskforce.

Recommendation 1: 1. Evidence of some reversal of the underlying cause for respiratory failure 2. Adequate oxygenation: $Pa0_2/Fi0_2 \geq$ 150-200 mmHg; PEEP $\leq$ 5-8cm H_2O; $FiO_2 \leq$ 0.4-0.5 and PH $\geq$ 7.25 3. Hemodynamic stability: absence of hypotension, no dose or low dose vasopressors <5 µg/kg/min 4. Patient can initiate a spontaneous breath *(Grade B evidence*)
Recommendation 2: Criteria to assess the patient during during the spontaneous breathing trial while still receiving ventilator support including respiratory pattern, adequate gaseous exchange, haemodynamic stability and comfort. After a 30-120 min spontaneous breathing trial, consider the patient for discontinuation of ventilation *(Grade A evidence)*
Recommendation 3: After ventilator support is discontinued, prior to removal of the airway, airway patency and the patient's ability to protect the airway needs to be assessed *(Grade C evidence)*
Recommendation 4: Once reversible causes of weaning failure are corrected a SBT should be performed every 24 hours. If the patient fails the SBT, determine the reason why *(Grade A evidence)*
Recommendation 5: A patient who fails an SBT should get a comfortable form of ventilator support. Tracheostomy should be considered after the patient is stabilised on the ventilator and when it becomes clear the patient will require prolonged ventilator assistance. Patients who may benefit include those requiring high levels of sedation to tolerate translaryngeal tubes, patients potentially gaining psychological benefit from the ability to eat orally, to communicate by speaking, and to experience enhanced mobility and in whom enhanced mobility may assist physical therapy efforts *(Grade B)*
Recommendation 6: Weaning protocols should be developed for non-physician clinicians and implemented by Intensive Care Units *(Grade A evidence)*
Recommendation 7: When medically stable for transfer, patients who failed discontinuation attempts should be transferred to facilities equipped to accomplish this *(Grade C)*
Recommendation 8: Unless clear evidence for disease, (e.g high spinal cord injury, amyotrophic lateral sclerosis) a patient requiring prolonged ventilation for respiratory support should not be considered ventilator dependent until 3 months of weaning attempts have failed *(Grade B evidence)*
Recommendation 9: A patient requiring prolonged weaning should be weaned at a slow pace with gradually lengthening SBT's *(Grade C)*
Recommendation 10: Anesthesia/sedation strategies and ventilator management aimed at early extubation should be used in postsurgical patients *(Grade A)*

(MacIntyre, 2004:832; Haas, 2012: 1651–taskforce guidelines for American Association for Respiratory care and Society for Critical Care Medicine).

Daily screening followed by a weaning test and then extubation if the test is successful can lead to shorter intubation times without the risk of re-intubation (Thille et al, 2013: 1299). An international consensus panel on weaning suggested that ventilated patients be categorised into three groups according to the difficulty of their weaning process.

2.9 SIMPLE WEANING

In the 2005 International Consensus Conference on weaning from mechanical ventilation, an updated classification system was proposed. Patients are classified into three groups, depending on the duration of weaning and the number of spontaneous breathing trials before being successfully extubated.

Table 2.2 Weaning Classification based on clinician experience but not literature data

Simple weaning	Successful extubation after the first SBT
Difficult weaning	Successful extubation after 2 to 3 SBT’s, weaning took less than seven days from the first SBT to successful extubation
Prolonged weaning	Not weaned after more than 3 SBT’s or weaning takes longer than seven +days

Tonnelier et al, 2011: 584

Patients passing the first weaning test and are extubated without difficulty. In up to 80% of intubated patients, ventilator support can be stopped within a matter of hours (Brochard, 1994, Esteban, 1995 cited in Newmarch, 2006: 57). In patients with normal lung function, it is possible to wean them rapidly from the ventilator. It is important for the nurse to identify patients who are ready for immediate spontaneous ventilation from those who need gradual weaning to achieve spontaneous ventilation. According to MacIntyre, 1988, (cited in Newmarch, 2006: 57), muscle atrophy begins 72 to 96 hours after mechanical ventilation has started, therefore patients should be weaned as soon as possible.

In literature, it was found that approximately 70% of patient’s fall into the simple weaning group, which refers to patients who can be successfully extubated after the first weaning test, or spontaneous breathing trial. Up to 70% of patients fall into this category and delayed extubation should be avoided by identifying which patients to wean as soon as possible (Peren & Brochard, 2013; Tonnelier et al, 2011:587). Reasons cited for weaning failure in the simple weaning group are delays due to the accumulation of drugs, lack of screening, high level of ventilator assistance, lack of staff and collaboration between personnel (Perren & Brouchard, 2013).

2.10 DIFFICULT WEANING

Patients who fail the first weaning test and need up to three tests, or seven days, to achieve successful weaning fall into this category. Between 30% and 40% of patients present as difficult to wean and reasons for this needs continual examination. The illness leading to invasive mechanical ventilation has not been resolved. Reasons found in literature as to why weaning may potentially fail in this group include the accumulation of sedative drugs, fluid overload, left heart failure, respiratory muscle weakness, excessive weakness due to infection, secretions, sepsis (Perren & Brouchard, 2013). In this instance, a work-up is necessary to reverse pathologies and a tracheostomy should be considered (Perren & Brouchard, 2013).

2.10.1 Respiratory pump failure

This is caused by an imbalance between respiratory workload and respiratory capability. Workload depends on elastance and resistance. Besides emphysema, the diseases affecting the lung such as pneumonia, pulmonary oedema, atelectasis, ARDS or the chest wall are said to reduce compliance of the lung and increase the elastic load, which is found to increase in patients with COPD and bronchial asthma. Clinical conditions, stiffening or affecting the chest wall, increase the elastic workload and may prevent successful weaning (Perrin & Brochard, 2013).

2.10.2 Cardiovascular dysfunction

This is also recognised as a cause of weaning failure, particularly in patients with left heart disease. Switching a patient from positive pressure ventilation to spontaneous breathing increases venous return or left ventricular preload, blood volume and left ventricular afterload. In turn, this can lead to volume overload and decompensated cardiopulmonary competency. A weaning strategy based on brain naturetic peptide may be used to reduce the duration of weaning from mechanical ventilation. Vasodilators, such as nitrates, are suggested to help increase venous return and left ventricular filling during weaning (Perrin & Brouchard, 2013).

2.11 PROLONGED WEANING

Patients who require more than seven days of weaning after the first tests (6% to 15% of patients). This group contains many of the patients who are chronically ill and have much worse outcomes than the other groups and is associated with a high mortality. In a retrospective cohort study to evaluate the relevance of weaning from the mechanical ventilation classification from the 2005 International Consensus Conference, mortality rates were 25% in the difficult and prolonged weaning groups, versus 5% in the simple weaning group (Tonnelier et al, 2011: 588). Full time ventilation with tracheostomy is frequently used.

Risk factors associated with prolonged weaning include severity of illness, days on the ventilator before discontinuation attempt, chronic pulmonary disease other than COPD, pneumonia as the reason for ventilation and the level of PEEP (positive end expiratory pressure) before discontinuation (Thille et al, 2013:1296; Hess, 2011:392).

There is also increased hospital mortality with patients with prolonged weaning but no difference in ICU mortality when comparing simple and difficult weaning. Weaning that is delayed for a week but still successful, does not impact on patient mortality (Penuelas, Frutas-Vivar, Fernandez et al,2011:230). Patients who are severely ill on admission to ICU and with chronic pulmonary disease other than COPD or pneumonia were shown to be more likely to have prolonged or difficult weaning. Patients with post-operative respiratory failure were more likely to be weaned easily. The need for a high PEEP during mechanical ventilation was also related to prolonged weaning (Penuelas et al, 2011: 230).

Prolonged weaning may be a result of pathology, including severe chronic heart failure, severe chronic respiratory insufficiency, prolonged muscle weakness or neuropathy, depression, poor sleep quality, constipation and sepsis (Perren & Brouchard, 2013).

2.12. MODES OF WEANING

Various weaning modes used to enable the patient to be liberated from the ventilator will be described. There are different techniques of weaning, which include spontaneous breathing trials (SBT's), pressure support ventilation (PSV) and synchronised intermittent mandatory ventilation (SIMV). Evidence based guidelines reinforce that after clinical assessment, the best way to determine readiness for discontinuation of the ventilator is a spontaneous breathing trial.

2.12.1 Spontaneous breathing trial

The daily spontaneous breathing trial is a period of unassisted breathing during which time the patient is observed for signs of respiratory failure. In this technique, the patient is taken off the ventilator and humidified oxygen is provided to the airway, through a device called a T-piece, or T-tube, a method based on the theory of slowly lengthening the periods of discontinuation from the ventilator.

Heated or cooled humidified gas is provided in an aerosol from a large volume nebuliser and the patient can be given an SBT without being removed from the ventilator. In this way, ventilator support can be re-established quickly if the patient fails the trial. (Hess, 2003: 475:S).

Firstly, extubation readiness needs to be identified and a two hour spontaneous breathing trial is normally used to assess readiness, but studies have shown that 30 min breathing trials have produced similar outcomes. Studies have also shown no difference when the SBT was carried out with a T-piece or 7cm H_20 PSV. The consideration here is the level of support needed to overcome the resistance of the tube. If a passive humidifier is used, a low level of PSV is required because of the resistance and dead space of the device.

In a multicentre randomised trial, comparing four methods of weaning from mechanical ventilation, Esteban and his co-workers found that a once daily trial of spontaneous breathing allowed faster weaning than other methods offering partial ventilatory support, meaning a patient's ability to breathe spontaneously only needs a trial once a day (Esteban, Frutos, Tobin et al, 1995:349). Esteban et al also found patient's managed with a weaning protocol using a daily wean screen followed by a spontaneous breathing trial were extubated one and a half days earlier than patient's managed with physician-led weaning (Esteban et al, 1995: 345)

2.12.2 Approaches to the spontaneous breathing trial

This can be conducted without positive pressure applied to the airway with a low level (5cm H_20) of continuous positive airway pressure (CPAP), or a low level of PS volume – 5-8 cm H_20.

2.12.3 PSV pressure support ventilation weaning

In this mode of weaning, breaths are patient-triggered and pressure limited. At a high level of pressure support, full ventilator support is provided, but as this pressure support is reduced, more patient effort is required to maintain the minute ventilation. When a low level of pressure support is reached, 5-8cm H_20, the patient is considered ready for extubation. Advantages of this mode of withdrawal include workload reduction and the opportunity to judge the patient's ability to be separated from the ventilator.

PSV reduces the workload imposed on the respiratory muscles. The level of assistance is reduced until it compensates for the work imposed by the ET tube and demand valve of the ventilator, by which time the tube can be removed. PSV assists each spontaneous breath by decreasing the respiratory workload on the respiratory muscles. By monitoring breathing frequency and accessory muscle activity the clinician is able to choose a workload for the patient that avoids excessive loading and total rest. A pressure support of 8 cm H_20 was sufficient to compensate for additional work caused by the ET tube and demand valve (Brochard, Raus, Benito et al, 1994:902).

One concern about the spontaneous breathing trial is that it could cause ventilatory muscle overload and fatigue and so patients should be closely screened in the beginning phases; f/Vt > 105 breaths/min/L predicts SBT failure. In this case, literature recommends the patient continue the SBT for a minimum of 30 min but no longer than 120 min to ensure safety.

PSV is often the preferred method of weaning as it has a greater efficacy in decreasing respiratory muscle workload. The strategy of progressive reduction of PSV until a threshold is reached offers more benefit than conventional methods and gradual withdrawal from mechanical ventilation in patients who are difficult to wean (Brochard et al, 1994:902). In PSV mode, the inspired tidal volume and respiratory rate must be measured to detect changes in lung compliance.

If compliance decreases or resistance increases, tidal volume decreases and the patient inspiratory rate will increase. PSV should be used cautiously in patients with bronchospasm (Mortan & Fontaine, 2013:528).

2.12.4 SIMV (Synchronised intermittent mandatory ventilation)

In SIMV mode, the rate and tidal volume are preset. Breaths taken above the set rate are spontaneous breaths taken through the ventilator circuit. With SIMV, breaths can be mandatory ventilator controlled or spontaneous. Mandatory breaths are patient triggered or synchronised with the effort of the patient. Mandatory breaths can be volume or pressure controlled.

The inspiratory effort of the patient to breathe spontaneously can be augmented by giving pressure support. The object of SIMV is to give the respiratory muscles a rest during mandatory breaths and work the muscles during spontaneous breaths. To wean the patient, the mandatory breath rate is reduced, requiring more spontaneous effort by the patient to maintain minute volume. However, evidence shows respiratory centre output and effort is no different during the mandatory breath delivery of SIMV and may lead to muscle fatigue rather than periods of rest and exercise (Hess, 2003: 475:S). Randomised control trials have reported the poorest outcomes for this approach (Hess, 2011:392).

2.12.5 Comparison of weaning methods

In randomised control studies, by Esteban et al, it was found the rate of successful weaning was dependent on the type of weaning technique used. Once daily trials of spontaneous breathing led to extubation three times more quickly than intermittent mandatory ventilation and twice as quickly as pressure support ventilation.

Once daily trials of spontaneous breathing versus multiple trials yielded no significant differences and intermittent mandatory ventilation and pressure support ventilation did not have significant results (Esteban et al, 1995:349).

2.13 WEANING FAILURE

Several criteria need to be recognised to identify when a patient is failing a weaning trial, as this may lead to cardiopulmonary distress.

Table 2.3 Commonly listed criteria for discontinuation of a weaning trial (Hess, 2001: 474S-476S).

Tachypnea	>35 bpm for more than 5 min
Hypoxemia	(oxygen saturation by pulse oximeter <90
Tachycardia	heart rate >140 bpm
Bradycardia	heart rate decrease by more than 20%
Hypertension	(systolic BP>180mmHg)
Hypotension	(systolic BP <90)
Signs of agitation	diaphoresis or anxiety

According to literature, when weaning failure is recognised, ventilator support should be re-established (Hess, 2001: 474S-476S). Unlike the anaesthetised patient intubated with the anticipated outcome of being extubated after surgery, the critically ill patient needs ventilator support for failure of the lungs – lung parenchyma, respiratory pump (neuromuscular), cardiac dysfunction or coma, etc. Failure of weaning can be attributed to several reasons, which include electrolyte disturbances, reversible respiratory muscle weakness, anaemia, left heart failure and sepsis. In literature a main reason cited for failure to wean is the inability of ventilator muscle function to cope with the workload. Weakness of the respiratory muscles may be attributed to chronic or acute malnutrition and prolonged mechanical ventilation.

The muscles have to compensate for high resistive and elastic loads due to elevated airway and tube resistance, reduced respiratory compliance and possible dynamic inflation. Rapid shallow breathing is another indicator of maladaptation of the muscles and may signal weaning failure. High levels of oxygen consumption are associated with catecholamine release and therefore inadequate support may lead to systemic problems (Brochard et al, 1994).

2.14 EXTUBATION

The goal of extubation is removal of the artificial airway. After weaning readiness is established and the patient has passed the spontaneous breathing trial on a T-piece or low levels of ventilator assistance, they are ready to be extubated. Once the patient is stable as per the weaning criteria, the patient can be extubated or considered for weaning. Failure of planned extubation has been reported in 10% to 20% of cases. Patients who fail extubation have a high mortality of approximately 25% to 50% (Thile, Cortes-Puch & Esteban, 2013: 57). Before extubating the patient, the airway should be suctioned to remove any secretions and to ensure it is not obstructed. The ET tube is then deflated (Newmarch, 2006: 57). The patient is asked to cough and the tube is removed. An oxygen mask is usually applied to the patient's face to deliver the equivalent FiO_2 as that administered before extubation. The nurse then monitors the patient's breathing rate and pattern, oxygen saturations and arterial blood gases. The patient should be told to cough up any sputum. Regular deep breathing exercises are helpful as they decrease the risk of atelectasis.

Extubation failure is said to occur in 10% to 20% of patients and is associated with poor outcomes; the mortality rate is between 20% and 50%. According to literature, strategies for identifying patients at high risk for extubation are essential to improve managing the patient during weaning and extubation. Non-invasive ventilation after extubation has proven beneficial, as well as steroid administration for several hours prior to extubation (Thile et al, 2013: 1294).

Extubation failure is defined as the need to re-intubate the patient within hours or days after planned extubation. The time interval varies from 48 to 72 hours to one week (Thile et al, 2013: 1294). Re-intubation, NIV ventilation or death, within 48 hours after extubation, are cited as extubation failure. Failure of planned extubation is associated with prolonged mechanical ventilation and high mortality rates of 25% to 50% and factors associated with extubation failure include neurological disorders. If airway secretions are minimal, it has been found in literature that it is possible to successfully extubate a patient with a glascow coma scale (GCS) of 8 or less. Cough strength and amount of secretion are good predictors of extubation failure.

Patients are usually re-intubated due to factors such as respiratory distress related to respiratory failure, congestive heart failure, ineffective cough with a build-up of secretions, or upper airway obstruction. Further reasons cited include sepsis, surgical complications and acute coronary syndrome.

2.14.1 Risk factors associated with extubation

The spontaneous breathing trial is done to predict the tolerance of the patient to breathe unassisted after extubation. However, according to literature, the SBT cannot predict how the patient will respond in terms of upper airway patency and lower airway protection, also whether there will be excess secretions and if the patient is able to breathe without the ventilator. Factors associated with extubation failure include age, reason for intubation, neurological dysfunction, ability to cough and secretions. In addition, the patient's perception of his/her ability to breathe without the assistance of the ventilator is also associated with successful extubation (Thille et al, 2013: 57).

Table 2.4 Factors associated with extubation failure

Age	65 years and older or underlying chronic cardio respiratory problems Higher severity at time of weaning and acute respiratory failure of cardiac origin
Pneumonia	Reason for intubation, a high rapid shallow breathing index (f/VT) and positive fluid balance
Neurological	Patients intubated for neurological reasons
Rapid shallow breathing index	(f/VT) < 105, PaO_2/FIO_2< 200 mm Hg, Glasgow Coma Scale score < 8
Abundant endotracheal secretions	$PC0_2 \geq 44$ mmHg during a spontaneous breathing trial, GCS $\leq$ 10
Peak expiratory flow	< 60 l/min and rapid shallow breathing index > 100
Moderate or abundant endotracheal secretions	Cough absent or weak, hemoglobin < 10 g/dl
Increase in B-type natriuretic peptide	During a spontaneous breathing trial
> 4.5% reduction in central venous saturation	30 min after spontaneous breathing trial initiation

(Thille et al, 2013: 60)

According to the literature, a survey on mechanical ventilation discovered that re-intubation was associated with the use of CPAP, when compared to CPAP or low pressure support tests. This shows weaning tests without PEEP can better detect latent cardiac dysfunction or lung pathology as PEEP, even at a low level, provides cardiac and ventilator support which may result in the extubation failure risk not being anticipated. Factors that may go unrecognised and could help identify patients at risk during extubation include delirium, poor sleep quality, limb muscle weakness, diaphragmatic muscle weakness, systolic or diastolic left ventricular dysfunction (Thille et al, 2013: 1300).

2.14.3 Non-invasive ventilation post extubation

According to literature, non-invasive ventilation used prophylactically after extubation may help to prevent acute respiratory failure (Thille et al, 2013: 61). However, non invasive ventilation (NIV) can reduce the risk of re-intubation in post-operative patients after abdominal resection or lung surgery and could reduce mortality.

In a study cited in Thille et al, with approximately 400 patients, it was found the prophylactic use of NIV was helpful in patients at high risk for re-intubation. It was also found to help prevent post extubation respiratory failure in patients with hypercapnia at the end of a SBT (Thille et al, 2013: 60).

2.15 SEDATION MANAGEMENT

Sedation is frequently used in the care of critically ill patients, especially those needing mechanical ventilation, as it is most commonly indicated to help manage anxiety. Narcotics are frequently used for pain management while benzodiazepines are most often prescribed for anxiety and agitation (Brook et al, 1999: 2609). The reasons for the patient's pain and anxiety have most frequently been attributed to their underlying disease pathology such as metastatic carcinoma, trauma, diagnostic procedures, mechanical ventilation, dialysis and physical isolation from their surroundings and family (Kollef, Levy, Ahrens et al, 1998: 541). There are few studies available evaluating the effect of sedation and narcotics on the overall outcomes of critically ill ICU patients (Kollef, 1998: 542).

Excessive sedation has been identified as an impediment to ventilator discontinuation (Hess, 2011: 393). Continuous intravenous administration may be associated with prolonged ventilation in patients suffering with acute respiratory failure (Brook, Ahrens, Schaiff et al, 1999:2609; Kollef et al, 1998:545). In a prospective, randomised control trial cited in Brook et al, it was found the duration of mechanical ventilation was shorter for patients who received protocol-directed sedation than non-protocol directed sedation (Brook et al, 1999:2611). The hospital length of stay and time in the ICU was also shorter for patients receiving protocol directed sedation (Brook et al, 1999:2612). Additionally, the use of a protocol also reduced the duration of continuous sedation, showing this does affect the duration of mechanical ventilation in patients with respiratory failure.

The use of sedation should therefore be achieved in a way that maximises patient outcomes (Brook et al, 1999: 2614). Results from a prospective cohort study cited in Kollef (1998) found careful administration of continuous IV sedation may reduce the duration of mechanical ventilation in patients admitted to the ICU (Kollef et al, 1998: 542).

Evidence based guidelines recommend an approach in which sedation is stopped, a screen is used to determine patient readiness for extubation and then extubation is considered if the SBT is successful, ventilator support is provided to those patients who fail the SBT and then the underlying disease process is corrected before it is repeated (Hess, 2011: 393).

2.15.1 Daily interruption of sedation

In the past, there was a tendency for clinicians to over-sedate in order to avoid post-ICU recollection trauma, which in turn prompted the question whether sedation breaks would affect the patient psychologically. Studies have confirmed there is no psychological impact resulting from daily cessation of sedative infusions (Pinder & Christensen, 2008: 64). In fact, post-traumatic stress disorder was found to be higher in sedated patients' versus factual memories from an increased level of consciousness. According to literature, polypharmacy and the prolonged residual effect of drugs result in cerebral dysfunction, agitation and confusion (Pinder & Christensen, 2008: 64). Agitation has been defined as "a syndrome of altered cognitive function and confusion that demonstrates in restless behaviour (Pinder & Christensen, 2008: 65). Agitation resulting from an imbalance in neurotransmitters controlling cognitive function and mood is controlled by sedation. Stress is another factor affecting the parasympathetic nervous system and causing elevation in plasma catecholamines. When the patient is awake, increased metabolism and increased oxygen demand causes increased lactate and CO_2 production. This increased CO_2 and lactate causes increased panic or agitation, with hypercapnia also stimulating hypertension and panic.

Studies have shown that sedation breaks decrease the number of mechanically ventilated days by 30% to 50% (Pinder & Christensen, 2008: 65) and a reduction in days spent in ICU by 40% (Kollef, cited in Pinder & Christensem, 2008: 65). Benefits of sedation breaks include a reduced amount of drugs being used therefore reduced costs and an increased reliability of tools to assess neurologically the patient. Reduced sedation has also been associated with a reduced prevalence of VAP, barotrauma, bacteraemia, upper GI bleeding and organ failure leading to increased recovery rates (Pinder & Christensen, 2008:66). Studies have used agitation as the "endpoint" to sedation and if the patient who is awake becomes anxious, the wake-up attempt should cease (Kress et al, cited in Pinder & Christensen, 2008: 66). Of concern, is that agitated patients are more likely to self-extubate (Pinder & Christensen, 2008: 65).

Included in the argument not to sedate is the fact that drugs used to sedate act on the central nervous system and can cause respiratory depression, hypotension and memory loss. Pain is cited as a frequent cause of agitation in ICU and sedatives should not be given as a substitute for analgesia. The cause of the pain should be identified, such as from an indwelling catheter etc. Distinction needs to be made between agitation, delirium and opiate sedative withdrawal (Pinder & Christensen, 2008: 67). It is clear that sedation breaks can reduce the incidence of post-traumatic stress disorder, drug tolerance and sedation. Agitation however, is not well understood and nurses have been found to over-sedate patients, perceiving agitation to be delirium (Pinder & Christensen, 2008: 69).

2.16 ROLE OF PROTOCOLS IN WEANING

A priority of healthcare professionals is to provide safe, error free care to patients. The development of knowledge has given priority to evidence based action, but what has become apparent from literature is that a gap exists between best evidence and best practice (Hansen & Severinsson, 2007:196-197).

The aim of ventilator weaning protocols is to standardise clinical decision-making (Girard & Ely, 2008: 241). In this way, they are found to have the potential to translate research findings into clinical practice and improve patient outcomes. The efficacy and adaptability of weaning protocols remain controversial, for various reasons, which will be further discussed (Girard & Ely, 2008: 242).

A protocol is defined as "a detailed plan of a scientific medical experiment or procedure". An explicit protocol normally provides the clinician with specific rules for decision making based on patient data or information (Girard & Ely, 2008: 242)

2.16.1 Disadvantages of protocols

Some practitioners are concerned that protocols are an oversimplified approach representing “cookbook” medicine because it is not flexible enough to apply to individual patients. Critics of protocols also prefer physician directed weaning as it is flexible and adaptable to individual patients, it can lead to new developments in practice and it does not require the resources to design, implement and sustain the use of protocols.

Staffing issues are also an influence here because closed ICU’s with intensivists may see no improvement in outcomes with a weaning protocol, however, an open ICU with low levels of staffing where a protocol is used, may see outcome improvements (Girard & Ely, 2008: 242). Barriers to using a protocol have been associated with reluctance on the part of the physician to prescribe it (Hansen & Severinsson, 2007: 204).

2.16.2 Advantages of protocols

Computerised, closed loop ventilator systems are now providing automated ventilator weaning, with the weaning process having very little control. This is a development on weaning still undergoing research and differs from the debate about non-physician lead weaning versus physician-led weaning. Protocols have been found to be both efficacious and efficient in weaning the ventilated patient. It was found in literature that SIMV weaning has continued to be used despite the evidence that daily spontaneous weaning trials are seldom used in the management of patients not extubated after their first trial of spontaneous breathing and physicians have not incorporated this evidence in their daily practice.

Protocols are thought to be the link between research findings and clinical practice and they minimise variation by providing stability to the decision making process. They are also less limited and biased by human error. The majority of research findings have found that weaning protocols led to superior outcomes compared to physician-led weaning. Protocols have been introduced to address the variability and ineffectiveness of physician led weaning and can be used to track and measure the quality of care being delivered and assist with keeping both patient and family informed during the decision making process (Girard & Ely, 2008: 242). Protocol directed weaning can improve clinical outcomes by increasing the use of weaning methods including daily wean screens and spontaneous breathing trials. The “wake up and breathe” protocol (Girard et al) demonstrates combining management of the ventilator and sedation to improve patient outcomes (Girard & Ely, 2008: 250).

2.16.3 Wake up and breathe protocol

This protocol elaborates on the traditional weaning protocol by including an evaluation of sedation status and spontaneous awakening trial, paired with a weaning screen and a spontaneous breathing trial. In a multi-centre randomised trial of 355 ICU subjects, the wake-up and breathe protocol was found to dramatically improve patient outcomes. It was found that patients managed with a paired spontaneous awakening trial and spontaneous breathing trial breathed for more days without assistance than those with sedation and also had less ICU days (Girard & Ely, 2008: 250).

In summary, protocol driven weaning can increase the use of daily wean screens and spontaneous breathing trials. While the use of protocols remains controversial, what is clear is that protocols including non-physician led protocols and closed loop computer systems can reduce the length of mechanical ventilation (Girard & Ely, 2008: 250).

2.17 TEAMWORK AND INTERDISCIPLINARY COLLABORATION

The environment of the ICU has been described as “dynamic, complex and stressful”. Failure in collaboration and communication in this time-pressured setting can lead to unintentional harm to patients. The specialised knowledge of the nurse, technical skill and territory of the nurse or patient can lead to conflict. Protocols have been identified as one way for nurses to achieve autonomy in decision making while still engaging in power sharing, or collaboration. Collaborative team members have less autonomy but interdependent practice has been found to produce optimal care for patients (Rose 2011:5; Rose & Nelson, 2005:73).

2.17.1 Role of nurses in weaning

Traditionally, the role of weaning has been the domain of the physician. Nurses were involved in the process, but were not responsible for changes on the ventilator. Weaning has been taken over by nurses, usually in the form of protocolised weaning. Nurses have been recognised for being available 24/7 and are therefore in the best position to assess physiological and psychological parameters for weaning readiness and to adjust the ventilator in accordance with the patients changing pathophysiology. Communication and planning between bedside nurses and physicians has been described as imperative to achieve collaboration (Rose & Nelson, 2011: 81). In the USA, respiratory therapists play a key role in weaning, whilst in Australia most nurses are autonomous in weaning, holding post-graduate certification in Critical Care. Studies have shown that the use of weaning protocols prolonged mechanical ventilation, revealing protocols may not be as beneficial in adequately staffed, closed ICU's with highly trained nurses and physicians (Rose & Nelson, 2006). In the UK, some nurses were afraid to take responsibility due to lack of experience and weaning was not formalised.

ICU's tend to be mixed in the UK and Australia, whilst in the USA they are separated into medical, surgical, cardiac, etc. and other specialties, making weaning easier and more practical to implement (Rose & Nelson, 2005: 83). Teamwork is important in managing patients in ICU's in South Africa. While decision making is the responsibility of the physician, nurses and physiotherapists are with patients for the most time, placing them at the bedside and in a good position to determine weaning readiness. In a randomised control study in a 30-bed trauma unit in South Africa, it was found that a nurse and physiotherapist driven weaning protocol was as safe, with similar results, as a physician led protocol, yet the role of nurses and physiotherapists could be broadened and expanded in ICU's in South Africa (Plani, Becker & van Aswegen, 2013: 218). That is why this study is integral to helping understand nurses' knowledge of evidence based practice regarding weaning and extubation.

2.18 OVERVIEW

Whilst mechanical ventilation can be life saving, it can also result in complications including lung injury, diaphragmatic dysfunction and infection (Haas, 2012:1649)

Ventilatory support is usually provided from the time of intubation to the patient hopefully passing a spontaneous breathing trial. Some patients are weaned quickly whilst others take longer and a small percentage do not make it through (Haas, 2012:1650). Delays in weaning are still occurring due to issues such as morphine, midazolam, elderly and the renally impaired (Crocker, 2002:272).Weaning from mechanical ventilation is less about what method is used than how the method is used. No method is superior according to literature, but non-physician led protocols have been found to reduce the duration of weaning (Crocker, 2002:272).

It remains the nurse's role to assist in the process from making assessments to ventilator adjustments in order to provide oxygenation and ventilation. The patients comfort needs to be maximised, with the objective being to prevent secondary injury including ventilator induced ling injury (VILI), ventilator associated diaphragmatic dysfunction (VADD), and ventilator associated pneumonia (VAP) (Haas 2012: 1650-1651).

Traditionally, the belief was weaning was a drawn out procedure, occurring over several days, but recent thinking indicates that once the reasons for respiratory failure have been addressed, the patients can be quickly liberated from the ventilator. The evidence supporting ventilator weaning methods and protocols were discussed to describe the elements required for the successful implementation of the protocols and improvement in patient outcomes.

Protocols were identified as support tools to help reduce clinician error and to implement evidence based practice.

They enable different clinicians to make the same decision for the same clinical scenario, complement and enhance decision making and this series of checklists enable the patient to receive the highest level of nursing care. Research has found non-physician-led protocols improve patient outcomes and reduced costs using Grade A evidence (well conducted control trials with statistically significant results) (Haas, 2012:1651).

The nursing profession has the opportunity to lead the way in reducing health costs through using standardised approaches to weaning patients from ventilator support (Knebel, 1991: 550). Collaboration in nursing care is essential to enable nurses to facilitate both individual and standardised nursing protocols so as not to wean too slowly or too aggressively, in order to continue to achieve differences in mortality, length of stay and patient outcomes (Knebel, 1991: 558).

It is important to bear in mind that the patient is a respondent, not a spectator in the weaning process and patients who are critically ill and mechanically ventilated experience feelings of helplessness as well as stress and anxiety, which affects their family. With the endotracheal tube in situ, they are unable to communicate and are usually weak and exhausted. Hospitalisation is unexpected and the involvement of family is integral in terms of assisting with life-sustaining treatment and end-of-life decisions (Martensson & Fridlund, 2002: 220; Brysiewitz & Bengu, 2010).

2.19 SUMMARY OF CHAPTER

This chapter summarised the various approaches used to address the weaning process. The definition of weaning was presented, modes of weaning, the role of weaning indices introduced and issues including pathophysiology of weaning, weaning protocols, sedation, weaning failure, the role of nurses and weaning complications discussed.

Nurses play a key role in weaning and it is challenging for nurses, due to the number of variables influencing weaning (Knebel, 1995:550-559). It is agreed in literature that a collaborative approach versus an autonomous approach is more successful as a weaning and extubation strategy (Newmarch, 2006:63).

Protocol directed versus physician directed weaning was found to be safe and led to extubation more rapidly (reduces the total duration of mechanical ventilation by 25%) and physicians were found to underestimate the probability of successful discontinuation (Blackwood et al, 2011: 5,17; Martenssen & Fridlund, 2002: 220).

Constant assessment of the patient by the nurse is necessary to evaluate the progress of the patient and ensure the patient is safely weaned. Protocolised weaning shows a significant reduction in the duration of mechanical ventilation (Blackwood et al, 2012: 17). Helping patients breathe with the mechanical ventilator can be life-saving, but with this comes the risk of adverse events such as injury to the throat and vocal cords, injury and infection of the lungs and complications associated with immobility. It is vital therefore that the nurse immediately recognises when patients are ready to breathe on their own, so ventilator support can be discontinued as soon as possible (Blackwood et al, 2011: 2). In recent years, there has been an increasing mandate to control costs in short and long term weaning therefore, it is important for nurses and physicians to select the most effective means of weaning the patient. Knowing the patient and recognising both physiological and psychological parameters is vital in the weaning process (Crocker, 2009:188).

There has been an increase in the clinicians understanding relating to the pathophysiology associated with weaning failure and why it occurs. Studies concentrate on three main methods of weaning: T-piece trials, pressure support and SIMV (Brochard, 1994, Esteban, 1995 & Crocker, 2002:275). There is no evidence to support one method of weaning versus another. A lack of randomised control trials with an homogenous patient group has been an obstacle (Crocker 2009:187). Information from literature suggests that the method of weaning may be less important than how the weaning is applied (Knebel, 1995:550-559).

Contextual influences in clinical practice can be such that use of protocolised weaning and autonomy of the nurse can affect how the patient is weaned, as well as the ICU setting – medical versus surgical ICU's (Blackwell et al, 2011: 19). Differences in the role of the ICU nurse and scope of practice can also influence weaning practices (Rose et al, 2011 e16). The next chapter will outline the research design and methods used in the study.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.0 INTRODUCTION

This chapter describes the research methodology and includes the study design, the research setting, population, sample and sampling, the inclusions criteria, data collection, a description of the instrument used in data collection including the reliability and validity of the instrument and the ethical considerations. An overview was provided in Chapter One and the detail is provided here.

3.1 RESEARCH SETTING

According to literature, external factors such as the environment in which the research takes place, can affect study results (Polit & Beck, 2010: 241). Therefore the researcher ensured consistency of conditions for the collection of data by restricting the data collection to a specific setting, i.e. two sites were used, namely the general Intensive Care Units in two level one public health care facilities, the CMJAH (Charlotte Maxeki Johannesburg Academic Hospital) and CHBAH (Chris Hani Baragwanath Academic Hospital). These two settings were chosen as they focus on research and training nurses in accordance with the guidelines set out by the World Federation of Critical Care Nurses for developing countries, namely by providing study grants and exchange programmes to facilitate studying, involvement in government lobbying, promoting international standards in clinical practice, nursing standards as well as training (Williams, Bost, Chaboyer et al, 2011:73).

In spite of these efforts, language barriers, lack of access to internet resources, lack of implementation of formal practice guidelines, staffing issues, poor wages and working conditions, compounded by lack of resources, poorly qualified staff and insufficient access to education are some of the issues facing nurses working in the Intensive Care Units in these hospitals (Williams et al, 2011: 77-78).

The majority of patients who use these health care facilities have no private medical aid cover and many are immigrants (Hatchett et al, 2010).

3.2 RESEARCH DESIGN

A research design can be defined as "a set of decisions regarding what topic is to be studied among what population with what research methods for what purpose" (de Vos, Strydom, Fouche et al, 2011:143). Research design is a step in the research process and is a logical process relating to decisions we make in planning a study, such as the type of design to use, sampling, ways of gathering data, measurement issues and data analysis (de Vos et al, (2011:143). The study aimed to describe a situation and classify the information obtained in order to describe the knowledge of ICU nurses about mechanical ventilation.

The research used a survey design and outlined the basic strategies used to answer the research objectives. The purpose of the research was to generalise from the sample population so that inferences could be made about the knowledge of this population, namely ICU nurses (Creswell, 2009:146). It focuses on the end product and steps taken to achieve an anticipated outcome or result (de Vos et al, 2010: 143). According to literature, research design is the plan or proposal to conduct research involving the interaction of strategies, ideas or philosophy and specific methods (Cresswell, 2009:5). It has also been defined in literature as the plan for obtaining answers to the questions being studied and for finding ways to handle the challenges presented by the research findings (Polit & Beck, 2010:74).

In this study, the researcher did not intervene by manipulating the independent variable (ICU nurses' knowledge of evidence based guidelines regarding weaning the mechanically ventilated patient) and the study is therefore non-experimental or observational which involves the accurate portrayal of a situation (Polit & Beck, 2010: 222). There are no dependent variables, as although a relationship can be shown, the effect cannot be measured. A non-experimental design was used, as the units selected to take part in the research were measured on all the relevant variables at a specific time without being manipulated (de Vos et al, 2011:144).

The disadvantage of non-experimental research is that it cannot define causal relationships between variables with assurance. The researcher can also not assume that the groups (ICU) nurses with different levels of experience) were similar, before the hypothesised cause or independent variable (knowledge), therefore pre-existing differences may have lead to group differences in outcomes (Polit & Beck, 2010: 237).

Relationships between variables that cannot be manipulated were examined and therefore the design was correlational as it looked at the relationship between years of experience of ICU nurses and their level of knowledge (Polit & Beck, 2010:235).

The design was prospective as it was presumed that ICU nurses' knowledge of evidence based guidelines regarding weaning the mechanically ventilated patient results in evidence based practice and set out to measure this.

The purpose of the descriptive research was to observe, describe and capture aspects of a situation (Polit & Beck, 2010:236), in this instance, to measure ICU nurses' knowledge of evidence based guidelines regarding weaning the mechanically ventilated patient. The researcher describes the relationship between ICU nurses' experience and level of knowledge, but does not try to explain or understand the underlying cause between these variables. Descriptive research also looks at what is happening within the context of the research situation, such as what is happening in weaning from mechanical ventilation. In essence, the research is a summary of events and based on naturalistic investigation (Polit & Beck, 2010: 273).

The study is quantitative as the dependent variable (evidence based practice) and independent variable (knowledge of ICU nurses) lend themselves to measurement using a rigorous and precise design (Creswell, 2009: 233). The dependent variable is the outcome or behaviour the researcher wants to understand and explain. The independent variable is the presumed cause and affects or is antecedent to the dependent variable (Polit & Beck, 2010:85). The variables were observed and measured. A quantitative study is defined as an inquiry into a social or human problem, that tests a theory composed of variables, measured with numbers and analysed with statistical procedures in order to see whether the predictive hypothesis or assumptions of the theory hold true (Cresswell, 1994, cited in de Vos, 2010: 64). The variables (a) knowledge of ICU nurses and (b) evidence based practice can be measured on an instrument (a self-administered questionnaire) so that the numbered data can be analysed using statistical procedures. A quantitative design was the design chosen as objective data were needed to answer the research question. A self-administered structured questionnaire was the data collection instrument and statistical methods were used to examine the data. The researcher's role was also that of an objective observer, free from bias and personal opinion and interpretation.

According to literature, research needs to have certain characteristics which have been applied to this study: it measures facts objectively, it focuses on variables, it is reliable, research is conducted independently of context, statistical analysis is used and many subjects are involved in the study (de Vos et al, 2010:91).

The study design was also cross sectional in nature as data (in the form of a self-administered questionnaire) were collected at one point in time. This was done as it is economical and easy to manage, as testing takes place over a limited time, however changes in trends over time are not captured.

The contextual design is only relevant to the environment or surrounds in which the research takes place. The study was conducted within the real world environment of the respondents (general ICU) and was not manipulated or changed during data collection.

The study was conducted in two parts. Stage I involved the validation of the instrument through a focus group of Critical Care experts to discuss whether the instrument was applicable for the South African context following a method by Lynn (1986) for face and content validation. The content validity index (CVI) and kappa co-efficient of agreement was analysed from the panelists' quantitative ratings. The panel was asked to judge the items for clarity, relevance and item content using a 1-to-4 scale and asked to provide suggestions for any revisions or changes needed. Stage II of the study was conducted using the instrument to evaluate Intensive Care Nurses' knowledge of EBP regarding weaning of the critically ill patient from the mechanical ventilator.

3.3 POPULATION

The population is defined as an entire set of individuals or objects that have characteristics in common, e.g all registered nurses in South Africa, also called a universe (Polit & Beck, 2010:563). It is also referred to as the accumulation of cases in which a researcher is interested (Polit & Beck, 2010:306). The target population is the entire population in which the researcher is interested and the accessible populaiton was that part of the population the researcher could access (i.e. ICU nurses within specific hospitals) (Polit & Beck, 2010: 307). According to Benner in her 1982 application of the Dreyfus model of skill acquisition, experience is a prerequisite for knowledge and nurses go through different stages: novice, advanced beginner, competent, proficient and expert (Messmer, Jones & Taylor, 2004: 132; Dracup & Bryan-Brown 2004: 448). This theory was used to define the population. The population of Stage I of the study comprised trained ICU nurses (expert) working in Intensive Care Units and also specialist nurse educators and pulmonologists. The population of Stage II of the study comprised trained ICU nurses (novice to expert) from the general Intensive Care Units from the CMJAH and CHBAH. A preliminary audit undertaken in May 2013 indicated there were approximately 195 (N=195) Intensive Care registered professional nurses working in these units.

3.4 SAMPLE AND SAMPLING

Sampling is when a portion of the population is selected to represent the entire population and is more practical and economical than a population (Polit & Beck, 2010: 307). The researcher endeavoured to use a representative sample whose characteristics approximated that of the population.

Stage I: A non-probability purposive sampling method was used to select experts to validate the questionnaire to ensure applicability of the instrument to the South African context. This method is non random and every element does not have a chance for inclusion. Judgemental sampling or purposive sampling was used to hand pick the population, judged to be particularly knowledgeable about the issue under investigation. This method was chosen for convenience and economy (Polit & Beck, 2010: 312).

Six specialists comprising ICU clinical nurse educators, ICU clinical nurse specialists and pulmonologists were invited to participate in a panel discussion for the instrument validation process.

Inclusion criteria for the expert group were:

- Registered with an additional qualification in Intensive Care nursing;
- Registered with an additional qualification in Intensive Care medicine;
- More than 10 years of experience in clinical practice and/or education;
- Working in the Intensive Care Unit at the selected study site;
- Provided written consent to participate has been obtained.

Stage II: Following discussion with a statistician from the Medical Research Council (MRC) a sample size of 80 nurses (n=80) was decided upon to ensure good representation of the population from which the sample was drawn. A sample size is the number of subjects in a sample and the largest sample possible was selected.

A large sample is needed to ensure a confidence interval of 95.0% but even a large sample cannot guarantee representativeness (Polit & Beck, 2010:316, 331). A representative sample was desirable, so the finding could be generalised to the population. A non-probability sampling method was used to select the nurses provided they were suitable and fit the inclusion criteria of the study.

Inclusion criteria for prospective respondents:

- Registered by the South African Nursing Council (SANC) with an additional qualification in Intensive Care nursing;
- More than six months of clinical experience in the selected unit;
- Provided written consent to participate has been obtained.

Exclusion criteria:

- Enrolled nurses and auxiliary nurses as this sub-professional category of nursing staff are not expected to have the skills and in-depth knowledge of evidence based guidelines regarding weaning the mechanically ventilated patient.

3.5 DATA COLLECTION

3.6. INSTRUMENT

A structured approach was used and data was collected using a self-report technique in the form a formal written document (Appendix 1). The instrument is a self-administered questionnaire completed by the respondents themselves. A thorough literature review was conducted to guide the questionnaire construction process and include questions relevant to the topic. The questionnaire was divided into different sections, which aimed to explore professional nurses' knowledge regarding weaning the critically ill patient from mechanical ventilation. Experts in the field were also consulted using a snowball method. The survey was first validated and critically reviewed by a panel of experts (Stage I) and then pretested with a small number of respondents (sample of ICU nurses) (Stage II).

Respondents were asked to give their response in writing by selecting their answer from closed-ended questions or fixed alternative questions in which the response alternatives are prespecified by the researcher. Questions were also presented using the Likert scale comprising several statements that express a viewpoint or category. The researcher decided on the number of categories to be used for each item. The minimum response categories are two, whilst the maximum is not determined but five to nine are suggested as ideal (de Vos et al, 2010: 219). The categories were as follows:

Section A: Demographic data of the respondent.
Section B: Factors predicting weaning failure.
Section C: Basic facts about weaning.
Section D: Weaning methods.
Section E: Spontaneous breathing trial.
Section F: Predictors for weaning and weaning index.
Section G: Weaning protocols and sedation.

Demographic data (Section A) were captured by the use of a nominal scale (coding of a closed ended question). In the rest of the questionnaire, respondents were asked to indicate how much they agree/disagree with a statement (Polit & Beck, 2010: 208-209).This scale used was an itemised rating scale with a series of statements designed to rank different positions on the variable being measured (de Vos et al, 2010: 208). The respondent's total score was given according to sum of the scored items. The benefit of this instrument is that it is economical to produce and can also be distributed over the internet. The information obtained was of a superficial nature and suited to extensive analysis (Polit & Beck, 2010:295). Closed ended questions were chosen for efficiency and for time saving purposes. Each question was worded for clarity, sensitivity to respondent's psychological state, absence of bias and reading level. The fact that some respondents do not choose from alternatives that represent their exact opinions was also taken into consideration (Polit & Beck, 2010: 345). The instrument contained items which were a sample of the possible universe of items (de Vos, 2010: 216).

The benefits of the questionnaire were that it was less costly and more time efficient than other methods. It affords the respondent more anonymity and perceived privacy and also avoids interviewer bias by reflecting the respondents' answer to the question rather than the interviewer (Polit & Beck, 2010: 345). Disadvantages of the questionnaire were that respondents were not able to provide additional information and also language barrier issues with English being a second language for some respondents.

3.7 VALIDITY AND RELIABILITY OF INSTRUMENT

3.7.1 Reliability

The reliability of the instrument refers to how consistently and how accurately an instrument measures an attribute (Polit & Beck, 2010:373).
The less variations appearing in repeated measurements, the greater the validity. The research was carried out in order to ensure true scores were reflected. Outside variables were taken into consideration including respondent fatigue. To eliminate this, the researcher would need to give the same questionnaire twice to a sample and then compare scores and a reliability co-efficient would need to be calculated.

The instrument was evaluated for internal consistency which is a reliability approach. It was evaluated by calculating the coefficient alpha (Cronbach's alpha. The normal range is between 0.00 and +1.00. The higher the reliability coefficient the more accurate the results (Polit & Beck, 2010: 375). The instrument was also assessed for equivalence or the degree to which coders agree on the scoring of the instrument. This was done through interrater

reliability (two or more coders make independent observations). Heterogeneity was taken into consideration regarding the reliability of the instrument; the sample was homogenous leading to similar scores and a lower reliability co-efficient. Also longer scales (with more items) tend to be less reliable than shorter ones.
In order to ensure reliability the following was done:

- Multiple items or observations of a variable (two or more questions on questionnaire)
- Items that were unclear were eliminated
- Precise level of measurement used
- Conditions under which the instrument was used were standardised
- The instrument was moderated for difficulty of use (if it is too difficult it will not reflect an accurate picture)
- The effect of external events were minimised
- Consistent scoring was manitained using a pretest or pilot study (de Vos et al, 2010:177).

3.7.2 Validity

The validity is the extent to which the instrument measures what is is supposed to measure. The researcher endeavoured to ensure that the instrument measured ICU nurses knowledge of evidence based guidelines regarding weaning the mechancially ventilated patient. The instrument needed to be reliable in order to be valid. Validity is the degree to which a measure reveals the meaning of the concept under consideration. It refers to truthfulness, accuracy and authenticity and considers not only what the instrument is measuring and why it operates as it does, but also the logical relationship among variables (de Vos et al, 2010:172).

3.7.3 Face validity

This refers to whether the instrument looks as though it is measuring the construct, especially with reference to the respondents completing the survey (Polit & Beck, 2010: 379).

3.7.4 Content validity

This is described as the extent to which the instrument has a sufficient sample of items for the construct being measured and covers the construct area adequately. This is applicable as the instrument tested knowledge where it was relevant to ask how representative the questions on the test were of the vast questions on this topic. The researcher calculated a content validity index (CVI) to show the level of expert agreement. A panel of experts were used to evaluate the content validity of the instrument. A content validity value of .90 is regarded as the correct number to confirm the scales content validity (Polit & Beck, 2010:379).

3.8 PROCEDURE

Specialist nurses and pulmonologists who meet the inclusion criteria were sent an information letter (Appendix II) and the instrument in the form of a questionnaire (Appendix I) and invited to comment on the validity of the instrument and its applicability to the SA context based on Lynn's Model of Agreement, by offering their expert opinions. A consent form (Appendix III) and data collection tool (Appendix I) was sent to the respondents.

Stage Two: Permission was requested from management of the hospitals where the study will be conducted using a letter of request for research conduction at each institution (Appendix IV, VII). Once permission was granted, unit managers were asked for permission to conduct the study in their respective units. Intensive Care nurses in the units were informed about the research purpose and objectives and given a respondent information letter. Confidentiality of data and anonymity were ensured and participation was voluntary. Nurses were informed of their right to refuse to participate, that they could decline to answer a question or discontinue their participation in the study at any time. An information letter was given to respondents (Appendix V) and they were requested to sign a consent form (Appendix VI). The data collection tool was given to the nurses consenting to participate in the study (Appendix I). Completed questionnaires were placed in sealed envelopes and collected by the researcher from each unit every week. The identity of the respondents was protected.

The data was made available to the respondents on request on completion of the research and was stored by the researcher and statistician from the medical control council.

3.9 VALIDITY AND RELIABILITY

Validity is defined as a quality measure, referring to the extent to which inferences are made in a study are accurate and supported by the evidence (Polit & Beck, 2010: 571).
A pilot study was done and validity scores captured to ensure feasibility of the study and detect possible flaws in the instrument used. Content validity was achieved by having the data collection instrument reviewed by experts in ICU nursing. The Panel in Stage I addressed the following objectives: (a) whether or not the 35 items on the instrument were relevant for evaluating the knowledge of ICU nurses regarding weaning (b) if an item needs rewording and suggestions for the rewording such as for language interpretation and consistency. Content validity for the instrument was established through a review of the literature, clinical experience and panel of experts in Critical Care nursing.

Reliability was maintained by ensuring consistency and accurate recording of data. Data collection was only done by the researcher. An appropriate sample size was discussed with a statistician so as to be representative of the population of the study, taking into consideration possible refusal to participate.

3.10 PILOT STUDY

A pilot study is defined as a study conducted before the main research in order to assess whether the methodology, sampling methods, instruments and analysis are sufficient and applicable (de Vos, 2010:237). A pilot study was conducted to ensure feasibility of the main study looking at the goals and objectives, resources, population, process of data collection, costs and potential errors (de Vos, 2010: 239). According to literature, a pilot study helps the researcher become orientated to the topic or project they are considering investigating (de Vos et al, 2010: 236). This is to ensure the procedures are suitable, valid, reliable and effective and precautions have been taken to eliminate potential errors. The instrument was tested for validity and administered to a small sample of (n=6) ICU nurse respondents in cardiac ICU at the CMJAH from the intended test population, so as not to contaminate the sample. The results were not used in the main study.

3.11 ETHICAL CONSIDERATIONS

Ethics is defined as the preferences that affect human behaviour in human relations, conforming to a code of principles or rules of conduct, responsibility of the researcher and the standards of conduct of a profession (De Vos et al, 2010: 114). These guidelines serve as a foundation upon which the researcher evaluated her own conduct. Ethically guided decision making and the humane and sensitive treatment of respondents was carried out.

Avoidance of harm: Respondents were informed beforehand about the nature of the research and they were given the opportunity to withdraw from the study if they wished. Respondents may have potentially experienced difficulty with regard to their employment situation, as participating in the research may have made them unpopular or singled them out in some way. By ensuring the privacy and confidentiality of respondents, all attemtps were made to protect them from emotional harm.

No physical harm was inflicted and physical exhaustion and stress was minimised by allowing the respondents to complete the questionnaire in their own time in a private area designated for the research (de Vos et al, 2010: 115).

Voluntary participation: No respondents were forced to participate. They were given information about the nature of the research without being told too much detail about the aim of the study. According to literature, respondents may still believe their non-participation may affect them negatively, for example if asked to participate by their unit manager (de Vos et al, 2010: 117).

Informed consent: Written, informed consent was obtained from respondents, procedures were explained to them and they were informed about the advantages of the study, its contribution to nursing research and knowledge of ICU nurses regarding weaning the mechanically ventilated patient. The respondents were given adequate information in terms of what the research would demand of them in terms of time and non disclosure of confidential information (de Vos et al, 2010: 117).

Violation of privacy, anonymity, confidentiality: This was guaranteed to respondents in that it was agreed their responses and personal information would be kept private and anonymous, the results only made to the researcher and her supervisor and statistician. Sufficient information was given to the respondents that they could evaluate the situation and make their own decisions (de Vos et al, 2010: 119). Debriefing of respondents: the respondents were given the opportunity to work through their experience of the research and have their questions answered. Respondents were sent a newsletter telling them the basic results of the study (de Vos et al, 2010:122).

Actions and competence of the researcher: Researchers are obliged to ensure they are competent, honest and able enough to undertake the investigation. According to Babbie, cited in de Vos et al, “science makes progress through honesty and openness while deception and ego defences retard it.” All attempts were made to conduct the research in a scientific manner (de Vos et al, 2010: 123).

- A research proposal was submitted to the University Postgraduate Committee for permission to conduct the study
- Application for clearance to conduct research was obtained from the committee for Research on Human Subjects (Medical) of the University of the Witwatersrand
- Phase I was validated/verified and changes made to the new version were submitted to the secretariat of the Committee for Research on Human Subjects (Medical) of the University of the Witwatersrand
- Application for permission to conduct the study was obtained from Hospital Management

3.12 SUMMARY

This chapter described the research methodology. The research design was selected to appropriately meet the study’s purpose and objectives. An in-depth description was given of the instrument used for data collection and a pilot study was conducted at the main study site using the interview schedule which successfully met the study’s objectives. The following chapter presents data analysis and research findings.

CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION OF FINDINGS

4.1 INTRODUCTION

Data files were set within the computer statistical package 'STATA' version 11, data entered once and then verified during the second direct data entry. Descriptive and comparative tests were used to achieve the study objectives. The descriptive tests (frequency, mean and standard deviation) synthesised nurse respondents's demographic data and questionnaire schedule, whereas inferential statistics were employed to describe and synthesise questionnaire scores and compare the demographic data with obtained level of measurements to test for statistical significance. Statistical tests included the Fisher's Exact Test. Testing was done at the 0.05 level of significance ($p<0.05$) and ensured at least 95% accuracy in findings. Findings will be discussed on construct, scale and item level.

This chapter describes the analysis of data using descriptive and comparative statistical tests and interpretation of findings.

4.2 APPROACH TO DATA ANALYSIS

Descriptive statistics were used to present interpretation of the data of nurse respondents: age, gender and years of working in Intensive Care, qualification in Intensive Care and current position in Intensive Care. Frequency distributions and cross tables were used to provide an overall coherent presentation and description of the data. Percentages in these findings are to the nearest whole numbers.

When comparing item scores for construct variables (basic facts about weaning; weaning methods; spontaneous breathing trial; predictors for weaning and weaning index; weaning tools and sedation), the application of Fisher's Exact Test was to test for significance of differences in the frequencies of responses for the basic facts. Testing was done on item level to further explore the data. When comparing categorical variables the response was as the aforementioned - the Fisher's Exact Test tested for significance of differences in the frequencies of respondents responses for basic facts about weaning, weaning methods, spontaneous breathing trial, predictors for weaning and weaning index, weaning tools and sedation and selected demographic variables (setting, age, years of experience in ICU and clinical position in ICU).

Frequency distributions and cross tables were used to provide an overall summary of the data. Collapsing of the categories on the Likert scale was done to facilitate presentation of the data, however, it was noted that a larger percentage of respondents answered agree, disagree or unsure in the itemised analysis.

The level of statistical significance was set on the level of $p<0.05$. A biomedical statistician from the Medical Research Council (MRC) analysed the data using the statistical package 'STATA' version 11.

Due to the homogeneity of the sample, findings may be of interest to other public sector Intensive Care Units (ICUs), clinical practice and education of Intensive Care nurses.

4.3 RESULTS AND DISCUSSION OF FINDINGS

4.3.1 Section A: Demographic Data

This section related to the demographic profile of the respondents who participated in the research study. Results of this process are summarised in **Table 4.1** for the total sample (n=80). Items were combined to form coherent groups to facilitate the discussion of the data.

Table 4.1 Frequencies obtained for demographic data (n=80)

Item	Statement	Frequencies	Percentage
Q1	Age		
	No response	2	2.5
	27 – 29	2	2.5
	30 – 39	20	25.0
	40 – 49	32	**40.0**
	50 – 59	24	30.0
Q2	Gender		
	No response	2	2.5
	Male	9	11.3
	Female	69	**86.3**
Q3	Years working in ICU		
	No response	1	1.3
	<5	11	13.8
	5 – 10	33	**41.3**
	10 – 20	26	**32.5**
	>20	9	11.3
Q4	Qualification in ICU		
	No response	3	3.8
	Degree	14	17.5
	Diploma	63	**78.8**
Q5	Current position in ICU		
	No response	2	2.5
	Primary registered nurse	45	**56.3**
	Shift leader	25	**31.3**
	Clinical facilitator	3	3.8
	Unit manager	5	6.3

4.3.1.1 Age and gender distributions

Females accounted for 86.3% (n=69) and males 11.3% (n=9) of the total sample (n=80). The highest numbers of nurses (40.0%: n=32) were between the ages of 40 and 49 years, and 30.0% (n=24) were in the 50 to 59 age category. It can be extrapolated from the findings that female nurses predominate in the total sample (n=80). However age categories indicated opposite higher and lower frequencies in the 40 to 59 (70.0%; n=56) and 27 to 39 (27.5%; n=22) age groups, implying in terms of age distributions this is a mature nursing population. **Figure 4.1** presents the findings.

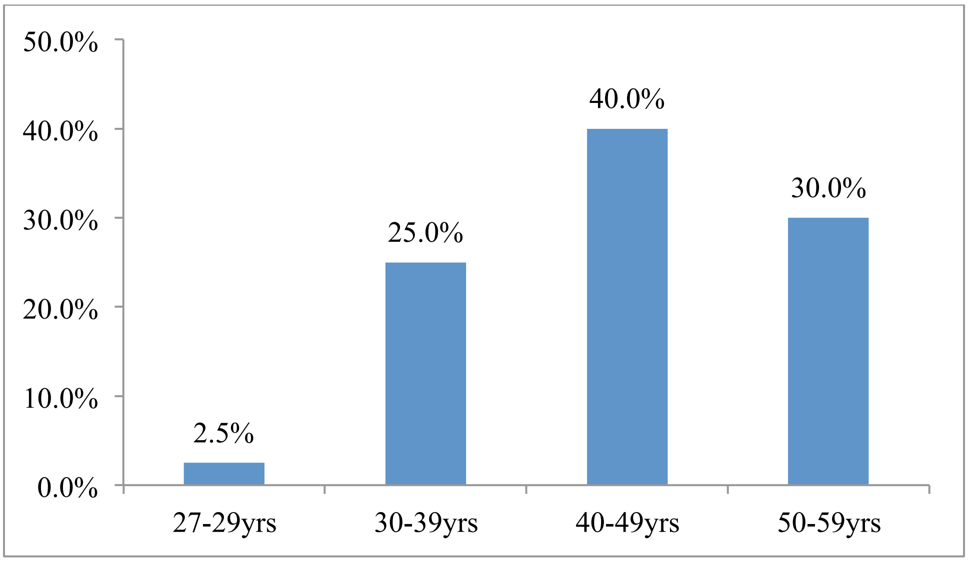

Figure 4.1 Age distribution of nurse respondents (n=78)

From these findings (**Figure 4.1**), it can be seen that 40% of nurses (n=42) were between 40 and 49 years of age, 30% were between 50 to 59 (n=24), 25% (n=20) were in the 30 to 39 age category, whilst only 2.5% were in the 27 to 29 year age group. Approximately 70% (n=56) of respondents fall within the 40 to 59 year age category, whilst 27.5% (n=22) are between 27 and 39 years of age, which indicates an ageing or mature nurse population.

In this study, females accounted for 86.3% (n=63), whilst males accounted for 11, 3% (n=9) showing a largely female dominated sample. These findings reflect global trends as in 2004 men comprised 5.7% of all nurses, which increased only marginally from the 5.4% in 2000. The 2007 American Association of Critical Care Nurses [ACCN] Member Demographic Data reported that 90% of Critical Care nurses are women and 10% are men. (Siela et al. 2009: 18).

The results from this sample reflect similar trends in demographics globally. In an overseas qualitative study in California on intensive care nurse perceptions of futile care and its effect on burnout, similar demographics were reflected with 50% of the sample being 31 to 45 years old and 70% being married (Meltzer et al, 2004: 205). Some of the reasons cited for a declining nurse work force in the ICU environment included workload, conflict with co-workers and management, lack of staffing and resources, emotional demands of patients and patients' families, dealing with life-sustaining technology and proximity to death and dying (Meltzer et al, 2004: 203).

Further reasons cited are high nurse turnover and vacancy rate, slowest rate of growing RN population in 20 years, job burn-out, dissatisfaction and lack of nurse educators, preceptors and budget constraints (Siela et al, 2009: 19).

In a position statement, released by the ACCN, it was stated the average age of Critical Care nurses in the USA is 45 years, with 9% between the ages of 22 and 29 and 61% between the ages of 40 and 60; 40% have more than 20 years of experience. These figures reflect a reduction in the number of nurses entering the specialty and that the majority of experienced Critical Care career nurses are nearing retirement in the USA, with insufficient nurses to fill the number of available positions (ACCN, 2001). It is possible the figures from this local study mirror these global trends. In 2004, the average age of RNs was 46.8 years, 26.6% of all nurses were younger than 40.1 years, 8.1% were younger than 30, with more than one quarter of all nurses being 55 years or older. In 2007, the ACCN Member Demographic Data revealed the following age information for Critical Care nurses: 18 to 29 years: 5%, 30 to 39 years: 19%, 40 to 49 years: 32%, 50 to 59 years: 35%, 60+ years: 9%, which reflects an ageing nurse population, similar to this study (Siela et al. 2009: 17-19).

4.3.1.2 Qualifications and clinical position

In line with the statistics of the South African Nursing Council (SANC, 2008), most of the nurses had a post basic diploma in Intensive Care (78.8%; n=63). Of the total sample (n=80), most of the nurses had between five and 10 years of ICU experience, followed by 32.5% (n=26) and 13.8% (n=11) from 10 to 20 years and less than five years respectively. **Figure 4.2** displays the findings.

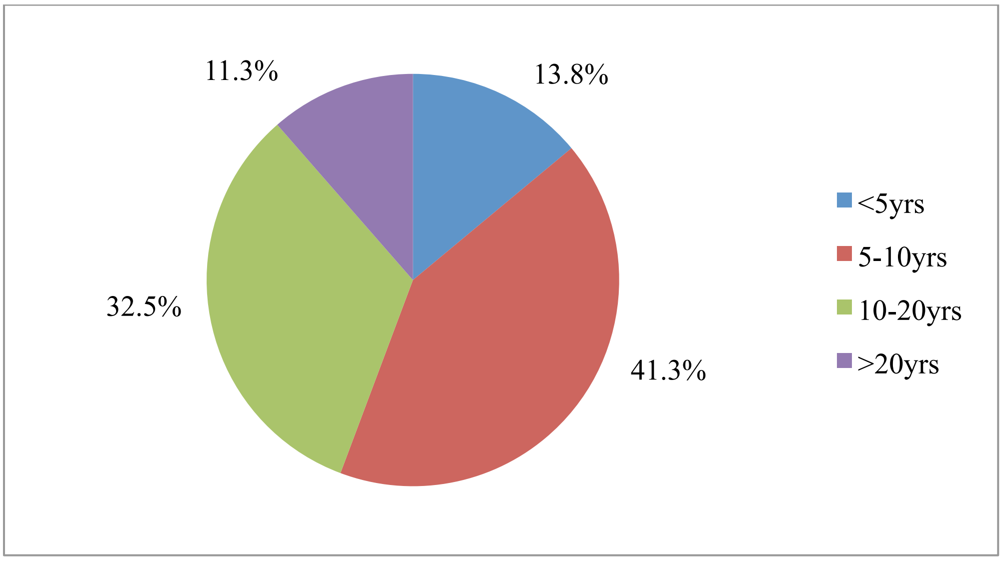

Figure 4.2 Distribution of years of working experience in ICU (n=79

As cited in literature, the requirements of a post basic certification in ICU are extremely necessary for the nurse to function competently, which substantiates why the majority of respondents (78.8%) **(Figure 4.2)** hold a diploma in Intensive Care nursing. As many as 50% of all ICU patients require mechanical ventilation and a study on protocol directed weaning in Norway, found the professional nurse needs technical competence in addition to a thorough understanding of lung pathology and ventilation, as well as being able to recognise objective and subjective weaning criteria (Hansen & Severinsson, 2007: 197).

The research tradition within nursing has habitually been short, relative to that of medicine (Hansen & Severrinson, 2007:203), with the findings of this study showing only 17.5% have a degree **(Figure 4.2).** In Italy, a degree in nursing and Master's degree in Intensive Care nursing was only introduced by the European Minister of Education in 1999 (Villa et al, 2011: 42). In Australia, studies by Aiken et al. (2007) indicate a higher percentage of university-trained nurses in the workforce leads to a statistically significant reduction in the hospital death rate, therefore it can be extrapolated that the low level of university graduates in this study (17.5%:n=14) (**Figure 4.2)** may be negatively impacting on patient outcomes (Rose & Nelson 2006:82).

The number of nurses with a postgraduate Critical Care qualification in Australia is higher than in other countries and the Australian College of Critical Care Nursing recommends that up to 50% of nursing staff employed within an ICU unit, are equipped with a postgraduate qualification in contrast to this sample, where only 78.8% have a diploma and 17.5% hold a degree **(Table 4.3)**. According to survey from the ACCN in 2004, intensive care nurse members report the following as their highest degree: BSN 54% Bachelor of Science in Nursing, Associate Degree in Nursing - 21%, Master of Science in Nursing - 15%, Associate Degree (AD) 4% in Nursing, Master of Science in another field- 2%, Bachelor of Science in another field- 2%.

In terms of the current position in Intensive Care, the majority (56.3%: n=45) of nurses were primary clinical nurses, followed by 31.3% (n=25), 6.3% (n=5) and 3.8% (n=3) reflected as shift leader, unit manager and clinical facilitator, respectively.
Figure 4.3 displays the findings.

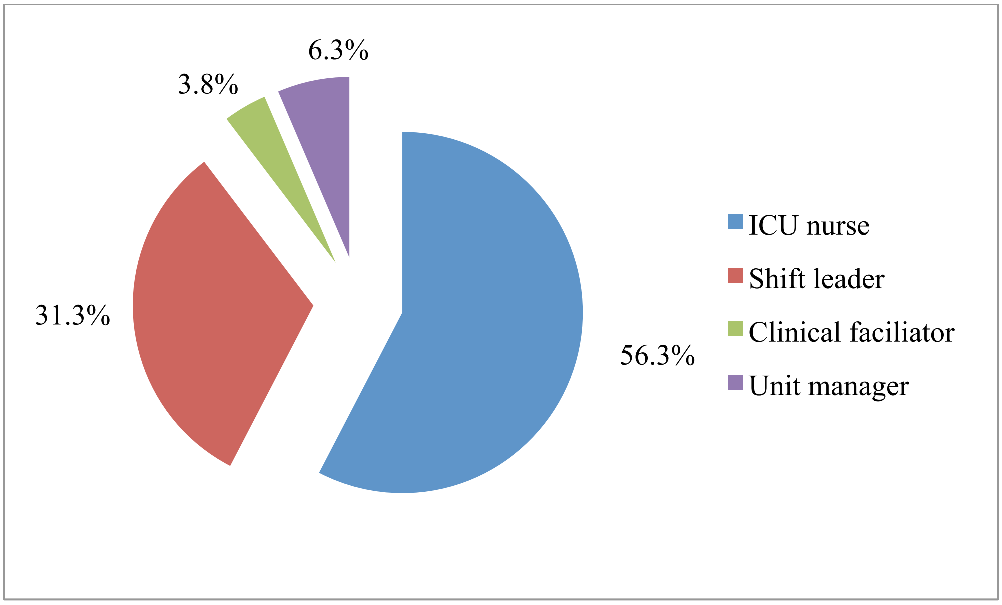

Figure 4.3 Distribution of nurse respondents current position in ICU (n=78)

From these results, it can be extrapolated that most nurses are in the 40 to 49 year old age group (**Figure 4.3**), with at least five to 10 years of experience in ICU. They are either not inexperienced or are new novice nurses, most likely functioning independently in collaboration with doctors, shift leader, unit manager and clinical facilitator. Therefore 86.61% (n=70) of the workforce comprises shift leaders and primary nurses. A qualitative study conducted in Ireland, assessing factors influencing nurses in weaning patients from mechanical ventilation, found assessing the patient, making decisions and collaborating with team members emerged as major themes influencing their decision to wean.

Similarly, Rose et al (2008) reported a high level of autonomy and decision-making amongst nurses (Lavelle & Dowling, 2011:245). In a study by Rose et al. (2007) of factors influencing decisions on weaning by nurses, it was found that of 2538 decisions, 64% were made by nurses alone, 693 (17%) by medical staff and 755 (19%) by nurses and staff in collaboration (Rose et al, 2007: 434). The skill mix in this study differs from Critical Care teams in the USA where an outcomes manager and respiratory therapist (holding a two-year certification in ventilation) are also involved as part of the weaning team (Rose & Nelson, 2006:75). Furthermore, nurse to patient ratios are 1:2 in North America, differing from the 1:1 nurse ratios in the UK and South Africa. This skill mix influences both ventilation times and patient outcomes (Rose & Nelson, 2006: 82).

The shift leader in South Africa is responsible for making the final clinical decision in the Intensive Care Unit and liaising directly with the doctors/physicians. Studies by Gelthorpe & Crocker in 2004 (cited in Rose & Nelson, 2006: 83) indicated that nurses are reluctant to take accountability for weaning decisions and fear being held accountable for making the wrong decision due to lack of experience (Rose & Nelson, 2006:83). In South Africa, the role of the clinical facilitator mirrors that of the preceptor found in North America, where new graduates work one-on-one with a clinical facilitator or preceptor until they improve their judgement and cognitive skills (Messmer et al. 2004:132). In this study, only 2.5% of respondents **(Figure 4.2)** were in the 27 to 29 year old age category, which may indicate that new graduates are not prolific in the Intensive Care Unit, probably due to their lack of experience.

4.3.2 Section B: Factors Predicting Weaning Failure

Section B focused on the factors of predicting weaning failure of the critically ill patient from mechanical ventilation (refer **Appendix A**). Respondents were given one (1) question (**Item Q6**) and asked to choose the correct response from a list of ten (10) sub-items (sub-item Q6a to Q6j). **Table 4.2** displays the findings**.**

Table 4.2 Frequencies obtained for factors predicting weaning failure (n=80)

Item	Statement	Frequencies	Percentage
Q6	No response	3	3.8
Q6a	A caloric regime providing nutrition and avoiding hypermetabolism (serum albumin >2.5)	-	-
Q6b	Pain is controlled and patient received night sedation.	3	3.8
Q6c	Adequate respiratory strength.	1	1.4
A6d	Sufficient oxygenation	2	2.5
Q6e	Patient is fatigued	**69**	**86.3**
Q6f	Patient is on low dose vasopressors	-	-
Q6g	Systolic BP <180 and >90mmHg	-	-
Q6h	Respiratory rate is 20 breaths per minute	1	1.3
Q6i	Hb 8 – 10g/dl	1	1.3
Q6j	Temperature <38° C	-	-

This statement noted that of the factors predicting weaning failure of the critically ill patient from mechanical ventilation, patient appeared fatigued (Q6e) was the correct response. A large (86.3%: n=69) portion of respondents agreed with this statement. The results obtained, as reflected in **Table 4.2,** are as follows:

- 3.8% (n=3) of respondents omitted this statement;
- 3.8% (n=3) of respondents agreed with sub-item Q6b;
- 1.4% (n=1) of respondents agreed with sub-item Q6c;
- 2.5% (n=2) of respondents agreed with sub-item Q6d;
- 86.3% (n=69) of respondents agreed with sub-item Q6e;
- 1.3% (n=1) of respondents agreed with sub-item Q6h;
- 1.3% (n=1) of respondents agreed with sub-item Q6j.

A study (Goodman, 2006) using an evidence based review to develop a weaning protocol, determined signs of patient fatigue, such as an increased respiratory rate >35, decreased tidal volume <5ml/kg, decreased PaO_2, SaO_2 and increased $PaCO_2$, with a patient who looks and feels distressed such as with tachycardia, sweating and changes in mental state, can predict weaning failure and it is clear the majority of respondents felt this factor was most likely to impact on weaning success (Goodman, 2006:28).

Similarly, a study conducted in Australia by Rose et al. (2008), which focused on decisions by nurses to wean, found experienced nurse clinicians are well situated to constantly monitor a patient's pathophysiological parameters and intervene with alterations in ventilatory support where necessary (Rose et al, 2007:440). In a qualitative study on nurse weaning in Ireland, experienced nurses said they know when to wean from experience and by just looking at a patient they knew if a patient could tolerate a weaning trial (Lavelle & Dowling, 2011: 249).

4.3.3 Section C: Basic Facts about Weaning

Section C focused on basic facts about weaning the critically ill patient from mechanical ventilation (refer **Appendix A).** The respondents received six questions (items **Q7 to Q13**) of Likert-type statements where they had to choose their responses from a list ranging from strongly agree to strongly disagree. Items were combined to form coherent groups to facilitate the discussion of the data. The results for this section are discussed below.

4.3.3.1 Timing and process of weaning

Respondents received a statement that the weaning of the critically ill patient from mechanical ventilation should be slow and gradual. The correct response was disagree, but only 7.5% (n=6) of the Intensive Care nurses responded correctly. **Figure 4.4** displays the responses obtained:

- 2.5% (n=2) respondents omitted the statement;
- 7.5% (n=6) respondents disagreed with the statement;
- 2.5% (n=2) respondents chose the neutral option;
- 87.5% (n=70) respondents chose the agree category.

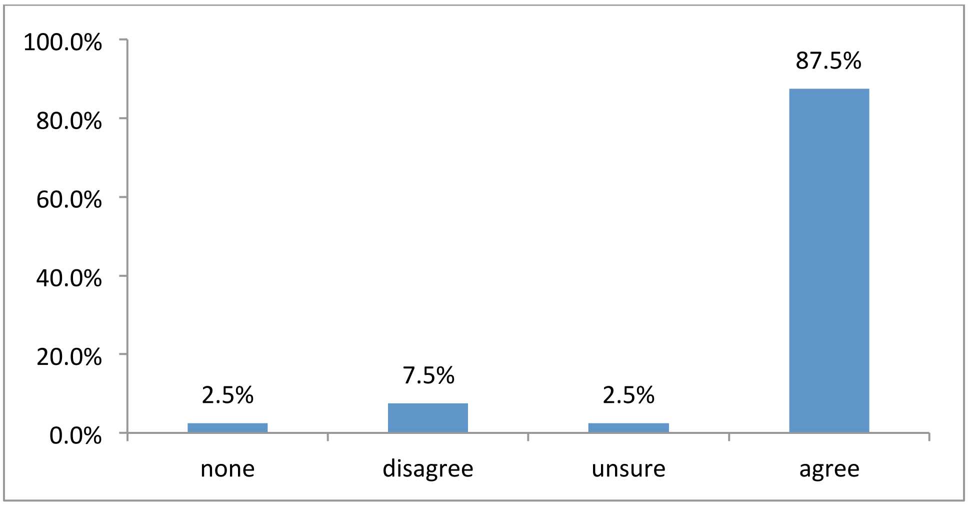

Figure 4.4 Frequencies obtained for timing and process of weaning

The majority of respondents 87.5% (n=70) agreed that weaning should be a slow and gradual process (**Figure 4.4**).

However, whilst weaning has been defined as a gradual reduction of respiratory support until the patient has reached their maximum potential or until reduction in support is no longer a necessity (Crocker, 2009, cited in Lavelle & Dowling, 2011: 245), the very definition of weaning is debated in literature with some using the term "ventilator discontinuation" (Lavelle & Dowling, 2011:245). The key issue is that weaning patients who no longer need ventilator support will delay the weaning process (Hess, 2011: 392).

Traditionally, the discontinuation of mechanical ventilation is through a gradual reduction in ventilator support, but the belief now is that adhering to this gradual approach may in fact delay some patients, who have recovered from respiratory failure, from being extubated (Haas, 2012:1650). The findings indicate that 10% of respondents were unsure or in disagreement and this may reflect their familiarity with immediate discontinuation of ventilation versus the gradual approach.

Exactly when weaning begins and ends remains controversial and this may in part explain the response of the majority of the respondents. Nevertheless, experts remain in agreement that weaning should be commenced as soon as possible, based on the judgement of the physician or nurse, which has led to many studies favouring the use of protocol directed weaning, as it has been found to expedite the weaning process (Blackwood et al, 2011: 958; Kollef et al, 1997:567; Lavelle & Dowling, 2011: 242-252).

4.3.3.2 Long term mechanical ventilation

This statement noted that long-term mechanical ventilation (LTMV), is when a patient is ventilated for 72 hours or less (**item Q8**). The correct answer was disagreed. It is clear from the results displayed in **Figure 4.5** that Intensive Care nurses possessed the knowledge on long-term mechanical ventilation (LTMV), as the majority (53.8%:n=43) chose the correct answer. A small proportion of respondents agreed with the statement or chose the neutral option. The results are as follows:

- 53.8% (n=43) respondents disagreed with the statement;
- 35.0% (n=28) respondents chose the neutral option; and
- 8.8% (n=7) agreed with the statement.

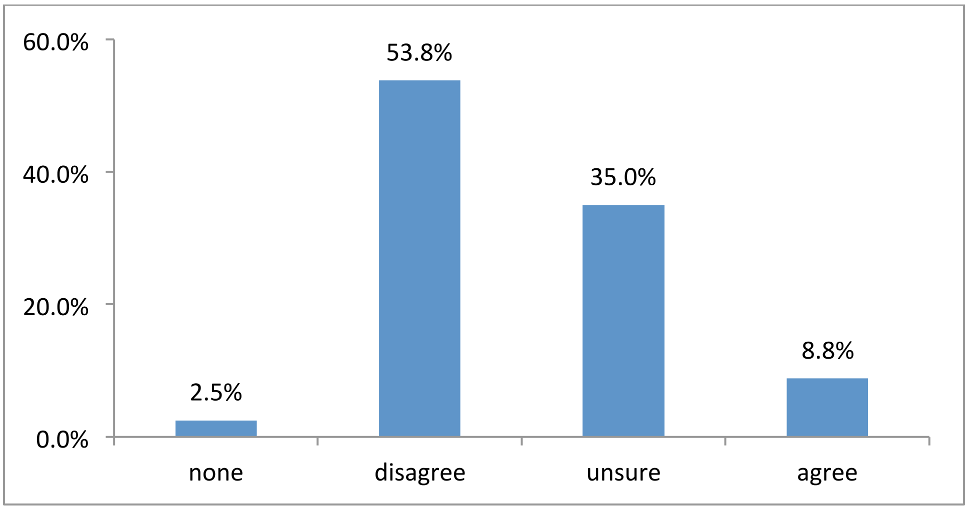

Figure 4.5 Frequencies obtained for long-term mechanical ventilation

Burns et al (cited in Crocker, 2002:275) define long-term weaning as a period of three days or 72 hours and 53.8% **(Figure 4.5)** of respondents responded correctly to this statement (**item Q8**).

However, literature debates as to what defines long-term versus short-term ventilation. According to Burns, long-term ventilation is over three days whereas Crocker defines it as over seven days (Lavelle & Dowling, 2011: 245). Prolonged weaning can be associated with adverse outcomes for patients (Blackwood et al, 2011:13) Prolonged weaning has also been defined in literature as including patients who need more than three SBT (spontaneous breathing trials) or >7 days of weaning after the first SBT, according to studies collated by a weaning task force (Boles, 2007: 1036). The controversy surrounding the exact definition of long-term weaning may account for 25% of the respondents being unsure.

4.3.3.3 Nurse-led weaning

Respondents received a statement that non-physician led (i.e. nurse-led) weaning reduces the patient's number of ventilated days, days spent in Intensive Care and cost of care (**item Q9**). The correct response was agreed, but only 55.0% (n=44) responded correctly. **Figure 4.6** displays the obtained responses:

- 8.8% (n=7) respondents omitted this statement;
- 20.0% (n=16) respondents disagreed with this statement;
- 16.3% (n=13) respondents chose the neutral option;
- 55.0% (n=44) respondents agreed with this statement.

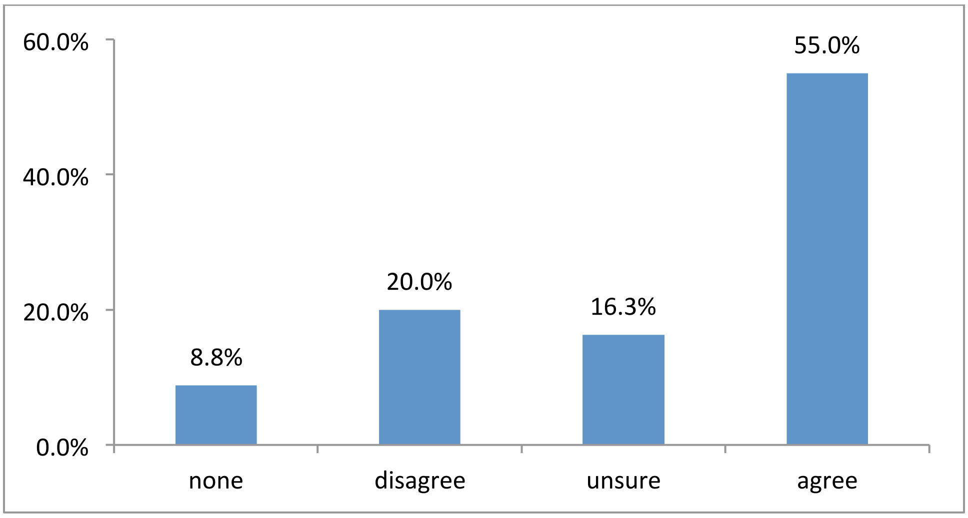

Figure 4.6 Frequencies obtained for nurse-led weaning

In the Cochrane systematic review, it was found the use of weaning protocols reduces the duration of mechanical ventilation by 25%, weaning duration by 78% and the length of stay in ICU by 10% (Blackwood et al, 2011:13). In randomised control studies by Kollef et al, it was found that protocol guided weaning by nurses and respiratory therapists is safe, leading to extubation more quickly than physician directed weaning (Kollef et al, 1997: 667). The main reason given is that nurses and respiratory therapists are able to start the weaning process more quickly than physicians can (Kollef et al, 1997: 573). Whilst the majority (55%) of respondents agreed **(Figure 4.6)**, some nurses (20%) remained in disagreement and some were unsure (16.3%). Factors cited in literature that may prevent nurses from weaning include physicians failing to accept their role in the weaning process, the workload in the ICU and frequent monitoring to ensure compliance with the protocols (Blackwood et al, 2011: 12).

4.3.3.4 Risk of re-intubation

The respondents received the statement that patients are at risk of re-intubation, if weaning takes place too quickly (**item Q10**). The correct response was disagreed, but only 12.5% (n=10) responded correctly. **Figure 4.7** displays the obtained responses:

- 2.5% (n=2) respondents omitted this statement;
- 12.5% (n=10) respondents disagreed with this statement;
- 5.0% (n=4) respondents chose the neutral option;
- 80.0% (n=67) respondents agreed with this statement.

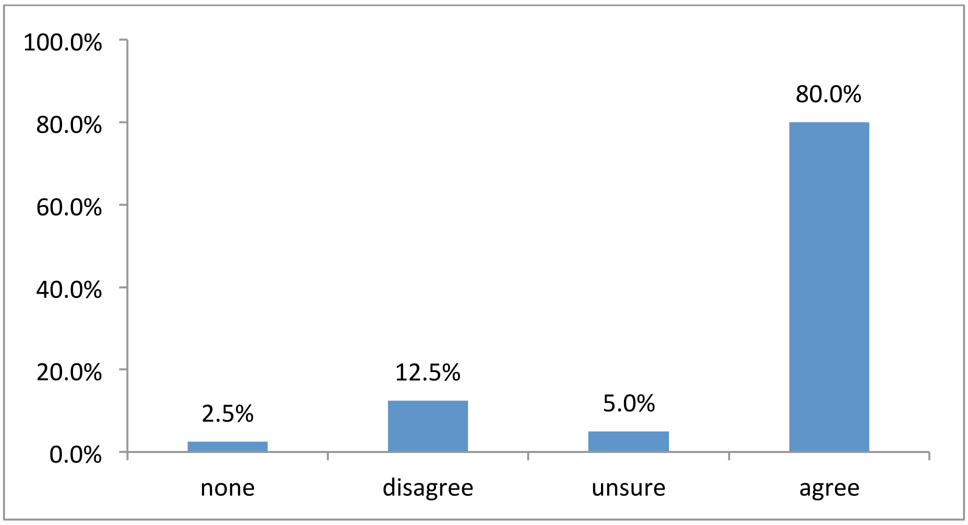

Figure 4.7 Frequencies obtained for risk of re-intubation

It is clear from the respondents that the majority (80%:n=74) **(Figure 4.7)** are familiar with the risks associated with extubation failure. In literature, re-intubation after premature extubation is associated with increased risk of nosocomial infection, prolonged hospital stay and death. However, delaying extubation in patients who have passed a weaning trial may increase morbidity and mortality due to prolonged mechanical ventilation

(Funk et al, 2010:88-94). The pros and cons of extubation need careful consideration. In literature, experts agree that if extubation is unsuccessful, or ventilator weaning is too aggressive and starts too early, it can result in setbacks with delayed weaning (Petterson, 2011:169).

Furthermore, according to Burns et al. (2000), aggressiveness in removing mechanical ventilation must be weighed against the chance that premature discontinuation may occur, including difficulty in re-establishing an artificial airway, compromised gas exchange, nosocomial pneumonia, ventilatory muscle fatigue and increased mortality (MacIntyre 2004, Ely et al. 2001, cited in Rose & Nelson, 2005: 74-75).

4.3.3.5 Complications associated with weaning

Respondents received the statement that weaning patients more quickly results in fewer complications such as VAP (ventilator associated pneumonia (**item Q11**). The correct response was agreed, which was chosen by the majority (83.8%: n=67) of respondents. The results obtained as reflected in **Figure 4.8** are as follows:

- 2.5% (n=2) respondents omitted this statement;
- 13.8% (n=11) respondents disagreed with this statement;
- 83.8% (n=67) respondents agreed with this statement.

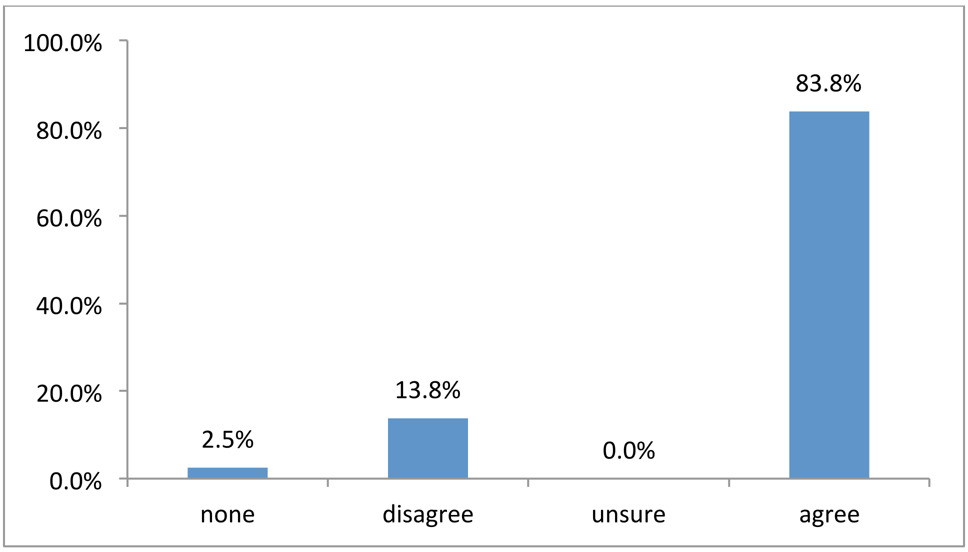

Figure 4.8 Frequencies obtained for complications associated with weaning

The majority of respondents (83.8%) **(Figure 4.8)** were in agreement with the notion of the urgency to liberate patients from mechanical ventilation, as according to literature, prolonged mechanical ventilation leads to longer length of stay in ICU and increased risk of mortality and complications (Penuelas et al, 2011: 430-437). In randomised control studies by Marelich et al, evaluating the effect of a ventilator weaning protocol, weaning protocols were associated with a 50% decrease in the incidence of ventilator-associated pneumonia (El Khatib & Bou –Khalil, 2008: 6).

Reducing the length of mechanical ventilation is associated with a reduction of ventilator-associated complications such as VAP (Marelich et al, 2000: 460). In further randomised control studies, removing the endotracheal tube as soon as possible was found to reduce the risk of ventilator induced lung injury, nosocomial pneumonia, airway trauma, unnecessary sedation and so on (MacIntyre, 2004: 830-836; Blackwood et al, 2011: 5).

4.3.3.6 Weaning protocols

This statement noted that the use of protocols shows no significant reduction in the time patients receive mechanical ventilation (**item Q12**). The correct response was disagreed, but only 17.5% (n=15) of respondents disagreed with this statement. **Figure 4.9** displays the obtained responses:

- 6.3% (n=5) respondents omitted this statement;
- 17.5% (n=15) disagreed with this statement;
- 22.5% (n=18) respondents chose the neutral option;
- 53.8% (n=43) respondents agreed with this statement.

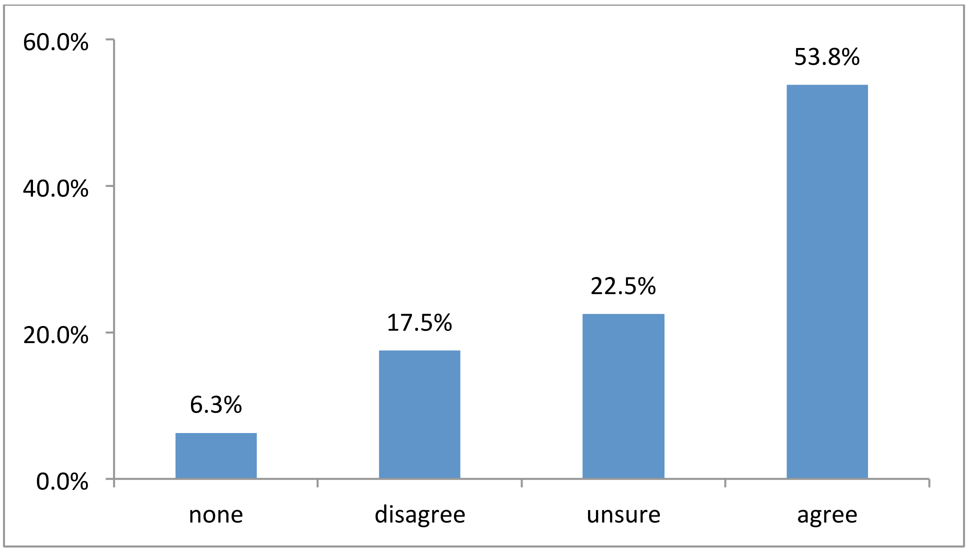

Figure 4.9 Frequencies obtained for use of weaning protocols

There is strong evidence that protocols driven by non-physician clinicians had better results than control patients managed with standard care (Blackwood et al, 2011:17). The minority of respondents (17.5%) in this study agreed that protocol patients were liberated from the ventilator earlier (**Figure 4.9**). In randomised control studies by Kollef, non-physician led protocols reduced the average duration of mechanical ventilation by 30 hours (MacIntyre, 2004: 830-836).

In addition, protocols have been found to be effective and efficient in providing ventilator support and timely weaning, resulting in a reduction in mechanical ventilation due to clinicians being able to recognise the patient's ability to breathe earlier, resulting in ventilator support being reduced faster (Rose & Nelson 2006:76). Conversely, a study by Krishnan et al, 2004, found the use of protocols in organisational settings or ICU's, where there are adequate numbers of skilled and trained staff with intensivists such as in Australia, protocols resulted in no difference in the length of mechanical ventilation, in contrast to the reductions found in other studies conducted in North America (Rose et al, 2007:434- 442).

4.3.3.7 Failed weaning attempts

This statement noted that a patient receiving prolonged ventilator support is not considered ventilator dependent until at least three attempts at weaning have failed **(item Q13).**

The correct response was agreed, but only 43.8% (n=35) respondents agreed with this statement. **Figure 4.10** displays the obtained responses:

- 5.0% (n=4) respondents omitted this statement;
- 33.8% (n=27) respondents disagreed with this statement;
- 17.5% (n=14) respondents chose the neutral option;
- 43.8% respondents agreed with this statement.

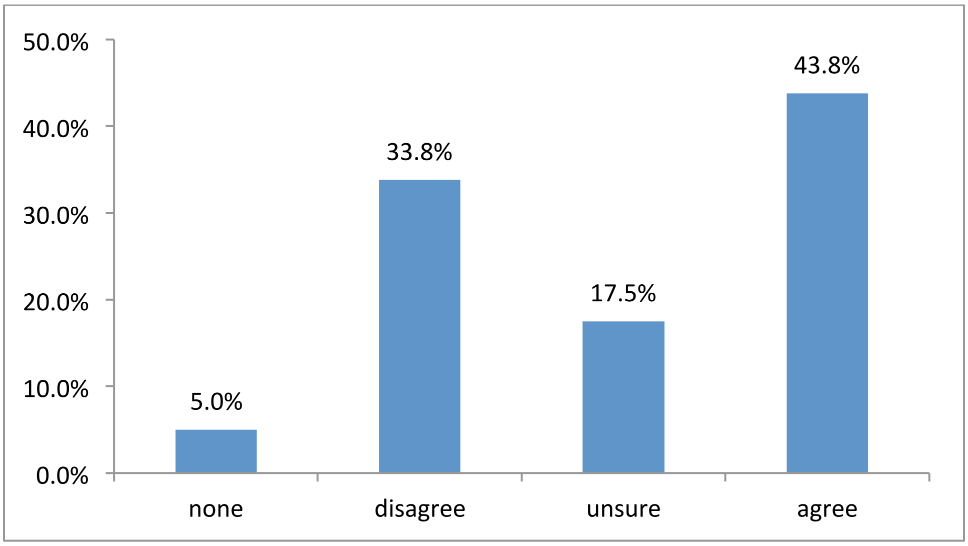

Figure 4.10 Frequencies obtained for failed weaning attempts

According to literature, unless there is evidence for clearly irreversible disease (e.g. high spinal cord injury, amyotrophic lateral sclerosis), a patient needing extended ventilatory support should not be considered permanently ventilator dependent until three months of weaning attempts have been made (MacIntyre el al, 2001, cited in Haas, 2012: 1651). This notion and the idea of prolonged weaning were concurred with by 43.8% of respondents **(Figure 4.10)** (Brochard, 2013: 3014-319). Simple weaning applies to patients who proceed from the discontinuation process to successful extubation on the very first attempt, difficult weaning refers to patients who fail the first tries at discontinuation and need as many as three SBT or seven days from the first SBT to successfully be removed from the ventilator, whilst prolonged weaning refers to patients who fail at least three discontinuation attempts or need more than seven days of discontinuation attempts after the first attempt (Hess, 2011: 392).

4.3.4 Section D: Weaning Methods

Section D focused on respondent's knowledge of weaning methods (**Appendix A**). The list of seven questions (**Q14** to **Q20**) required Intensive Care nurses to respond to a rating scale giving them the options from strongly disagree to strongly agree. Items were combined to form coherent groups to facilitate discussion of data. The results for this section are discussed below.

4.3.4.1 Reducing ventilator support

Respondents were given the statement that guidelines for reducing ventilator support may be abrupt, for example a spontaneous breathing trial on a T-piece, or gradual, such as intermittent mechanical ventilation with reductions in ventilator rate (**item Q14**). The most correct response was agreed, which only 33.8% (n=27) of the respondents concurred with. The results as illustrated in **Figure 4.11** are as follows:

- 11.3% (n=9) of respondents omitted this statement;
- 22.5% (n=18) of respondents disagreed with this statement;
- 32.5% (n=26) of respondents chose the neutral option;
- 33.8% (n=27) of respondents agreed with this statement.

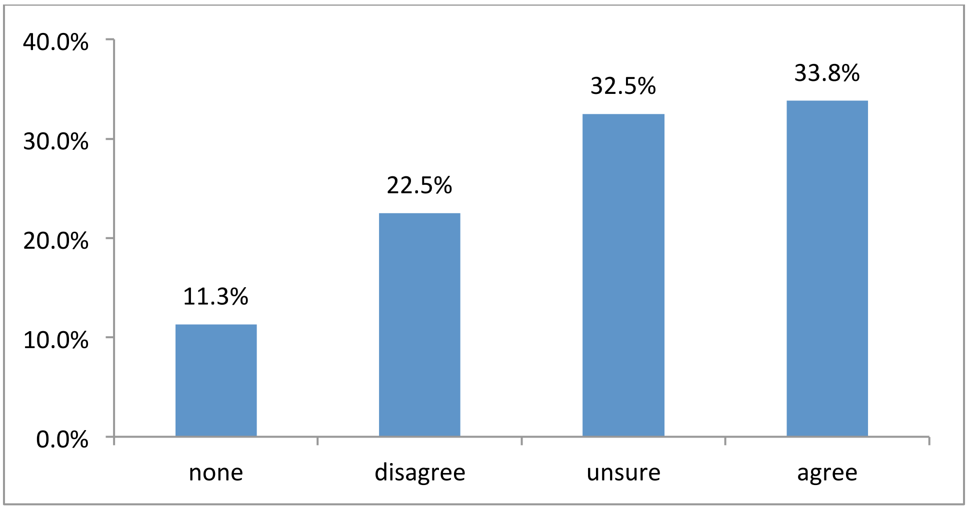

Figure 4.11 Frequencies obtained for reducing ventilator support

The goal of weaning is to reduce the support given by the ventilator and enable the patient to resume the task of breathing. More than half (55.5%) of respondents **(Figure 4.11)** disagreed or were unsure that reducing ventilator support may be rapid, with the patient undergoing a short trial of spontaneous breathing and then being extubated gradually, with slow decrements in support given by the ventilator (Rose & Nelson, 2006: 74). From this, it can be surmised this sample of nurses regard gradual weaning as safer, possibly knowing the risks associated with extubation and that re-intubation is associated with an increased risk of mortality (Perren & Brochard, 2013: 3014-9).

4.3.4.2 Least frequently used methods of weaning

This question stated that pressure support and T-Piece trials used at several intervals daily are the least frequently used methods of weaning **(item Q15).** The most correct answer was disagreed, which was given by 46.3% (n=37) of the respondents as reflected below and in **Figure 4**.12.

- 3.8% (n=3) of respondents omitted this statement;
- 46.3% (n=37) of respondents disagreed with this statement;
- 23.8% (n=19) of respondents chose the neutral option;
- 26.3% (n=21) of the respondents agreed with this statement.

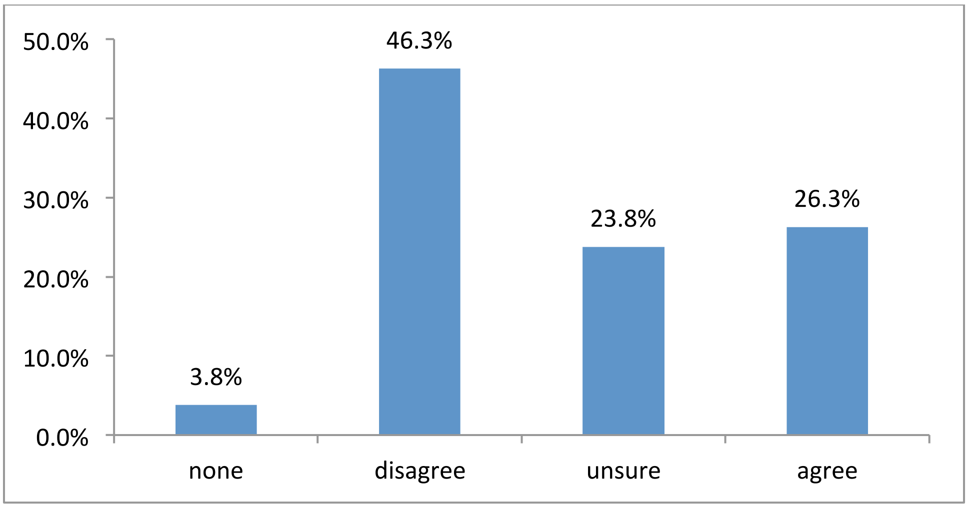

Figure 4.12 Frequencies obtained for least frequently used methods of weaning

According to literature, randomised control trials showed once-daily trials of spontaneous breathing led to extubation three times more quickly than intermittent mandatory ventilation and twice as quickly as pressure support ventilation. Once daily trials of spontaneous breathing versus multiple trials yielded no significant differences and intermittent mandatory ventilation and pressure support ventilation did not have significant results (Esteban et al, 1995:349). Therefore, it can be surmised that the majority of respondents (46.3%) **(Figure 4.12)** are more familiar with the pressure support and T-piece trials as a more frequently used method of weaning, versus the once daily trials.

4.3.4.3 Notification for extubation

Respondents received a statement that the physician should be informed the patient is ready for extubation when he/she passes a daily spontaneous two hour breathing trial on CPAP 5cm H_2O **(item Q16).** The correct response to this question was agreed, which was given by 68.5% (n=55) of the respondents. The results as illustrated in **Figure 4.13** are as follows:

- 7.5% (n=6) of respondents omitted this statement;
- 18.5% (n=15) of respondents disagreed with this statement;
- 5.0% (n=4) of respondents chose the neutral option;
- 68.5% (n=55) of respondents agreed with this statement.

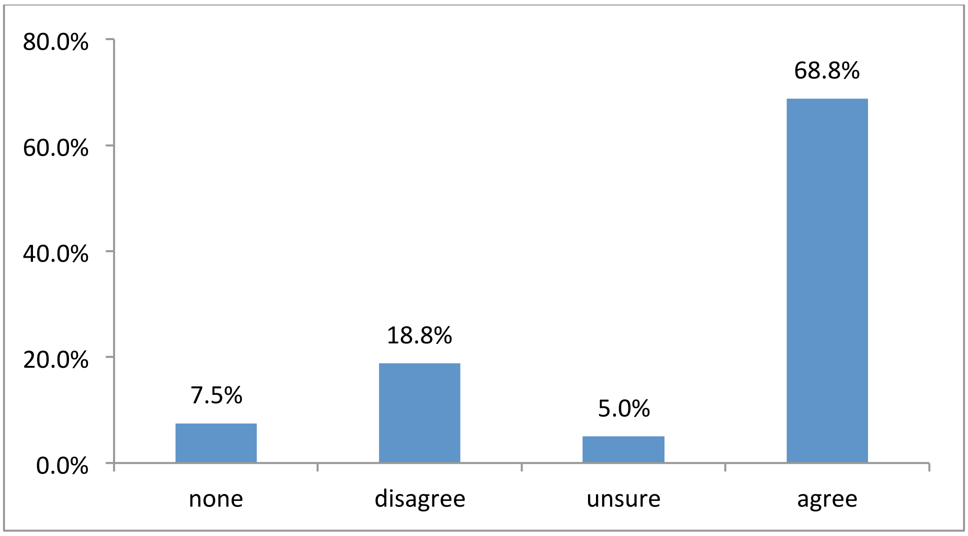

Figure 4.13 Frequencies obtained for notification for extubation

A clear majority of respondents (68.8%) **(Table 4,4)** were in agreement with evidence based guidelines that a once daily trial of spontaneous breathing allowed faster weaning than other methods offering partial ventilatory support. Therefore a patient's ability to breathe spontaneously only needs a trial once daily (Esteban et al, 1995:349). A 2 hour SBT on CPAP 5cm H_20, and notifying the physician is recommended if the SBT is successful (Blackwood et al, 2011: 18). Ely et al , (cited in Grap et al, 2003: 455) also found that daily screening of patient's respiratory function and spontaneous breathing trials and notification of the patient's physician when the trials were completed, reduced the duration of mechanical ventilation as well as the cost of intensive care. It can be extrapolated from the results that most respondents 68.8% (n=55) are aware that extubation needs to be expedited once a patient tolerates a breathing trial successfully.

4.3.4.4 Spontaneous breathing trial

Respondents received a statement that a spontaneous breathing trial of 30 to 60 minutes on CPAP, 5 cm H_2O, pressure support 6 cm H_2O is considered as a weaning indicator (**item Q17**). The correct response to this statement was agreed, given by 45.0% (n=36) of the respondents. The results are as follows and are graphically represented in **Figure 4.14.**

- 7.5% (n=6) of respondents omitted this statement;
- 31.3% (n=29) of respondents disagreed with this statement;
- 11.3% (n=9) of respondents chose the neutral option;
- 45.0% (n=36) of respondents agreed with this statement.

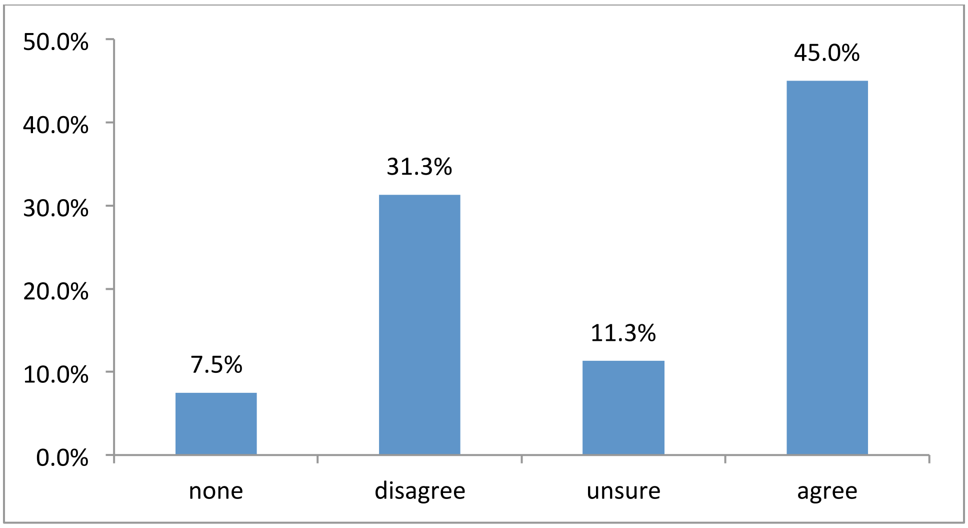

Figure 4.14 Frequencies obtained for spontaneous breathing trials

According to literature, a spontaneous breathing trial with a T-piece, CPAP or PSV should be carried out for 30 to 120 minutes to test readiness for liberation from the mechanical ventilator. Some studies recommend the use of 5cm to 7cm H_20 of pressure support to offset the work of breathing, which is caused by the ventilator circuit and endotracheal tube ((El Khatib & Bou –Khalil, 2008: 4). More than one third **(Figure 4.14)** of respondents disagreed with these criteria as predictors for extubation. In randomised control trials, the duration of a spontaneous breathing trial ranged from 30 to 120 minutes through a T tube or ventilator circuit with continuous positive airway pressure ranging from 2cm to 5 cm H_2O, with or without pressure support of 6cm or 7 cm H_2O (Blackwood et al, 2011:6). The inference is that respondents are perhaps familiar with other methods as criteria for extubation.

4.3.4.5 Respiratory muscle rest

Respondents received a statement that respiratory muscle rest does not occur during the mandatory breath delivery of SIMV (**item Q18**). The most correct answer to this question was agreed. **Figure 4.15** illustrates the results as follows:

- 5.0% (n=4) of respondents omitted this statement;
- 32.5% (n=26) of respondents disagreed with this statement.
- 25.0% (n=20) of respondents chose the neutral option;
- 37.5% (n=30) of respondents agreed with this statement.

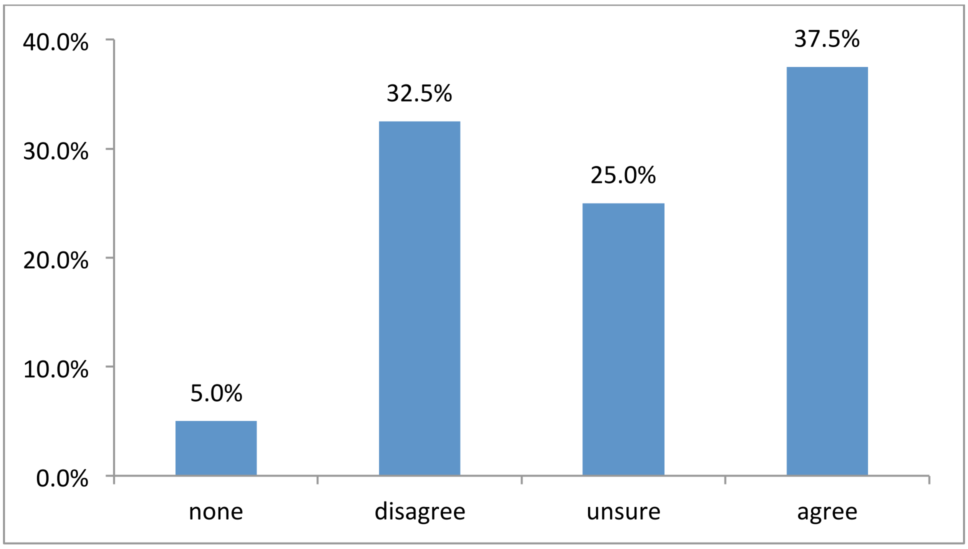

Figure 4.15 Frequencies obtained for respiratory muscle rest

Evidence shows that respiratory centre output and effort is no different during the mandatory breath delivery of SIMV and may in fact lead to muscle fatigue rather than periods of rest and exercise (Hess, 2003: 475:S). Randomised control trials have reported the poorest outcomes for this approach (Hess, 2011:392). Evidence indicates that respiratory sensor output does not affect breath-to-breath changes in respiratory load and intermittent mandatory ventilation may potentially cause the development of respiratory muscle fatigue (Esteban et al, 1995:348). It can be extrapolated that 37,5% **(Figure 4.15)** of respondents believe that SIMV gives the respiratory muscles a rest during mandatory breaths and works the muscles during spontaneous breaths, but this not supported by literature.

4.3.4.6 SIMV preferred weaning mode

Respondents received the statement that SIMV (synchronised intermittent mandatory ventilation) is the preferred weaning mode available (**item Q19**). The most correct response was disagreed. **Figure 4.16** illustrates the following results:

- 2.5% (n=2) of respondents omitted this statement;
- 70.6% (n=56) of respondents disagreed with this statement;
- 2.5% (n=2) of respondents chose the neutral option;
- 68.5% (n=55) of respondents agreed with this statement.

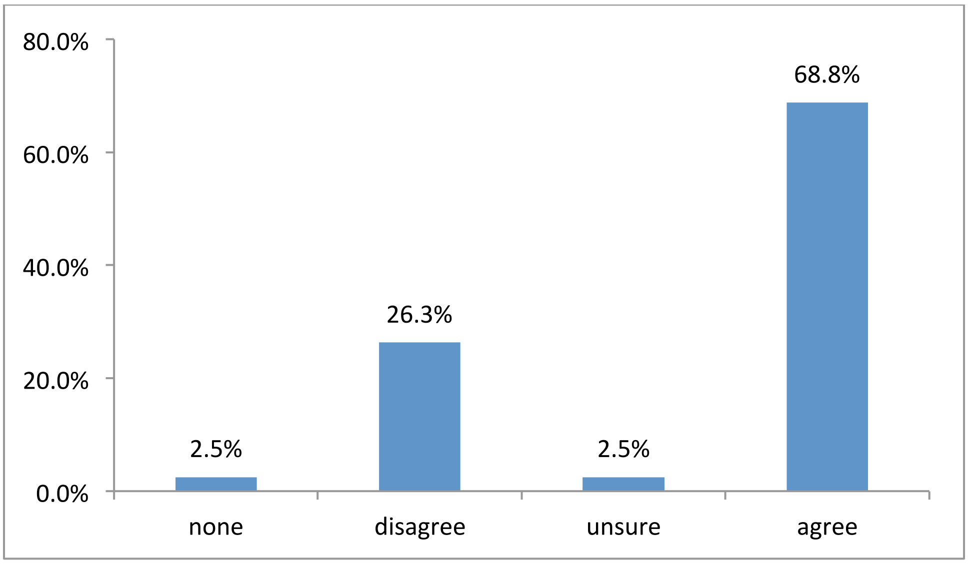

Figure 4.16 Frequencies obtained for SIMV as a preferred method of weaning

Literature states that a once-daily trial of spontaneous breathing led to extubation three times more quickly than intermittent mandatory ventilation and twice as quickly as pressure support ventilation (Esteban et al, 1995:349) Randomised control trials have reported the poorest weaning outcomes using SIMV (Hess, 2001: 474S). Further studies by Epstein found that SIMV delays the weaning process (Epstein, 2009: 39). The majority of respondents (68.8%) **(Figure 4.16)** believe SIMV to be the preferred weaning mode.

4.3.4.7 Other superior methods of weaning

Respondents received the statement that T-piece and pressure support ventilation are superior to SIMV as methods of weaning (**item Q20**). The most correct response was agreed. Figure 4.17 displays the results obtained:

- 2.5% (n=2) of respondents omitted this statement;
- 70.0% (n=56) of respondents disagreed with this statement;
- 8.8% (n=7) of respondents chose the neutral option;
- 18.8% (n=15) of respondents agreed with this statement.

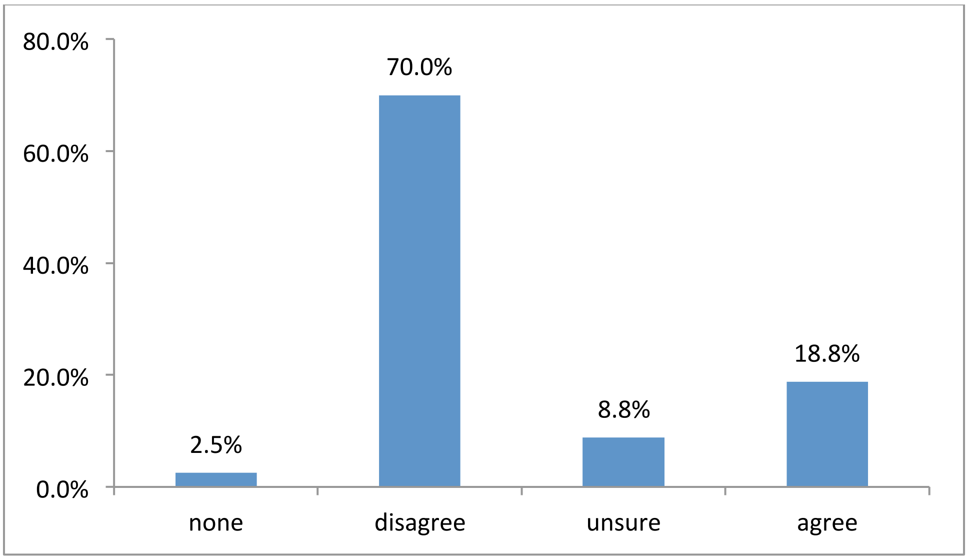

Figure 4.17 Frequencies obtained for other superior methods of weaning

Evidence based practice shows that studies by Esteban et al, comparing daily SBTs (and a constant level of support for those who failed SBT) to two other approaches using gradual support reductions, namely weaning with pressure support and intermittent mandatory ventilation, revealed daily spontaneous breathing trials with support in between SBTs, actually resulted in faster weaning (McIntyre, 2004: 833).

A systematic review of trials evaluating modes of weaning revealed that only using synchronised intermittent mandatory ventilation may in fact lead to more extended weaning than either T-piece or pressure support ventilation (Penuelas, 2011: 435).

From the results it can be seen that the majority of respondents (70%) **(Figure 4.17)** rely on SIMV as the preferred weaning method. According to literature, some people are reluctant to use the T-piece as patients have to work harder to breathe through the endotracheal tube (Vivar & Esteban, 2003:393; Esteban et al, 1997: 460). Therefore, some prefer using pressure support to counteract this, which is approximately 7cm H_2O to compensate for the work of breathing caused by the ventilator.

Additionally, it has been cited that up to 35% of patients are unable tolerate their first trial of spontaneous breathing and make the transition using T-tube, pressure support or SIMV (Vivar & Esteban, 2003: 393). It was also found in studies regarding extubation outcomes in spontaneous breathing trials, that 1% of patients successfully extubated after spontaneous breathing trials was 10% higher with pressure support of 7 cm versus T-piece, so it can be extrapolated that nurses' disagreement (70%) **(Figure 4.17)** could have been due the impression that T-tube trials can increase extubation failure rates (Esteban et al, 460: 1997).

4.3.5 Section E: Spontaneous Breathing Trial

Section E focused on spontaneous breathing trial for weaning the critically ill patient from mechanical ventilation (refer **Appendix A).** The respondents received eight questions (**items Q21** to **Q28**) of Likert-type statements where they were asked to choose their responses from a list ranging from strongly disagree to strongly agree. Items were combined to form coherent groups to facilitate the discussion of the data. The results of this section are discussed below.

4.3.5.1 Spontaneous breathing trial

Respondents were given the following statement. Patients managed with SBT, who can breathe without the assistance of the ventilator, are extubated more quickly than via gradual reductions in support (**item Q21**). Respondents were asked to what extent they agreed or disagreed with the statement. The most correct response was agreed, but only concurred with by 36.3% (n=29) of respondents. The following is a list of responses obtained as displayed in **Figure 4.18**.

- 7.5% (n=6) of respondents omitted this statement;
- 18.8% (n=15) of respondents disagreed with this statement;
- 37.5% (n=30) of respondents chose the neutral option;
- 36.3% (n=29) of respondents agreed with this statement.

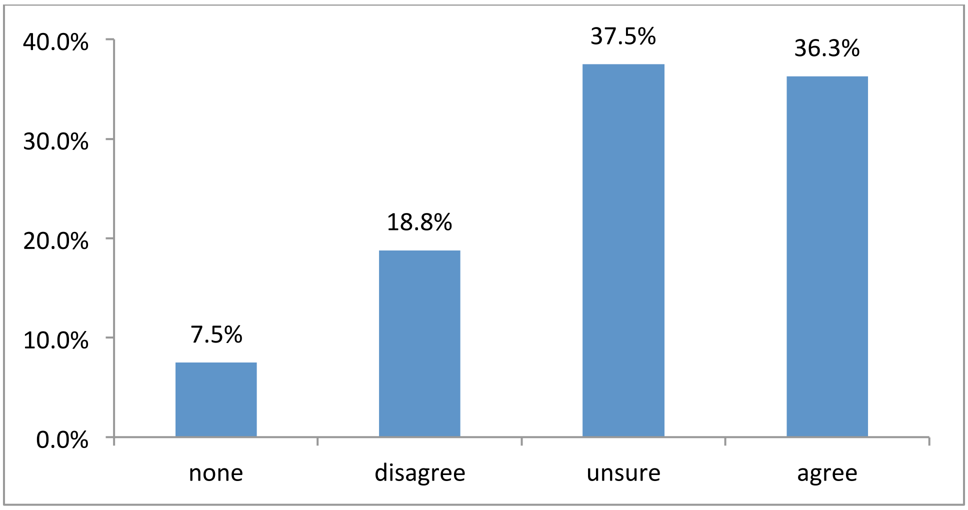

Figure 4.18 Frequencies obtained for spontaneous breathing trial

As cited in literature, the patient may experience a short trial of spontaneous breathing and if this is successful, then extubated, or the weaning process may instead be a gradual withdrawal with slow decreases in the level of support given by the ventilator (Rose and Nelson, 2006), cited in Lavelle & Dowling, 2011: 245). There are no studies definitively proving that respiratory muscle training, through the use of decremental ventilator support, speeds up the recovery to unassisted breathing. Only 36.3% of respondents **(Figure 4.18)** were in agreement that the gradual withdrawal of ventilatory support intended to slowly strengthen the muscles, is of unproven benefit and may in fact prolong mechanical ventilation (Manthous et al, 1998: 895).

There is no evidence supporting outcome benefits from gradual reduction of respiratory support in the literature (Hess, 2011; 2009). It is suggested that the ventilator discontinuation process should deal with treating the underlying disease process rather than manipulation of the ventilator settings (Hess, 2011:393). It can be surmised that respondents were influenced by their knowledge of the risks associated with unsuccessful extubation, as was found in studies overseas regarding nurse perceptions of strategies for weaning, where premature extubation can lead to patient deterioration and in some cases, their return to the ICU (Eckerblad et al, 2009: 229).

4.3.5.2 Inferior modes to SIMV

Respondents received the statement that once daily SBTs and pressure support are inferior modes to synchronised intermittent mandatory ventilation (SIMV) **(item Q22).** The most correct response was disagreed, but only 37.5% (n=14) of the respondents were correct as illustrated below and in **Figure 4.19**

- 13.8% (n=11) of respondents omitted this statement;
- 37.5% (n=30) of respondents disagreed with this statement;
- 31.3% (n=25) of respondents chose the neutral option;
- 17.5% (n=14) of respondents agreed with this statement.

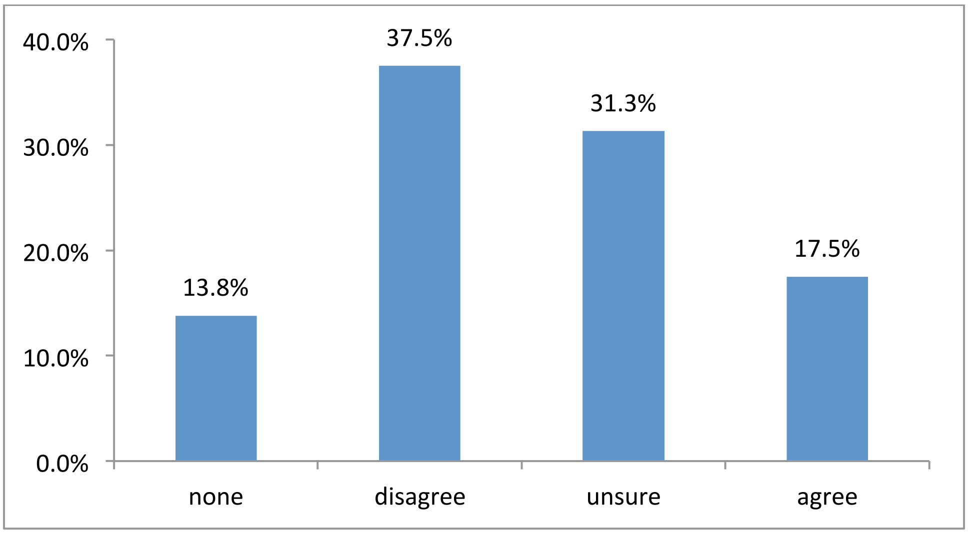

Figure 4.19 Frequencies obtained for inferior modes to SIMV

Daily SBTs rather than SIMV or PSV weaning has been recommended in several clinical practice guidelines since the publication of Esteban and colleagues' landmark trial (Girard & Ely, 2008: 241). SBTs are done in various ways, including T-piece breathing, low-level continuous positive airway pressure, low-level PSV, or manipulating the ventilator to flow-triggering with no pressure affecting the airway. In pressure-support weaning, the level of pressure support is gradually reduced over time. With weaning using SIMV, the mandatory rate setting on the ventilator is gradually reduced (Hess, 2001: 474S). There is some belief that respiratory muscle rest is dependent on the assistance of the ventilator, which could account for 68.8% **(Figure 4.19)** of respondents preferring SIMV.

However, evidence indicates that respiratory sensor output does not fluctuate with breath-to-breath changes in respiratory load and intermittent mandatory ventilation may actually cause the development of respiratory-muscle fatigue or prevent recovery from it (Esteban et al, 1995:348). Overall, there is strong support from literature for the use of PSV as a weaning mode after initial failed SBT, which may account for 47.8% of respondents being either unsure of disagreeing with PSV being an inferior mode. The use of PSV has proven to assist in liberating patients from mechanical ventilation after several failed attempts at spontaneous breathing. However, literature does not support the use of SIMV as a weaning mode by itself and little evidence exists for the use of SIMV and PSV combined (Boles, 2007:1043).

4.3.5.3 Multiple ventilator manipulations

Respondents were given the statement that multiple ventilator manipulations should be made in an effort to wean or train the patient **(item Q23).** The most correct response was disagreed, which 56.3% (n=43) of the respondents concurred with. The results are as follows:

- 3.8% (n=3) of respondents omitted this statement;
- 56.3% (n=45) of respondents disagreed with this statement;
- 21.3% (n=17) of respondents chose the neutral option;
- 18.8% (n=15) of respondents agreed with this statement.

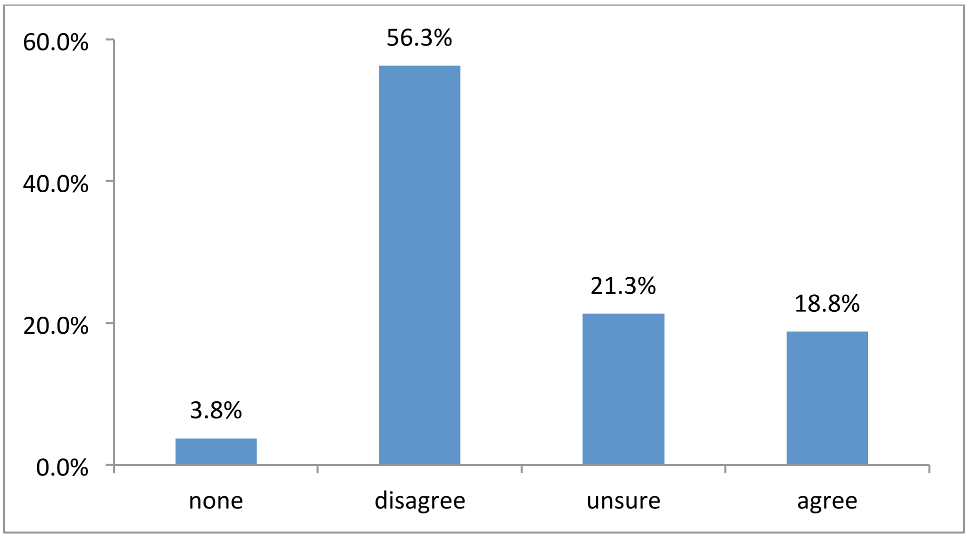

Figure 4.20 Frequencies obtained for multiple ventilator manipulations

According to the guidelines of Hess (2011), the ventilator discontinuation process needs to focus on treating the underlying disease process, rather than manipulation of the ventilator settings (Hess, 2011: 393). The majority of respondents (56.3%) agreed that multiple ventilator changes do not result in outcomes beneficial in weaning (**Figure 4.20**).

4.3.5.4 Other weaning modalities

This statement noted that spontaneous breathing trials can be safely performed using a T-piece, continuous positive airway pressure (CPAP) without pressure support, or with pressure support up to 7 cm H_2O and for durations of 30 minutes to two hours (**item Q24**). The most correct answer was agreed, but only 38.8% (n=31) responded correctly. **Figure 4.21** displays the following obtained responses**:**

- 6.2% (n=5) of respondents omitted this statement;
- 30.0% (n=24) of respondents disagreed with this statement;
- 25.0% (n=20) of respondents chose the neutral option;
- 38.8% (n=31) of respondents agreed with this statement.

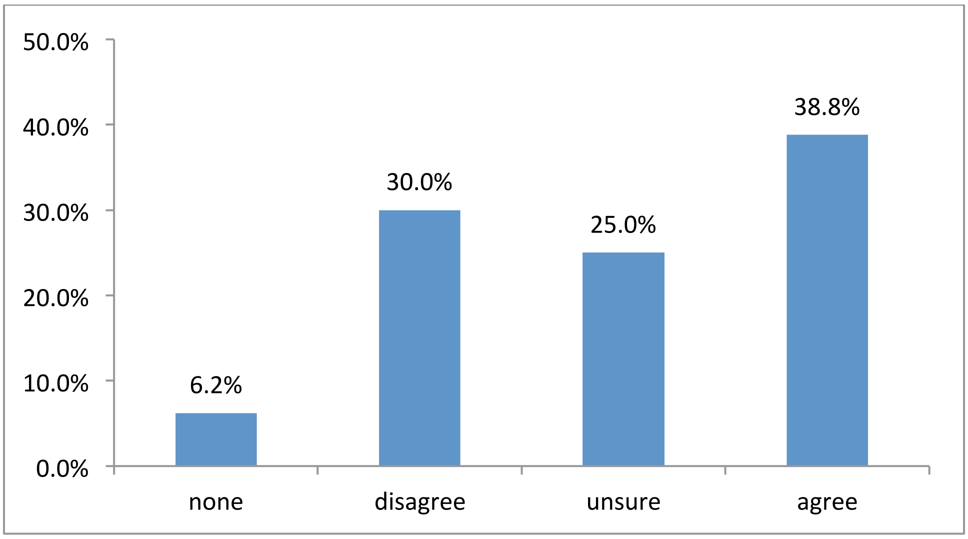

Figure 4.21 Frequencies obtained for other weaning modalities

In earlier literature, it was found SBT's can be conducted without positive pressure applied to the airway, with a low level (5cm H2O) of continuous positive airway pressure (CPAP) or a low level of PS volume – 5-8 cm H2O. Firstly, extubation readiness of the patient needs to be identified and a two hour spontaneous breathing trial is normally used to assess readiness, but studies have shown that 30 min breathing trials have produced similar outcomes (Esteban et al, 1995:349). In randomised control studies cited in Blackwood et al, the duration of SBTs ranged from 30 to 120 minutes, through a T-tube or ventilator circuit with continuous positive airway pressure (CPAP) ranging from 2cm to 5cm H20 with or without PS of 6cm or 7cm H20 (Blackwood et al, 2012: 10; Funk et al, 2010: 89). As cited in literature, different methods are available but 55% (**Figure 4.21**) of respondents in this study were unsure, possibly due to the fact that the duration of mechanical ventilation and weaning is variable, depending upon the individual condition of the patient and progress of the patient (Blackwood et al, 2009: 962).

4.3.5.5 Respiratory muscle fatigue and recovery

A failed trial can precipitate respiratory muscle fatigue and complete recovery from fatigue can take longer than 24 hours **(item Q25).** The correct response was agreed, but only 50.0% (n=40) of the respondents answered correctly. **Figure 4.22** displays the following obtained responses**:**

- 6.3% (n=5) of respondents omitted this statement;
- 20.0% (n=16) of respondents disagreed with this statement;

- 23.8% (n=19) of respondents chose the neutral option;
- 50.0% (n=40) of respondents agreed with this statement.

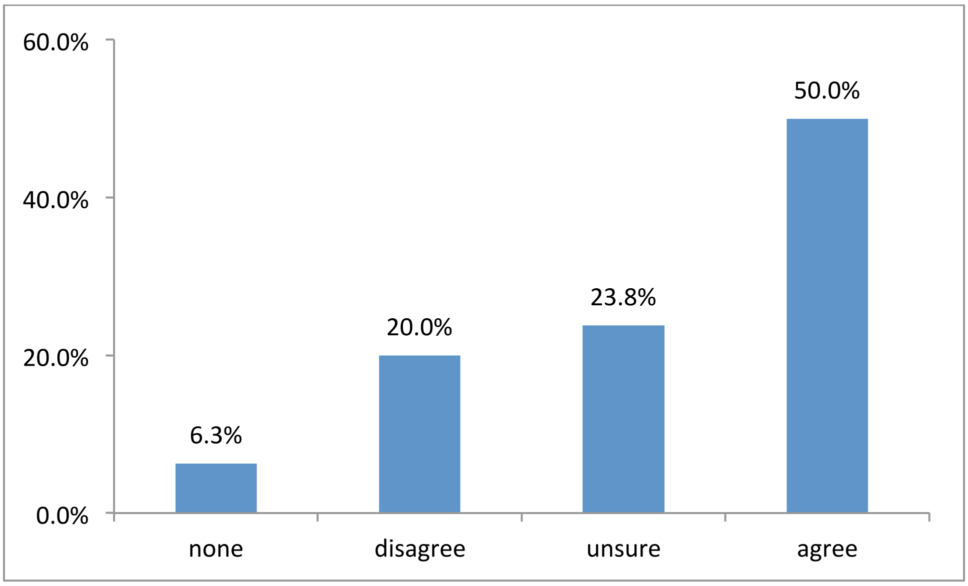

Figure 4.22 Frequencies obtained for respiratory muscle fatigue and recovery

According to literature, the majority of respondents (50%) **(Figure 4.22)** were in agreement with the notion that in the difficult to wean patient, the primary objective is to identify and treat possible causes for SBT failure, such as respiratory muscle weakness (Haas, 2012:1658). If the patient fails an SBT, the cause for failure should be determined. After reversing the cause for failure, if the patient then meets SBT criteria, SBTs should be carried out every 24 hours (Grade A evidence) (Haas, 2012:1651).

4.3.5.6 Multiple daily breathing trials

Respondents received a statement that multiple daily breathing trials offer no advantage over a once-daily trial **(item Q26).** The correct response was agreed, but only 12.5% (n=10) of the respondents responded correctly. F**igure 4.23** displays the following obtained responses:

- 10.0% (n=8) of respondents omitted this statement;
- 38.8% (n=31) of respondents disagreed with this statement;
- 38.8% (n=31) of respondents chose the neutral option;
- 12.5% (n=10) of respondents agreed with this statement.

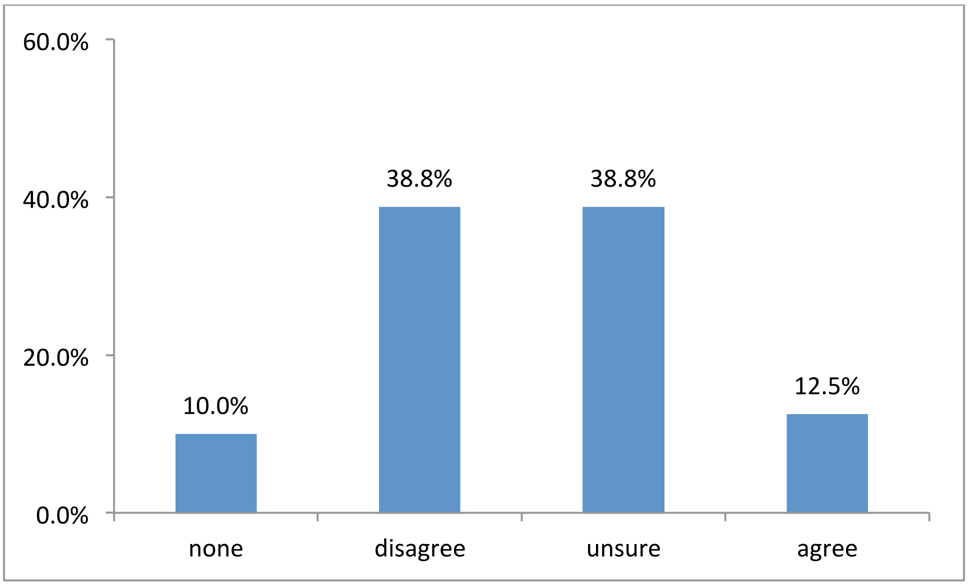

Figure 4.23 Frequencies obtained for multiple daily breathing trials

The majority of respondents (77.6%) **(Figure 4.23)** were either in disagreement or unsure regarding the benefit of once daily breathing trials.

A multi-society, evidenced based task force recommended a wean screen be used daily to identify mechanical supported patients who are ready to be weaned from the ventilator (Girard & Wesley, 2008). Once daily trials of spontaneous breathing versus multiple trials revealed no significant advantages over a once-daily trial and intermittent mandatory ventilation and pressure support ventilation did not have significant results (Esteban et al, 1995:349)(Esteban & Vivar, 2003:394). Typically, an SBT can last up to two hours but not much difference in outcome has been found regarding this between patients on an SBT for 30 to120 min (79,5% vs. 73%, P= 0.43) and if the trial fails, a waiting period of 24 hours is recommended before commencing the next trial versus multiple trials in one day (Esteban & Vivar, 2003:397).

4.3.5.7 Extubation failure prediction

Respondents received a statement that poor cough and greater secretions predict extubation failure **(item Q27).** The correct response was agreed and the majority 85.0% (n=68) of the respondents concurred. F**igure 4.24** displays the following obtained responses:

- 3.8% (n=3) of respondents omitted this statement;
- 11.3% (n=9) of respondents disagreed with this statement;
- 85.0% (n=68) of respondents agreed with this statement.

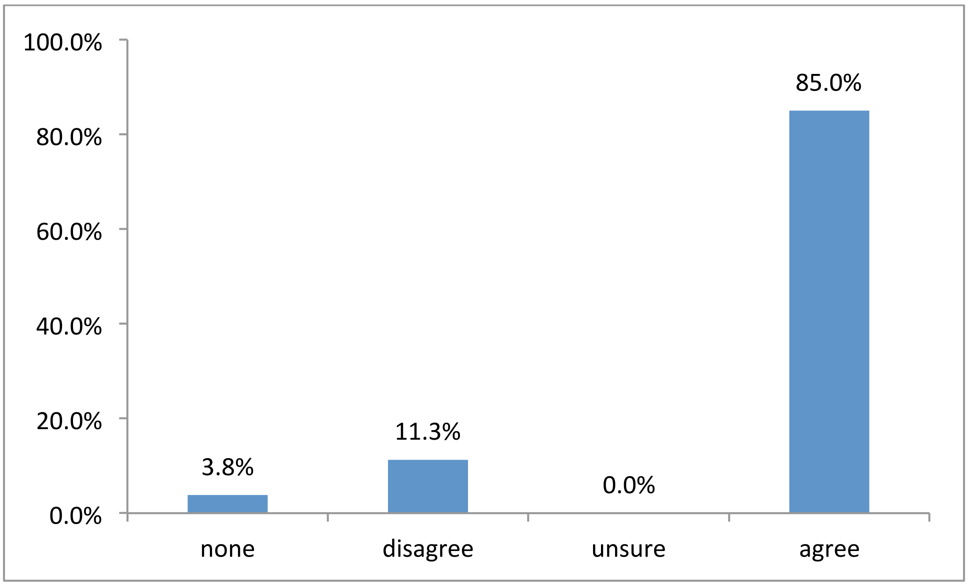

Figure 4.24 Frequencies obtained for extubation failure predictions

Factors associated with extubation failure include cough efficacy and amount of secretions (Thille, 2013; 60) and the majority of respondents (85%) in this study were clearly in agreement and aware of these predictors for weaning failure (**Figure 4.24**). Literature states that a weak cough and moderate amount of secretions (e.g. requiring suctioning everyone to two hours) are predictive of extubation failure (Haas, 2012: 1658). It can be surmised that respondents are familiar with clinically assessing the patient prior to extubation and assessing objective criteria including the patient's ability to cough (Burns, 2010:234).

4.3.5.8 Factors contributing to failure of SBT

Respondents received a statement that some of the factors contributing to the failure of spontaneous breathing trial include electrolyte imbalances, bronchospasm, patient positioning and malnutrition **(item Q28).** The correct response was agreed and the majority (78.8%: n=63) of the respondents responded correctly. F**igure 4.25 displays** the following obtained responses:

- 15.0% (n=12) of respondents disagreed with this statement;
- 78.8% (n=63) of respondents agreed with this statement.
- 6.3% (n=5) of respondents omitted this statement.

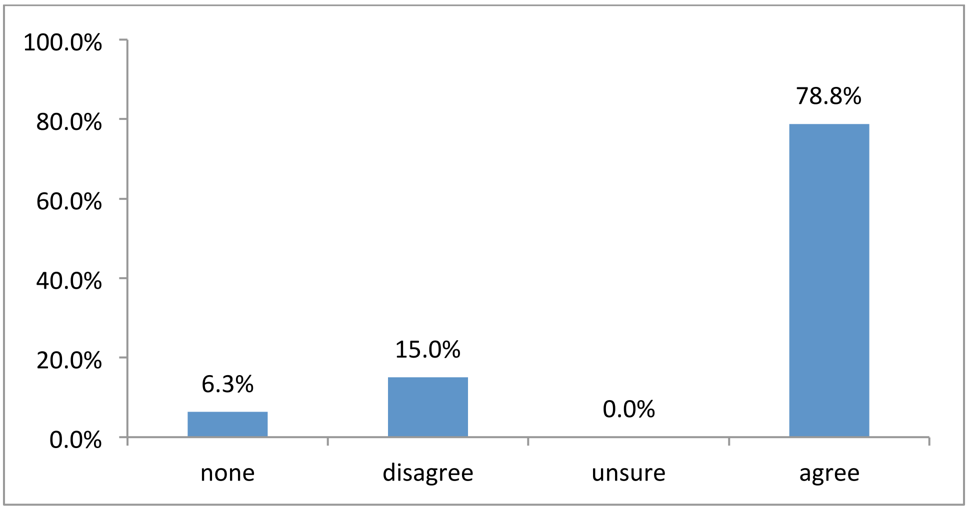

Figure 4.25 Frequencies obtained for factors contributing to failure of weaning

In this study **(Figure 4.25**), the majority of respondents (78.8%) agreed that common pathophysiologies affecting a patient's ability to wean from mechanical ventilation included: airway bronchoconstriction, malnutrition, metabolic disturbances, neuromuscular, e.g. metabolic alkalosis and malnutrition (Boles et al, 2007: 1036). General body strength, conditioning and endurance were also cited in weaning assessment criteria (Burns, 2010: 434). According to MacIntyre et al, the consideration of factors such as electrolyte imbalance, bronchospasm, malnutrition, patient positioning and excess secretions need to be rectified to enhance the chances of successful liberation from MV (MacIntyre, 2005: 454S).

4.3.6 Section F: Predictors for Weaning and Weaning Index

Section F focused on predictors for weaning and weaning index of the critically ill patient from mechanical ventilation (refer **Appendix A).** The respondents were given eight questions (**items Q29 to Q36**). The first question comprised a multiple-choice question, the other seven required the respondents to respond to Likert-type statements where they were asked to choose their responses from a list ranging from strongly disagree to strongly agree. Items were combined to form coherent groups to facilitate the discussion of the data. The results of this section are discussed below.

4.3.6.1 Use of laboratory results

The respondents were given a list of laboratory tests commonly used to assess metabolic factors when weaning a critically ill patient from mechanical ventilation **(item Q29).** The correct response was Q29 (a) ($PaCO_2$, base excess, serum K, serum phosphate, serum magnesium, serum Na, serum calcium). This response was selected by 17.5% of respondents.

Figure 4.26 displays the obtained results**:**

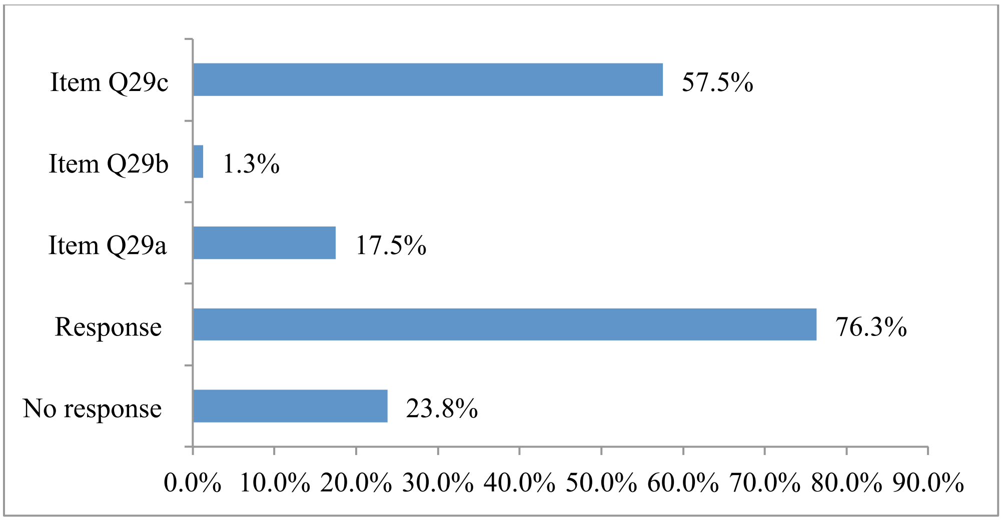

Figure 4.26 Frequencies obtained from nurse respondents for item 29

4.3.6.2 Physiological well-being of the patient

The respondents were given the statement, the physiological well-being of the patient and the presence of relatives, may affect weaning **(item Q30).** The most correct response was agreed, with 65.0% (n=44) of respondents responding correctly. **Figure 4.27 displays t**he following obtained responses:

- 3.8% (n=3) of respondents omitted this statement;
- 18.8% (n=15) of respondents disagreed with the statement;
- 22.5% (n=18) of respondents chose the neutral option;
- 65.0% (n=44) of respondents agreed with this statement.

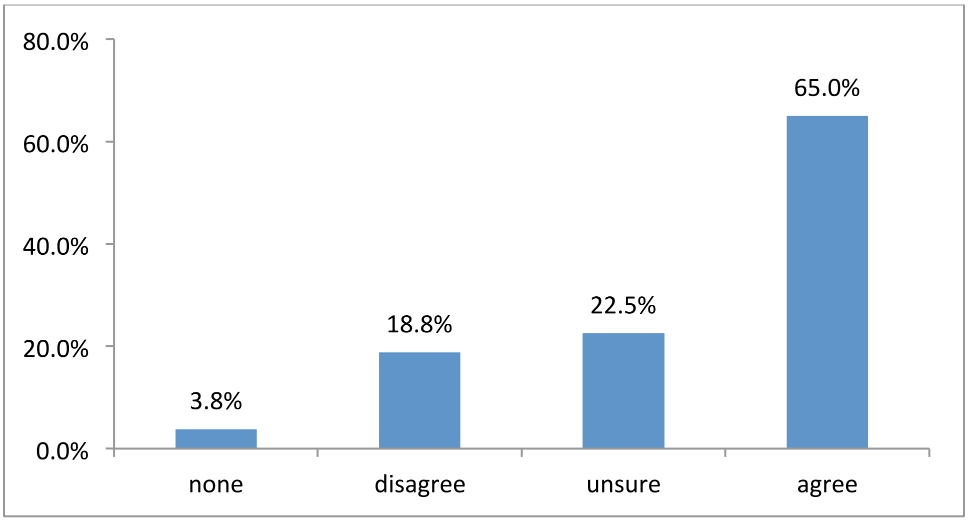

Figure 4.27 Frequencies obtained for physiological well-being of patients

According to evidence based guidelines, psychological support is important for patients being weaned during a spontaneous breathing trial (MacIntyre, 2004: 835). The majority of respondents (65%) were in favour of this (**Figure 4.27**). Literature also found that psychological factors might be essential for successful weaning in some patients. Jubran, (cited in Perren & Brochard, 2013: 3014-319) found a significant association between depressive disorders and failed weaning attempts, as well as with mortality. In addition, literature has reported that next of kin are important for nursing development as communication between the nurse and family helps the nurse gain understanding of the patient's physiological and psychological reserves and can achieve a balance between rest and work periods during weaning (Eckerblad et al, 2009: 226). It is clear from the responses to this question that most of the respondents are aware of the importance of the patient's mental status and family involvement in the success of weaning.

4.3.6.3 Readiness for weaning

Respondents received a statement that PaO_2/FIO_2 ratio should be equal or greater than 200 mmHg before you can wean the patient (**item Q31**). The correct response was agreed, but only 12.5% (n=10) of respondents answered correctly. **Figure 4.28 displays** the following obtained responses:

- 11.3% (n=9) of respondents omitted this statement;
- 23.8% (n=19) of respondents disagreed with this statement;
- 52.5% (n=42) of respondents chose the neutral option;
- 12.5% (n=10) of respondents agreed with this statement.

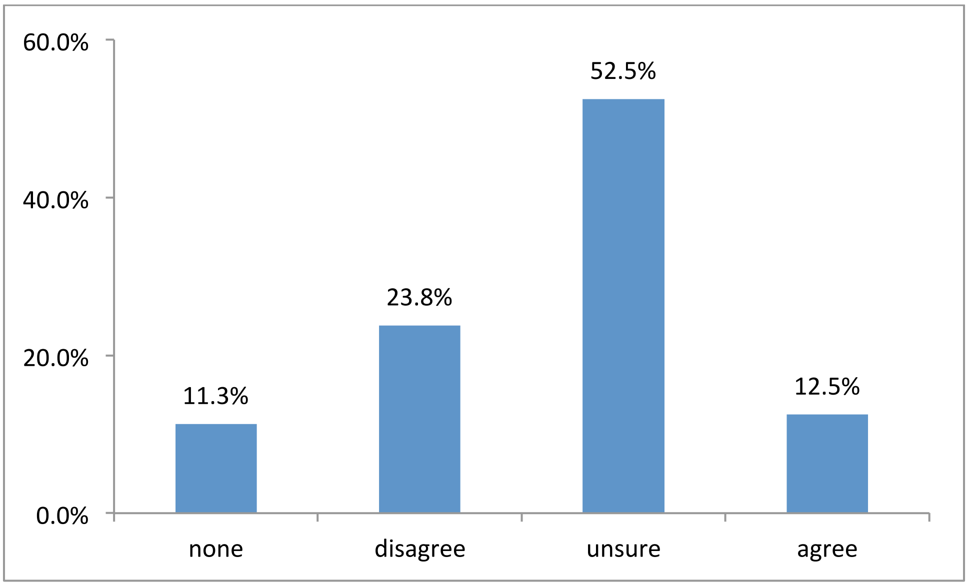

Figure 4.28 Frequencies obtained for readiness for weaning

From these findings (**Figure 4.28**), the majority of respondents were unsure (52.5%) if adequate oxygenation (eg, PaO_2/FIO_2 > 150–200 mm Hg) is a predictor for successful weaning, as found in evidence based studies and that patients should be given a formal assessment for discontinuation of mechanical ventilation if the following criteria are met: adequate oxygenation (e.g. PaO2/FiO_2 ratio >150 to 200, requiring positive end-expiratory pressure PEEP ≤5 to 8cm H_2O, $FiO_2 \leq$ 0.4 to 0.5) and pH (e.g. ≥ 7.25) (MacIntyre et al, 2002 (69-90) cited in Haas, 2012: 1651). It can be extrapolated that the majority of the sample were unfamiliar with this criteria, although this objective measure is a fundamental gauge of adequate oxygenation of a patient.

4.3.6.4 Use of respiratory parameters

The respondents received a statement that the patient should have a spontaneous tidal volume of more than 5ml/kg, PaO_2 greater than 60 mmHg, $PaCO_2$ less than 40 mmHg or baseline, with minute ventilation less than 10 litres per minute, low positive end expiratory pressure (PEEP at 5cm H_2O) and a FiO_2 less than 40% prior to weaning (**item Q32**).

The most correct response was agreed, with the majority (78.8%: n=63) of respondents responses being correct. F**igure 4.29 displays** the following obtained responses:

- 3.8% (n=3) of respondents omitted this statement;
- 8.8% (n=7) of respondents disagreed with this statement;
- 8.8% (n=7) of respondents chose the neutral option;
- 78.8% (n=63) of respondents agreed with this statement.

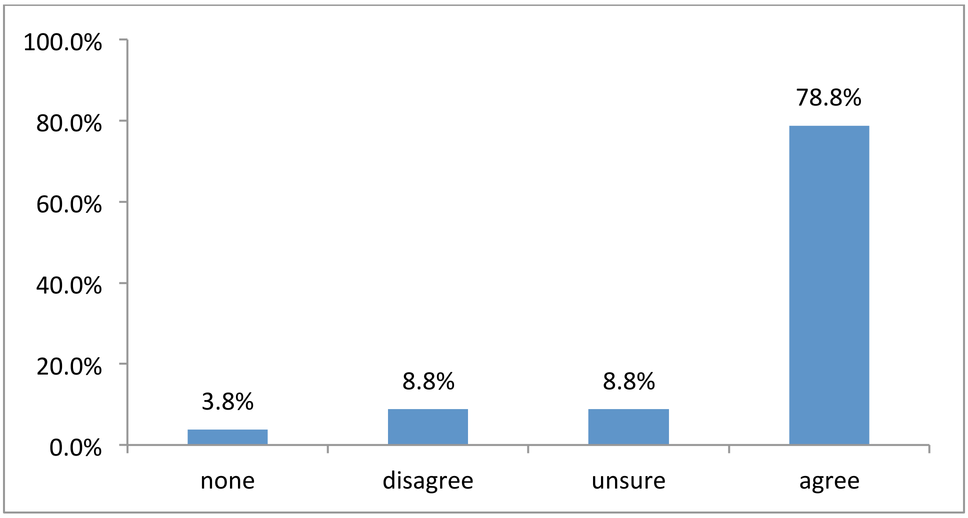

Figure 4.29 Frequencies obtained for use of respiratory parameters

Evidence based task force guidelines recommend adequate oxygenation: PaO_2 FiO2 > 150–200 mm Hg, required PEEP ≤ 5–8 cm H2O, FiO2 ≤ 0.4–0.5 and pH ≥ 7.25 prior to discontinuing weaning (MacIntyre 2004: 832). The patient should also have a spontaneous tidal volume >5 mL/kg, vital capacity >10 to 15 mL/kg, PaCO2 approximately 40 mm Hg (or baseline) with minute ventilation <10 L/min, PaO2 >60 mm Hg with fraction of inspired oxygen <40% (Burns et al, 2010:434). It is clear that these criteria resound positively with the respondents (**Figure 4.29**).

4.3.6.5 Presence of thick secretions

The respondents received a statement that a patient with copious amounts of thick secretions will improve with extubation (**item Q33**). The correct response was disagreed, but only 45.0% (n=36) of respondents answered correctly. F**igure 4.30** displays the following obtained responses**:**

- 3.8% (n=3) of respondents omitted this statement;
- 45.0% (n=36) of respondents disagreed with this statement;
- 11.3% (n=9) of respondents chose the neutral option;
- 40.0% (n=32) of respondents agreed with this statement.

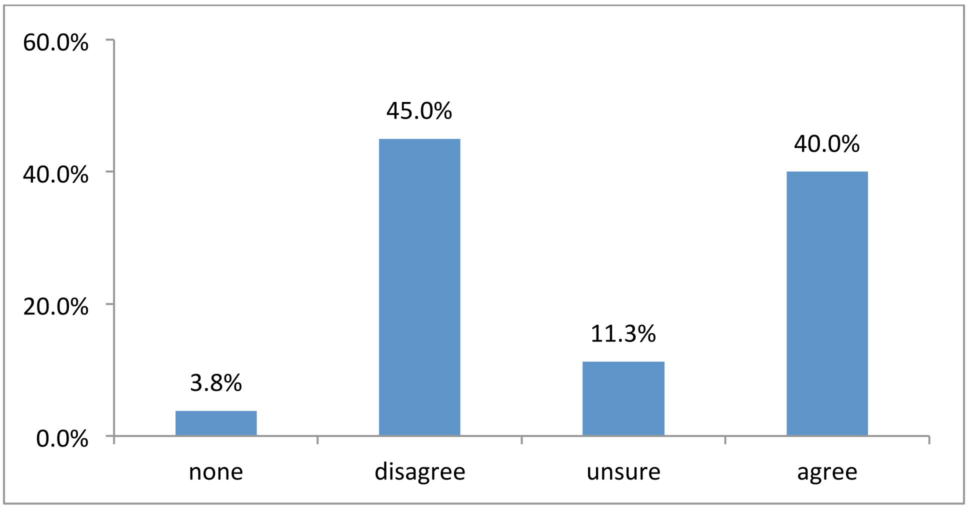

Figure 4.30 Frequencies obtained for presence of thick secretions

According to literature, amongst the most common reasons included for extubation failure are: upper-airway obstruction in the patient, failure to protect the airway and clear secretions (MacIntyre, 2004: 832). If a patient has copious secretions, it is a predictor for weaning failure. The ability of the patient to protect his/her airway and expel secretions by coughing, are considered important for extubation success. The quality of the cough can be examined on airway suctioning, as well as lack of excessive secretions or frequency of airway suctioning (MacIntyre, 2001:382S). Forty percent of respondents (**Figure 4.30**) were in agreement that a patient with copious thick secretions would not improve with extubation and would most likely precipitate extubation failure, whilst the majority (51.25%) believed secretions would improve on extubation.

4.3.6.6 Use of Dobutrex with haemodynamic instability

The respondents received a statement that a patient on Dobutamine greater than 5µ/kg/minute with haemodynamic instability can be weaned (**item Q34**). The correct response was disagreed, which 72.5% (n=58) of respondents answered correctly. F**igure 4.31** displays the following obtained responses:

- 3.8% (n=3) of respondents omitted this statement;
- 72.5% (n=58) of respondents disagreed with this statement;
- 2.5% (n=2) of respondents chose the neutral option;
- 21.3% (n=25) of respondents agreed with this statement.

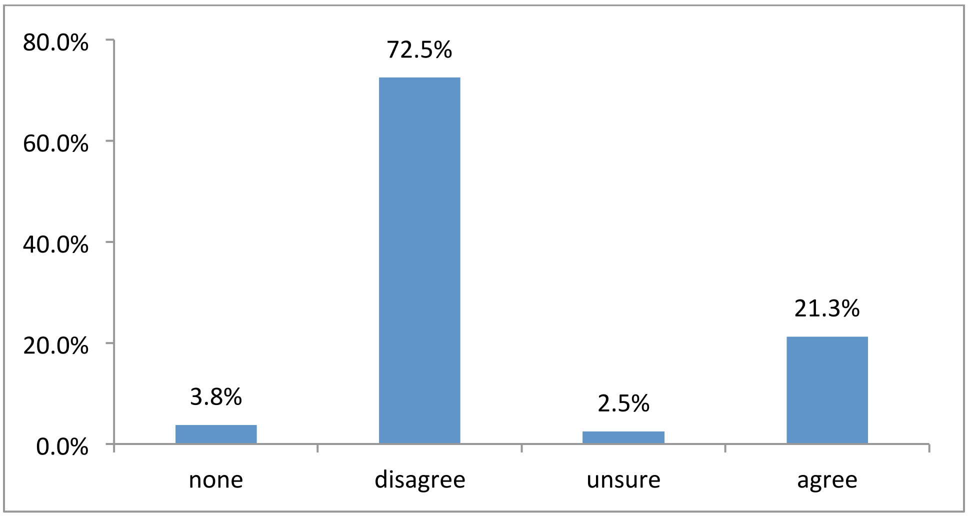

Figure 4.31 Frequencies obtained for use of Dobutrex with haemodynamic instability

According to literature, the following criteria would indicate a patient suitable for weaning: haemodynamic stability, no active myocardial ischemia, no clinically important hypotension (no vasopressors, low dose< 5 µg/kg/min dopamine or dobutamine are OK) and the majority of respondents were in agreement, whilst only 21,3% (n=17) agreed that they would wean a patient who was haemodynamically unstable (**Figure 4.31**), which is in agreement with the guidelines of MacIntyre et al., (2002:69-90) (cited in Haas, 2012: 1651).

4.3.6.7 Patients ability to initiate an inspiratory effort

The respondents received a statement that prior to weaning, the patient needs to initiate an inspiratory effort (**item Q35**). The correct response was agreed, with 92.5% (n=74) of respondents answering correctly. **Figure 4.32** displays the following obtained responses:

- 2.5% (n=2) of respondents omitted this statement;
- 2.5% (n=2) of respondents disagreed with this statement;
- 2.5% (n=2) of respondents chose the neutral option; and
- 92.5% (n=74) of respondents agreed with this statement.

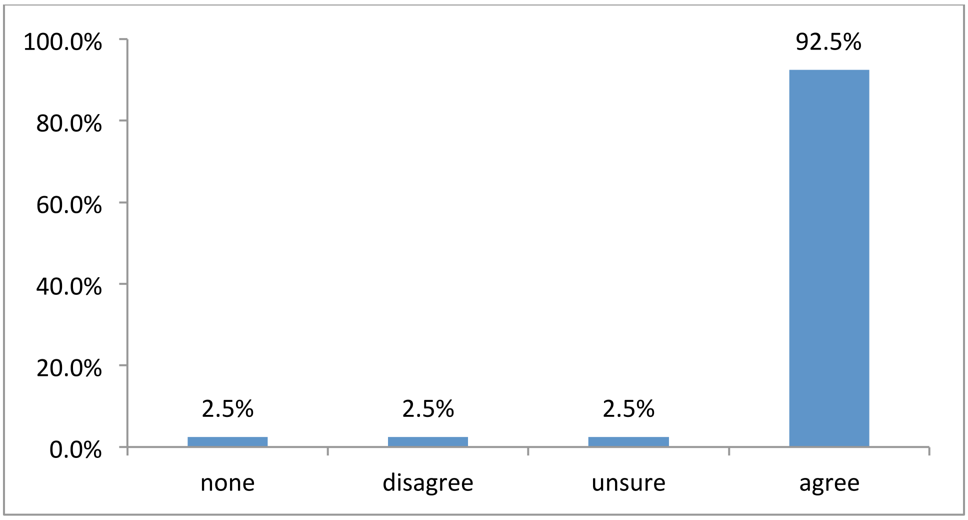

Figure 4.32 Frequencies obtained for patients ability to initiate an inspiratory effort

According to literature, it is necessary in any successful weaning attempt to minimise or temporarily stop sedation and analgesia sufficiently in order to observe patient awakening and assess their ability to spontaneously breathe (Ely et al, 2001: 462S). The majority of respondents (92.5%) were in agreement that spontaneous breathing needs to occur before extubation (**Figure 4.32**). The Burns Weaning Assessment Programme (a 26 factor weaning worksheet based on evidence based practice), recommended that eupneic respiratory rate and pattern (spontaneous respirations <25/min), no dyspnea and no use of accessory muscles) be part of the weaning protocol (Burns, 2010: 433).

4.3.6.8 Rapid shallow breathing index

The respondents received a statement that a RSBI (rapid shallow breathing index) calculated by frequency (*f*) divided by the tidal volume (VT) less than 105 is an indicator for weaning (**item Q36**). The correct response was agreed, but only 18.8% (n=15) of respondents answered correctly. **Figure 4.33** displays the obtained responses**:**

- 8.8% (n=7) of respondents omitted this statement;
- 15.0% (n=12) of respondents disagreed with this statement;
- 57.5% (n=46) of respondents chose the neutral option;
- 18.8% (n=15) of respondents agreed with this statement.

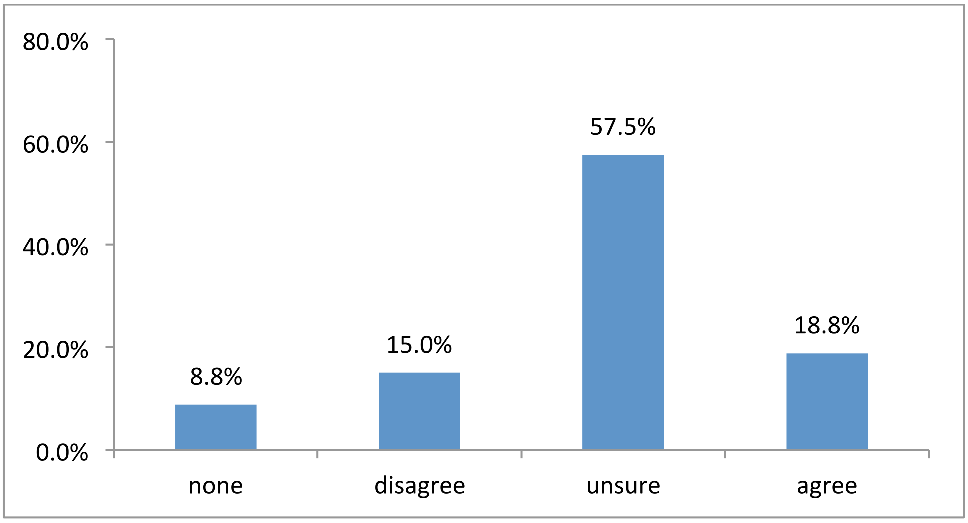

Figure 4.33 Frequencies obtained for use of rapid shallow breathing index

According to literature on weaning readiness assessment, the most often studied predictor is the rapid shallow breathing index. The ratio of respiratory rate to VT (f/VT, the rapid-shallow breathing index) is the most widely used weaning parameter and often used in protocols. This predictor is identified as having high sensitivity and specificity for predicting weaning success and is considered by the Evidence-Based Medicine Task Force of the American College of Chest Physicians to be a PaO_2/FiO_2 ratio greater than 150 (Rose & Nelson, 2005:75; Haas & Loik, 2012:1654). It can be surmised from the findings in this study (**Figure 4.33**) that this weaning criteria was not part of a weaning protocol familiar to the sample.

4.3.7 Section G: Weaning Protocols and Sedation

Section G focused on respondent's knowledge regarding the use of weaning protocols and sedation for weaning critically ill patients from mechanical ventilation (**Appendix A).** Respondents were given seven questions **(Q37 to Q40)** of Likert-type statements where they were asked to choose their responses from a list ranging from strongly disagree to strongly agree. Items were combined to form coherent groups to facilitate discussion of data. The results for this section are discussed below.

4.3.7.1 Implementation of weaning protocols

The respondents received the statement that the implementation of weaning protocols by nurses and physiotherapists leads to extubation more rapidly than physician-directed weaning **(item Q37).** The most correct response was agreed, which was given by 66.3% (n=53) of respondents. **Figure 4.34** displays the following obtained responses:

- 1.3% (n=1) of respondents omitted this statement;
- 16.3% (n=13) of respondents disagreed with this statement;
- 16.3% (n=13) of respondents chose the neutral option;
- 66.3% (n=53) of respondents agreed with this statement.

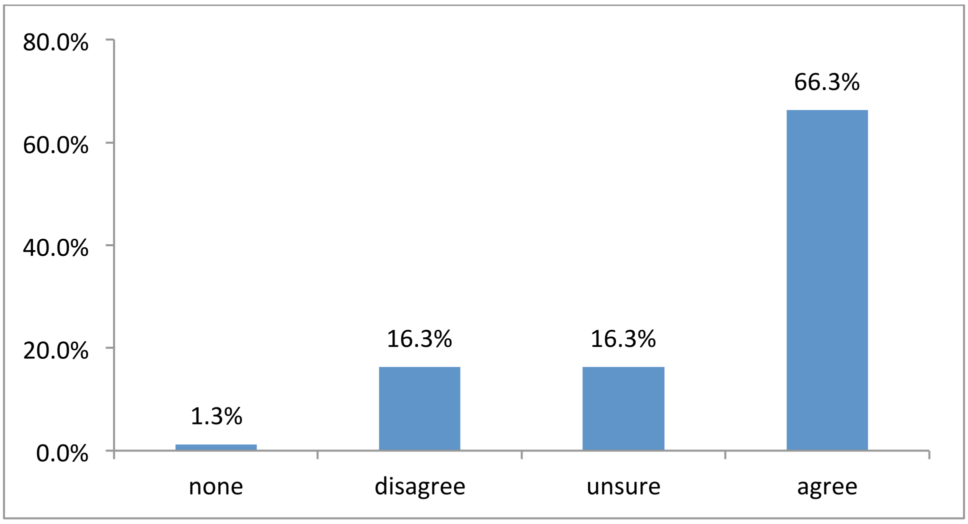

Figure 4.34 Frequencies obtained for implementation of weaning protocol

Weaning trial protocols used in randomised controlled trials by Ely et al and Kollef et al, (cited in Burns, 2004: 382) compared randomly assigned patients to protocol directed weaning conducted by nurses and therapists versus physician directed weaning. Both trials showed the superiority of the protocols in reducing time on the ventilator, ICU and hospital LOS, but not mortality. It may be that a high percentage (60.3%) **(Figure 4.34)** remained in disagreement, as it has been reported in studies overseas that many nurses do not feel confident to extubate, even on receiving a physician's order, being unconfident of their ability particularly in the absence of a physician (Lavelle & Dowling, 2011:245).

4.3.7.2 Use of sedation agent Propofol

The respondents were given a statement that Propofol is often used in ICU because of its rapid onset and offset of sedation (**item Q38**). The most correct response was agreed, but only 35.8% (n=29) of respondents answered correctly. **Figure 4.35** displays the following responses:**.**

- 1.3% (n=1) of respondents omitted this statement;
- 60.0% (n=48) of respondents disagreed with this statement;
- 2.5% (n=2) of respondents chose the neutral option;
- 35.8% (n=29) of respondents agreed with this statement.

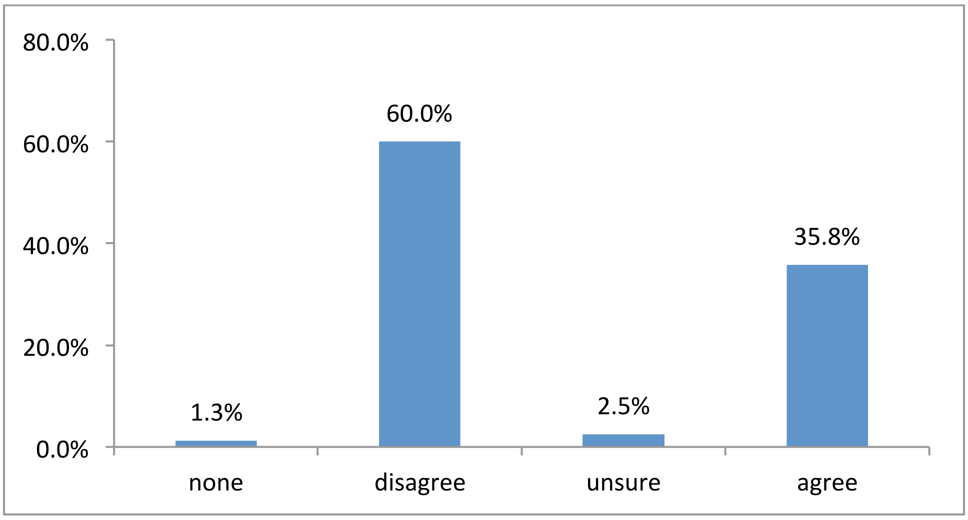

Figure 4.35 Frequencies obtained for use of sedation agent propofol

It can be surmised from these findings that only 35.8% of respondents answered correctly (**Figure 4.35**).

In evidence based studies (Rumke & Zimmerman, 2010; Kress et al. 2000; Goodman, 2006) to revise ventilator and sedation protocols, it was recommended that Propofol (Diprivan) should remain the number one sedative option for use in a weaning protocol, up to a maximum of 80mcg/kg/min (Rumke & Zimmerman, 2010). According to studies on sedation in mechanically ventilated patients, it was found "the concentration of Propofol in plasma declines rapidly after administration is discontinued" (Kress et al, 2000: 1476). In studies overseas this idea was supported and patients are given medication for discomfort, agitation, restlessness and so on, often to the point of being over-sedated but this can hinder weaning – therefore recommendations are: "sedation off or minimal, pain controlled, intact respiratory drive" (Goodman, 2006: 27).

4.3.7.3 Reducing patient anxiety

The respondents were given the statement that reducing patient anxiety and ensuring a good nights sleep, prior to weaning, using sedatives is recommended (**item Q39**). The correct response was agreed and 70.0% (n=56) of respondents answered correctly. **Figure 4.36 displays** the following responses:

- 2.5% (n=2) of respondents omitted this statement;
- 23.8% (n=19) of respondents disagreed with this statement;
- 3.8% (n=3) of respondents chose the neutral option;
- 70.0% (n=56) of respondents agreed with this statement.

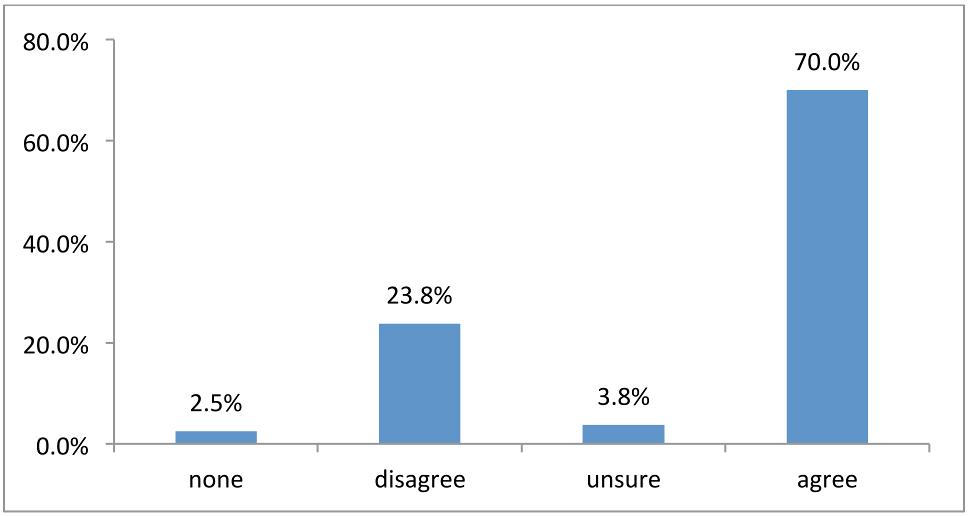

Figure 4.36 Frequencies obtained for reducing patient anxiety

From these findings, the majority (70.0%) of respondents answered correctly (**Figure 4.36**).

According to literature, the nurse weaning the patient needs to ensure the patient has sedation breaks by following the "wake up and breathe" protocol, where the patient initiates spontaneous breath prior to weaning. Conversely, the majority of respondents agree with evidence based guidelines recommending that the patient needs to be well rested to prevent fatigue before weaning (Ely et al ,2001: 462:S). According to the Richmond Agitation Sedation Scale (RASS), the patient needs to be assessed as to whether they are anxious or apprehensive and the use of sedatives is recommended to alleviate this (Grap et al, 2003: 457).

4.3.7.4 Daily interruption of sedation

The respondents were given the statement that daily interruption of sedation and sedation goals should be used to reduce the duration of mechanical ventilation and length of stay in the ICUs (**item Q40**). The correct response was agreed, but only 43.8% (n=35) of the respondents answered correctly. **Figure 4.37** displays the following responses:

- 5.0% (n=4) of respondents omitted this statement;
- 46.3% (n=37) of respondents disagreed with this statement;
- 5.0% (n=3) of respondents chose a neutral option;
- 43.8% (n=35) of respondents agreed with this statement.

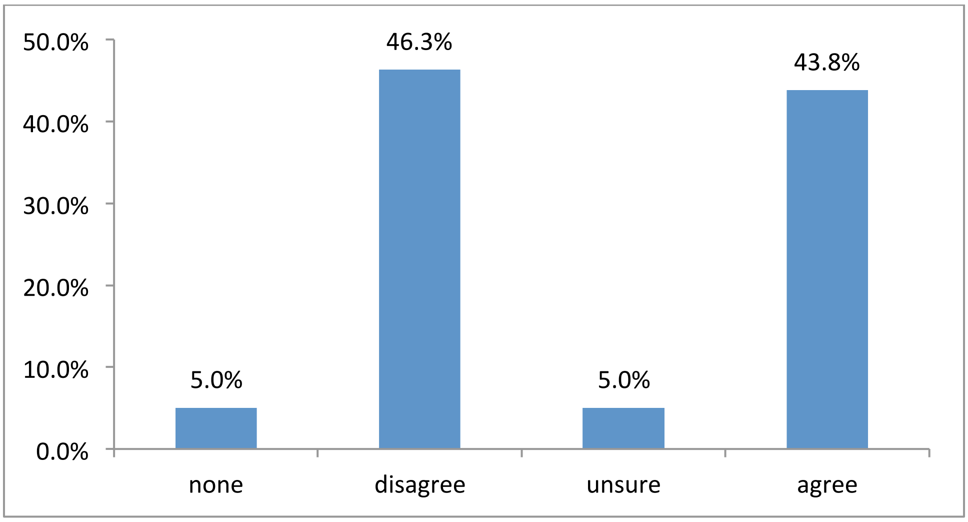

Figure 4.37 Frequencies obtained for daily interruption of sedation

It can be surmised from the results that a large portion of respondents disagreed (46.3%) that over-sedation can be problematic prior to extubation (**Figure 4.37**). While pain needs to be controlled, the patient should have an intact respiratory drive (Goodman, 2006:27). However, according to literature, shorter ventilation periods and length of stay in the Intensive Care Unit and hospital are associated with intermittent boluses of sedation and analgesia as opposed to continuous infusions. Daily interruption of infusions (sedation breaks) and assessment for weaning and a protocol combining daily sedation breaks with trials of spontaneous breathing is recommended (Blackwood et al, 2011: 12).

Daily interruption of continuous sedation infusions has been linked to enhanced patient outcomes, including decreased length and total number of ventilator days (Rumke & Zimmerman, 2010: 44). Furthermore, the daily interruption of the infusion of sedation is considered a safe and practical approach to treating patients, as it was found to reduce the duration of mechanical ventilation, the length of stay in the Intensive Care Unit and amount of sedation used (Kress et al, 2000:1476).

4.4 COMPARATIVE STATISTICS

Construct scores and questionnaire scores were of interest for further analysis to compare results with categorical variables. Based on an observed difference in the frequency distribution of knowledge scores for categories by setting, age, gender, years of ICU experience, qualification and clinical role, the questionnaire scores were then tested to determine whether they were significant or not. Collapsing of the Likert scale was done to facilitate presentation of the data, where 0 = less than 50% (<50%) total scores and 1 = greater than 50% (>50%) totals scores to test for differences in the population. The employment of Fisher's Exact Test was to proportionate the data by categorical variables.

Tables 4.3 to 4.6 present a summary of Fisher's Exact Test for comparison of frequency distribution of knowledge by categorical variables for weaning protocols, weaning methods, basic facts about weaning and spontaneous breathing.

Table 4.3 Summary of Fisher's Exact Test for frequency distribution of knowledge for selected demographic variables by weaning protocols

Category	Variable	<50%		>50%		Fisher's exact
		n	%	n	%	
Setting	Site A	27	62.79	13	35.14	0.024*
	Site B	16	37.21	24	64.86	
Age	No response	-	-	2	5.41	0.060
	27 - 29	-	-	2	5.41	
	30 – 39	14	32.56	6	16.22	
	40 - 49	19	44.19	13	35.14	
	50 - 59	10	23.26	14	58.33	
Gender	Male	3	6.98	6	16.22	0.181
	Female	38	88.37	31	83.78	
	No response	2	4.65	-	-	
Experience	No response	-	-	1	2.70	0.233
	<5	6	13.95	5	13.51	
	5 – 10	22	51.16	11	29.73	
	10 – 20	12	27.91	14	37.84	
	>20	3	6.98	4	10.81	
	5	-	-	2	5.41	
Qualification	No response	1	2.33	2	5.41	0.740
	Degree	7	16.28	7	18.92	
	Diploma	35	81.40	28	75.68	
Role	No response	2	4.65	-	-	0.003*
	Primary registered nurse	31	72.09	14	37.84	
	Shift leader	8	18.60	17	45.95	
	Clinical facilitator	1	2.33	2	5.41	
	Unit manager	1	2.33	4	10.81	

Key: *=statistical significance

Findings indicated that of the selected demographic categories, only two were statistically significant different for frequency distribution of knowledge scores **by weaning protocols**. Results for setting indicated the total score of > 50% (64.86%) was higher for site B study setting than the score for site A (35.14%), implying that >50% correct responses for site B is statistically (p=0.024) different from site A. Similarly, results indicated for role showed total scores of >50% (45.95%) was higher in shift leader than the score for primary nurse (37.84%), unit manager (10.81%) and clinical facilitator (5.41%), implying that >50% correct responses for shift leader is statistically (p=0.003) different from >50% correct responses for primary nurse, unit manager and clinical facilitator. **Table 4.3** summarises these results.

Table 4.4 Summary of Fisher's Exact Test for frequencies obtained for selected demographic variables by categories for weaning methods

Category	Variable	<50%		>50%		Fisher's exact
		n	%	n	%	
Setting	Site A	19	50.00	21	50.00	1.000
	Site B	19	50.00	21	50.00	
Age	No response	-	-	2	4.76	0.195
	27 - 29	-	-	2	4.76	
	30 – 39	8	21.05	12	28.57	
	40 - 49	15	39.47	17	40.48	
	50 - 59	15	39.47	9	21.43	
Gender	Male	5	13.16	4	9.52	0.503
	Female	33	86.84	36	85.71	
	No response	-	-	2	4.76	
Experience	No response	1	2.63	-	-	0.478
	<5	4	10.53	7	16.67	
	5 – 10	16	42.11	17	40.48	
	10 – 20	12	31.58	14	33.33	
	>20	5	13.16	2	4.76	
	5	-	-	2	4.76	
Qualification	No response	3	7.89	-	-	0.065
	Degree	4	10.53	10	23.81	
	Diploma	31	81.58	32	76.18	
Role	No response	-	-	2	4.76	0.003*
	Primary registered nurse	25	65.79	20	47.62	
	Shift leader	8	21.05	17	40.48	
	Clinical facilitator	-	-	3	7.14	
	Unit manager	5	13.16	-	-	

Key: *=statistical significance

Findings indicated that of the selected demographic categories, **only one was statistically significant (p=0.003)** for frequency distribution of knowledge scores **by weaning methods**. Results indicated >50% (47.62%) of total scores for primary nurse was higher than the score for shift leader (40.48%) and clinical facilitator (7.14%), implying that >50% correct responses for primary nurse is statistically significantly (p=0.003) different from shift leader and clinical facilitator. Results of this process are summarised in **Table 4.4.**

Table 4.5 Summary of Fisher's Exact Test for frequencies obtained for selected demographic variables by categories for basic facts about weaning

Category	Variable	<50%		>50%		Fisher's exact test
		n	%	n	%	
Setting	Site A	31	77.50	9	22.50	0.000*
	Site B	9	22.50	31	77.50	
Age	No response	-	-	2	5.00	0.008
	27 - 29	-	-	2	5.00	
	30 – 39	14	35.00	6	15.00	
	40 - 49	19	47.50	13	32.50	
	50 - 59	7	17.50	17	42.50	
Gender	Male	3	7.50	6	15.00	0.316
	Female	35	87.50	34	85.00	
	No response	2	5.00	-	-	
Experience	No response	1	2.50	-	-	0.175
	<5	5	12.50	6	15.00	
	5 – 10	21	52.50	12	30.00	
	10 – 20	11	27.50	15	37.50	
	>20	2	5.00	5	12.50	
	5	-	-	2	5.00	
Qualification	No response	1	2.50	2	5.00	0.046*
	Degree	11	27.50	3	7.50	
	Diploma	28	70.00	35	87.50	
Role	No response	-	-	-	-	0.000*
	Primary registered nurse	31	77.50	14	35.00	
	Shift leader	6	15.00	19	47.50	
	Clinical facilitator	-	-	3	7.50	
	Unit manager	1	2.50	4	10.00	

Key: *=statistical significance

Findings indicated that of the selected demographic categories, **three were statistically significant ($p<0.05$) for basic facts about weaning**. Results indicated >50% (77.50%) of scores for site B was higher than the score for site A (22.50%), implying that >50% correct responses for site B is statistically significantly ($p=0.000$) different than site A. Similarly, results indicated >50% (87.50%) of total scores for diploma was higher than the score for degree (7.50%), implying that >50% correct responses for diploma is statistically significantly ($p=0.046$) different for degree. Other results indicated >50% (47.50%) total scores for role in ICU was higher for shift leader than the score for primary nurse (35.00%), unit manager (10.0%) and clinical facilitator (7.50%), implying that >50% correct responses for shift leader is statistically significantly (p=0.000) different for primary nurse, unit manager and clinical facilitator. Results of this process are summarised in **Table 4.5.**

Table 4.6 Summary of Fisher's Exact Test for frequencies obtained for selected demographic variables by categories by spontaneous breathing trials

Category	Variable	<50%		>50%		Fisher's exact test
		n	%	n	%	
Setting	Site A	10	58.82	30	47.62	0.586
	Site B	7	41.18	33	52.38	
Age	No response	-	-	2	3.17	0.917
	27 - 29	-	-	2	3.17	
	30 – 39	5	29.41	15	23.81	
	40 - 49	8	47.06	24	38.10	
	50 - 59	4	23.53	20	31.75	
Gender	Male	-	-	9	14.29	0.227
	Female	17	100.00	52	82.54	
	No response	-	-	2	3.17	
Experience	No response	-	-	1	1.59	0.718
	<5	4	23.53	7	11.11	
	5 – 10	8	47.06	25	39.68	
	10 – 20	4	23.53	22	34.92	
	>20	1	5.88	6	9.52	
	5	-	-	2	3.17	
Qualification	No response	-	-	3	4.76	1.000
	Degree	3	17.65	11	17.46	
	Diploma	14	82.35	49	77.78	
Role	No response	-	-	2	3.17	0.545
	Primary registered nurse	12	70.59	33	52.38	
	Shift leader	4	23.53	21	33.33	
	Clinical facilitator	1	5.88	2	3.17	
	Unit manager	-	-	5	7.94	

Key: *=statistical significance

Findings indicated that of the selected demographic categories, no categories were statistically significant (p>0.05) for spontaneous breathing trials, implying that no significant difference was observed in the total scores. Results of this process are summarised in **Table 4.6**.

Table 4.7 Summary of Fisher's Exact Test for frequencies obtained for categories of years of ICU experience by selected construct variables

Category	Variables	Years of ICU experience				Fisher's Exact test
		<10 years		>10 years		
		n	%	n	%	
Weaning protocols	<50%	28	**65.12**	15	34.88	0.114
	>50%	17	45.95	20	**54.05**	
Weaning methods	<50%	21	**55.26**	17	44.74	1.000
	>50%	24	**57.14**	18	42.86	
Basic facts about weaning	<50%	27	**67.50**	13	32.50	0.071
	>50%	18	45.00	22	**55.00**	
Spontaneous breathing trials	<50%	12	**70.59**	5	29.41	0.271
	>50%	33	**52.38**	30	47.52	

Data were analysed to determine whether the difference indicated by the Fisher's Exact Test was statistically significant (p>0.05) for frequency distribution of knowledge scores between **years of experience categories**. Findings yielded in terms of **two categories** (<10 and >10) **of years of experience**, the **total scores >50% are equal**, implying that >50% responses for <10 years and >10 years of experience are **statistically not different** for weaning protocol, weaning methods, basic facts about weaning and spontaneous weaning trials. **Table 4.7** presents the results of this process**.**

Table 4.8 Summary of Fisher's Exact Test for frequencies obtained for categories of role in ICU by selected construct variables

Category	Variables	Role in ICU				Fisher's Exact test
		Primary nurse 1		Shift leader 2		
		n	%	n	%	
Weaning protocol	<50%	31	79.49	8	20.51	0.005*
	>50%	14	45.16	17	**54.84**	
Weaning methods	<50%	25	75.76	8	24.24	0.005*
	>50%	20	**54.05**	17	45.95	
Basic facts about weaning	<50%	31	83.78	6	16.22	0.000*
	>50%	14	42.42	19	**57.98**	
Spontaneous breathing trials	<50%	12	75.00	4	25.00	0.383
	>50%	33	61.11	21	38.89	

Data were analysed to determine whether the difference indicated by the Fisher's Exact Test was statistically significant ($p>0.05$) between **role in ICU categories**. Findings yielded in terms of two categories (1= primary nurse and 2=shift leader) of roles in ICU, three wer **statistically significant** ($p<0.05$) **for weaning protocol ($p=0.005$), weaning methods ($p=0.005$) and basic facts about weaning ($p=0.000$).** Results indicated for >50% (54.84%) scores showed that total scores for shift leader was higher than the score for primary nurse (45.16%), implying that >50% correct responses for shift leader is statistically significantly different from correct responses for primary nurse for weaning protocol. Similarly, results indicated for >50% (57.98%) scores for shift leader was higher than scores for primary nurse (42.42%), implying that >50% correct responses for shift leader is statistically significantly different from correct responses for primary nurse for basic facts about weaning. This **contrasts with results indicating >50% (54.05%) of scores for primary nurse was higher than the score for shift leader (45.95%)**, implying that >50% correct responses for primary nurse is statistically significantly different from correct responses from shift leader for weaning methods. Results of this process are summarised in **Table 4.7**.

4.5 SUMMARY

This chapter discussed the descriptive and inferential statistics used to describe and analyse the data collected and presented the interpretation of the findings. Generally, the study showed that nurses lack adequate knowledge on weaning the critically ill patient from mechanical ventilation, which was evident throughout the questionnaire and not only in isolated cases, so the results may be unambiguous.

The following chapter will discuss the limitations of the study, summary of research findings, conclusion and recommendations for further research.

CHAPTER FIVE

SUMMARY OF MAIN FINDINGS, RECOMMENDATIONS AND CONCLUSIONS

5.1 INTRODUCTION

The final chapter of the report presents a summary of the study, discussion of results and conclusion of the study. This is followed by a discussion of the limitations of the study and recommendations for clinical practice, nursing education and for further research in this area.

5.2 SUMMARY OF THE STUDY

Whilst mechanical ventilation can be life-saving, it also increases the risk of secondary injury including ventilator induced lung injury (VILI) and ventilator associated pneumonia (VAP). Once regarded as a slow and gradual process, current evidence shows that as soon as the cause of respiratory failure has been rectified, the patient is ready to be weaned from the ventilator. Prolonged hospitalisation due to mismanagement can lead to irreversible patient complications and even death. It follows that nurses' knowledge of evidence based practice regarding weaning the mechanically ventilated patient is essential, in order to expedite ventilator liberation as early as possible and minimise patient morbidity and mortality as well as cost of care (Burns, 2004: 379; Rose & Nelson, 2006:74).

Effective liberation is a step by step approach and this can be done rapidly, in minutes or hours, in patients who do well, or gradually over days, in patients who are moderately ill (Ely et al, 2001:454S). Assessment of weaning readiness, interruption of sedation infusions and spontaneous breathing trials are done by the nurse. In randomised control studies made public by a ventilator discontinuation task force in 2001, 12 evidence based recommendations were introduced to facilitate the ventilator discontinuation process (MacIntyre, 2005: 454-463S). It was found that weaning protocols implemented by non-physician healthcare workers lead to faster weaning and shorter length of ICU stay (grade A evidence) (Blackwood et al, 2011:9; Crocker, 2009:185).

This was followed by a meta-analysis of weaning protocols by Blackwood and colleagues of 11 randomised control studies showing that weaning protocols led to a 25% reduction in the mean duration of mechanical ventilation. Protocolled weaning is associated with speeding up the weaning process and reducing the duration of mechanical ventilation.

Testing for patient readiness to wean requires criteria that can be assessed on a daily basis. Weaning has been declared both an art and a science and indicators include vital signs, pulmonary mechanisms and oxygenation as well as subjective criteria such as the absence of anxiety (Crocker & Kinnear, 2009:187). Abstract criteria such as the patient's use of accessory muscles is also important in determining patient readiness to wean and key issues raised against the use of protocols is that they need to be flexible and the clinician needs to be able to use sound judgment when weaning (Blackwood et al, 2004: 26- 34). Exactly when to start weaning the patient from the ventilator remains controversial and one of the best ways according to literature, is through the use of a weaing protocol managed by nurses, respiratory therapists or both (MacIntyre, 2004:830; Rose & Nelson, 2005:73). Pressure support ventilation and weaning via a T-piece are two of the preferred methods of weaning. Whilst no single weaning method was found to be superior, it was found that synchronised intermittent mechanical ventilation may lead to a longer weaning process (Vivar & Esteban, 2004: 389).

In order to optimise nursing care in Critical Care Units, evidence based research needs to be applied and practices based on myths and false beliefs challenged. Nurses' knowledge and involvement in decision making and the process of using protocolled weaning is necessary for the implementation of evidence based practice.

5.2.1 Purpose of the study

The purpose of the study was to evaluate and describe Intensive Care nurse's knowledge of evidence based practice (EBP) guidelines with regard to weaning the mechanically ventilated patient, within selected general Intensive Care Units in two public hospitals in Gauteng, in order to determine barriers to evidence based practice.

5.2.2. Objectives of the study

- To evaluate and describe ICU nurses' knowledge of EBP regarding weaning the mechanically ventilated patient through the use of an instrument (self-administered questionnaire), administered to a sample of Intensive Care trained nurses (with different levels of experience) in public hospitals in Gauteng.
- To determine ICU nurses' level of knowledge of EBP and whether levels of knowledge correlate with experience in order to identify possible barriers to the implementation of evidence based guidelines and procedures for weaning in the Intensive Care Units because the research has shown that nurse-led evidence based weaning protocols improve patient outcomes.
- The evidence will be integrated and assessed to identify opportunities for further use of evidence based weaning protocols in order to enhance nursing education and further improve patient outcomes, reduce patient mortality and the cost of long term mechanical ventilation.

5.2.3. METHODOLOGY

Prior to conducting the study, ethical clearance and permission to conduct the study from relevant authorities and university committees was obtained. Five adult Intensive Care Units at two tertiary public sector academic hospitals were used to conduct the study: Multi-Disciplinary ICU, Neurosurgery, Cardiothoracic, Coronary and Trauma ICUs.

A pilot study was conducted prior to the beginning of the main data collection in order to refine the methodology and data collection instrument. A non-experimental, descriptive, prospective two-staged design was utilised to meet objectives of the study. Following consultation with a biostatistician from the Medical Research Centre (MRC), a sample size of 80 (n=80) was decided upon, to ensure a Confidence Interval of 95% and accuracy to achieve ($p<0.05$) testing. It was decided 80 respondents would constitute an adequate sample size. Data collection took place between the months of August and November 2013. Following further consultation with the biostatistician, descriptive, inferential and comparative statistics were used to analyse the data.

Stage I involved testing the instrument for content validity using a panel of expert members, following a method developed by Lynn (1986). *Stage II* established Intensive Care nurses' knowledge of EBP guidelines with regard to weaning the mechanically ventilated patient. In this study, *Stage I* procedures were completed prior to commencing *Stage II* procedures.

In *Stage I* of the study, the sample size comprised a panel of six (n=6) specialist expert members selected from the ICU's at the study site using a non-probability purposive sampling method. In *stage II* of the study, the sample size comprised 80 (n=80) Intensive Care nurse respondents selected from the ICU's between August and November 2013. Simple random sampling was utilised. In *Stage I* data was collected by means of a data collection instrument developed by the researcher comprising 40 items relevant to nursing practice derived from EBP weaning guidelines. Expert panel members were asked to rate all the items independently using a 4-point Likert scale. Questions were in the form of closed-ended questions and Likert scales (agree/disagree). Different categories included: demographic data (age, experience, etc.), factors predicting weaning failure, basic facts about weaning, weaning methods, spontaneous breathing trial, predictors for weaning, weaning index, weaning protocols and sedation. In *Stage II* data was collected by means of a data collection instrument developed by the researcher, comprising items derived from EBP weaning guidelines.

5.3 SUMMARY OF MAIN FINDINGS

The demographic data of 80 nurses (n=80) working in the Intensive Care Units at the CMJAH and CHBAH were collected. Nurses were then asked to complete a Likert-scale self-administered questionnaire consisting of 40 items related to weaning the mechanically ventilated patient. All the nurses working in the study had experience working in the ICU and had obtained a diploma or degree in Intensive Care nursing. This reflects that the nurses had knowledge, skills and experience in the caring of ICU patients.

They were asked to sign a consent form agreeing to participate in the study and then complete the questionnaire on "Intensive Care nurses" knowledge regarding weaning the mechanically ventilated patient." The main findings of the study for demographic data are summarised below. The first part of the data analysis utilised descriptive and inferential statistics reflecting more generalised knowledge about weaning and were used to describe and synthesise questionnaire scores and compare demographic data. The second part of the data analysis, utilising comparative statistics, allowed the researcher to selectively state whether nurses are comparable in their knowledge levels. The Fisher's Exact Test was applied to test for significance of differences in the frequencies of responses for the different categories within the self-administered questionnaire, namely weaning protocols, weaning methods, basic facts about weaning, spontaneous breathing trials, years of experience and role in ICU. The level of statistical significance was $p<0.05$. Collapsing the Likert scale facilitated presentation of the data where 0=less than 50%(<50%) total scores and 1=greater than 50% (>50%) total scores to test for population differences. The main findings from the results were as follows:

Demographic findings reflect similar global trends with frequencies of demographic data showing that 40% (n=32) of the respondents were in the 40 to 49 year age group. The sample was predominantly female, 86.3% (n=69), with 41.3 % (n=33) having five to 10 years of experience in ICU and 32.5% (n=35) having 10 to 20 years work experience. This shows it is reasonable to expect that nurses have both knowledge and skills in the field. In literature, these findings reflect similar trends globally, with 61% of nurses in the USA between the ages of 40 and 60 (Meltzer et al, 2014:203). Most respondents (78.8%: n=63) were in possession of a post basic ICU diploma versus a degree and held the role of primary registered nurse (56.3%: n=45), comprising the majority of the sample and shift leaders comprised 31.3% (n=25) of the sample.

From these results, it can be inferred that the sample reflects an ageing or mature nurse population. Some of the reasons given for a declining nurse population globally include high nurse turn over, burn out, job dissatisfaction, lack of nurse educators and preceptors, lack of staffing and budget constraints (Siela et al, 2009:19).

Intensive Care nurses showed a general lack of knowledge regarding weaning the mechanically ventilated patient, which was not isolated to specific topic areas within the questionnaire. The key areas where lack of knowledge was reflected, within the confines of the different categories of the questionnaire (factors predicting weaning failure, basic facts about weaning, weaning methods, spontaneous breathing trial, predictors for weaning and weaning index and weaning protocols and sedation) are highlighted and discussed below. Frequencies obtained for the following categories revealed the following:

Section B: Weaning predictors: Here the majority of respondents (86.3%) identified the predictors for weaning failure correctly and this tested their ability to intervene with alterations in ventilator support where necessary, in order to wean the patient. Therefore, there was no lack of knowledge reflected in this category.

Section C: Basic facts about weaning: A key finding from the frequencies is that the majority of respondents (87.5%: n=70) indicated weaning should be a slow and gradual process. However, newer thinking amongst experts is that weaning should be discontinued as soon as possible to avoid delaying extubation in patients who have recovered from respiratory failure (Hess, 2011:392).

The majority (53.8%: n=43) of respondents disagreed with the statement that long term mechanical ventilation is when a patient is ventilated for 72 hours or less, however experts agree that ventilation from three to seven days is considered long term.

A lack of knowledge was reflected regarding weaning protocols and only 17.5% (n=15) of respondents disagreed with the statement that the use of protocols show no significant reduction in the time patients receive mechanical ventilation. Evidence based practice supports the use of protocols in reducing the length of mechanical ventilation (MacIntyre, 2004: 830-836).

Only 43.8% (n=35) of respondents agreed that a patient receiving prolonged ventilator support is not considered dependent until at least three weaning attempts have been made. There was a lack of knowledge about patients being categorised into those who require simple weaning and those who are difficult to wean. (Hess, 2011: 392).

Section D: Weaning Methods

This section of the questionnaire reflected the widest knowledge gap within the sample (n=80).

Only 33.8% (n=27) of respondents agreed that guidelines for reducing ventilator support may be abrupt (e.g a spontaneous breathing trial on a T-piece) or gradual (intermittent mechanical ventilation with reductions in ventilator rate). However, the urgency for immediate discontinuation of ventilation is stressed in the guidelines, in order to prevent long term mechanical ventilation and reduce patient morbidity and mortality

Once daily spontaneous breathing trials versus multiple attempts at weaning are cited in literature as being more successful, however 46.3% (n=37) of respondents were more familiar with pressure support and T-piece trials as a more commonly used method of weaning, versus the once daily trials revealing a lack of knowledge here.

Less than half (45%: n=36) of respondents agreed that a spontaneous breathing trial of 30 to 60 minutes on CPAP (continuous positive airway pressure), 5 cm H_2O, pressure support 6 cm H_2O is considered as a weaning indicator. As many as 31.3% (n=29) of respondents disagreed with these criteria as predictors for extubation.

As few as 37.5% (n=30) of respondents correctly agreed with the statement that respiratory muscle rest does not occur during the mandatory breath delivery of SIMV (synchronised intermittent mandatory ventilation) and may in fact lead to periods of muscle fatigue rather than periods of rest and exercise. In fact, randomised control trials have reported the poorest weaning outcomes using SIMV (Hess, 2001: 474S).

Frequencies showed that 68.5% (n=55) of respondents regarded synchronised intermittent mandatory ventilation (SIMV) as the preferred weaning mode, whilst only 26.3% (n=21) disagreed with this statement. Randomised control studies have reported the poorest outcomes using SIMV (Hess 2001: 474S).

Once daily spontaneous breathing trials, with support in between, were shown to result in faster weaning (McIntyre, 2004: 833). As few as 8.8% (n=15) of respondents agreed that T-piece and pressure support ventilation are superior to SIMV as methods of weaning, whilst as many as 70.0% (n=56) disagreed. Only using SIMV may lead to extended weaning and nurses lacked knowledge about this (Penuelas, 2011:435).

Only 17.5% (n=14) of respondents agreed that once daily spontaneous breathing trials SBT's and pressure support are inferior modes to SIMV (synchronised intermittent mechanical ventilation), despite daily SBTs, rather than SIMV or pressure support ventilation (PSV) weaning, being recommended in practice guidelines (Girard & Ely, 2008: 241).

Only 38.8% (n=31) of respondents agreed that spontaneous breathing trials can be performed using a T-piece, CPAP, with or without pressure support up to 7cmH_20 for periods of 30 min to two hours. Of the respondents, 55.0% disagreed or omitted to answer, displaying a knowledge gap about the importance of a successful SBT as a predictor for weaning.

Respondents were informed that a failed trial can lead to respiratory muscle fatigue and recovery from this can take longer than 24 hours. Fifty percent (n=40) of respondents agreed and once again, this supports the once daily spontaneous breathing trial (SBT) versus multiple attempts at weaning throughout the day.

Only 12.5% (n=10) of respondents agreed that multiple daily breathing trials offer no advantage to a once daily trial. As many as 77.0% were unsure or disagreed. The literature supports once daily trials of up to two hours and if it fails, waiting 24 hours before trying again versus multiple trials (Girard & Wesley, 2008:249).

Section F: Predictors for weaning and weaning index

Of the respondents, only 17.5% agreed that $PacO_2$, base excess, serum K, serum phosphate, serum magnesium, serum Na, serum calcium are laboratory tests commonly used to assess metabolic factors when weaning a critically ill patient from mechanical ventilation, reflecting a lack of knowledge about laboratory results with regard to weaning.

The results reflected that nurses were unfamiliar with weaning indexes and only 12.5% (n=10) of respondents agreed that the $Pa0_2/Fi0_2$ ratio should be greater than 200 mmHg before weaning the patient. Up to 52.5% of respondents were unsure that adequate oxygenation PaO_2/FiO_2 ratio greater than 150-200 mmHg is a predictor for successful weaning.

Additionally, only 18.8% 9 (n=15) of respondents agreed that an RSBI (rapid shallow breathing index) (calculated by frequency divided by tidal volume less than 105) is an indicator for weaning. This is the most widely used weaning parameter and is most often used in protocols and reflects that perhaps protocols are not being used by this sample and nurses are not being exposed to this indicator.

Section G: Weaning protocols and sedation

As many as 60% (n=48) of respondents disagreed that Propofol is often used in ICU due to its rapid onset and offset of sedation. However, studies by Kress et al showed that the concentration of Propofol in plasma declines rapidly after it is stopped and that is why it is widely used in ICU. With regard to the question of interruption of sedation and sedation breaks, only 43.8% of nurses agreed that daily interruption of sedation should be used to reduce the duration of mechanical ventilation, length of ICU stay and enhance patient outcomes. It is vital that nurses have knowledge of sedation practices as this is integral to weaning the patient. It is necessary to rest the patient at night to reduce anxiety and wake them to ensure spontaneous breathing during the day in order to extubate.

In the second part of the data analysis, Fisher's Exact Test, for comparison of frequency distribution of knowledge by categorical variables for ***weaning protocols, weaning methods, facts about weaning and spontaneous breathing trials,*** was utilised. This demographic data allowed the researcher to selectively state whether nurses have the same knowledge levels. Findings yielded, in the categories of primary nurse and shift leader, three were statistically significant ($p<0.05$) for weaning protocol ($p=0.005$), weaning methods ($p=0.005$) and basic facts about weaning ($p=0.000$).

Setting:

Of the two sites, scores for the Fisher's Exact Test for frequency distribution of knowledge for demographic variables by **weaning protocols** showed >50% were significantly higher for Site B (CHBAH) at 64.86%, than for Site A (CMJAH) at 35.14%. This implies that >50% responses for site B is statistically ($p=0.0024$) different from site A. Results also showed that scores for site B were higher than site A (22.50%), implying that >50%

correct responses for site B is statistically significantly different than site A (p=0.000) for **basic facts about weaning**. It could be speculated that nurses at site B were more exposed to evidence based research within the clinical practice area.

Role:

Results showed that total scores >50% (45.95%) by **weaning protocols** were higher for shift leader than for primary nurse (37.84%), unit manager (10.81%) and clinical facilitator (5.41%) implying that >50% correct responses for the shift leader is statistically significant (p=0.03) which is what one would expect to find as the shift leader is responsible for the final clinical decision and primary nurses report to the shift leader.

Of the categories, total scores obtained for the primary nurse was higher than for the shift leader (40.48%) and clinical facilitator (71.4%) indicating that more than 50% correct responses for the primary nurse is statistically different from the shift leader and clinical facilitator (p=0.003). It can be presumed that within the ICU setting the trained ICU nurse, in a primary nurse role, is nevertheless providing 1:1 care for the ventilated patient, making independent decisions within her scope of practice with regard to ventilation.

Qualification:

Results showed that for >50% (87.50%) of scores for **basic facts about weaning**, total scores for diploma was higher than for degree, (7.50%) implying that > 50% correct responses for diploma is statistically significantly different (p=0.046) for degree. Many more nurses are in possession of a diploma versus a degree, with 78.8% (n=63) of respondents having a diploma versus 17.5% (n=14) holding a degree. In South Africa, it is possible to function as a clinical nurse specialist with a post basic ICU certification, whereas in countries such as the USA and Australia, nurses need to have a Master's degree to function as a clinical nurse specialist and these differences, their impact on clinical practice and the implementation of evidence based research could be investigated in the future.

Experience:

Findings showed that two categories, in terms of years of experience (<10 and >10) the total scores >50% are equal implying they are not statistically different for weaning protocol, weaning methods, basic facts about weaning and spontaneous breathing trials. Therefore, years of experience does not influence nurses' knowledge level, as there is no statistical difference in these items.

Overall findings:

Overall findings indicate that Intensive Care nurses lack adequate knowledge on weaning the critically ill patient from the mechanical ventilator. This is evident across the questionnaire and not in isolation, with results inferred as ambiguous. It is generally believed that experienced nurses make better decisions, however this study shows the opposite. Experience, <10 years or > 10 years, is not statistically significant. In literature, according to Benner, nurses can gain knowledge and skills without ever learning the theory, but to move from novice to expert requires the extension of practical knowledge through research and an understanding of clinical skills (Dracup & Bryan-Brown, 2012:448).

5.4 LIMITATIONS OF THE STUDY

The following limitations are acknowledged by the researcher for this study:

- A quantitative study with a small sample size (n=80)
- The findings were confined to two academic public sector hospitals and cannot be generalised to other settings.
- A larger number of nurses and more clinical practitioners could make it possible to generalise the results of the study.

- The knowledge of the clinical facilitator was found to be minimal (not even comparable due to the small numbers) and this is a limitation.

- The data collection instrument was developed by the researcher. It was used for the first time and may need to be reviewed and updated for future studies on weaning the mechanically ventilated patient

5.5 CONCLUSION

Nurses' knowledge of evidence based practice regarding the mechanically ventilated patient is lacking, as reflected broadly throughout the different categories within the self-administered questionnaire.

Knowledge scores between knowledge levels of the primary nurse and shift leaders is minimal, although significant ($p<0.05$), indicating that shift leaders were more knowledgeable than primary nurses for weaning protocols, basic facts about weaning and weaning methods.

The results indicate no statistical significance in knowledge based on years of experience, as we would expect to find, according to the novice-expert model of Dr. Patricia Benner, who introduced the concept that expert nurses acquire skills and knowledge over time through education as well as experience. Nurses go through the stages of novice to expert as they acquire education and clinical skills (Dracup & Bryan Brown, 2012:448).

It can be speculated as to why this is so, possibly due to an ageing nurse population where continuing education credits are not a requirement to keep their nursing registration, as in other countries such as the USA, or the fact that they trained many years ago and are not given the financial and professional opportunities for continued education within the public hospital setting. This could potentially be an area for further research. The need to keep knowledge updated is crucial and this is lacking in this study. EBP is relatively new and most of these nurses, 70% (n=56) are in the 40 to 59 year age category and trained a long time ago. Therefore the conclusion or assumption is that nurses have not kept their knowledge up to date with the latest developments.

From the results it can also be inferred that nurses are able to follow 'protocol' but not individualise care for a patient, which is a requirement for EBP. Generally, barriers to evidence based practice include lack of time and the need for greater education surrounding research (Hewitt-Taylor, Heaslip & Rowe, 2012:356).

A large number of patients in ICU are mechanically ventilated and will require weaning at some stage, so the knowledge deficit needs to be addressed in order to properly care for these patients.

Nurses' knowledge regarding weaning methods reflected several gaps, for example SIMV (synchronised intermittent mechanical ventilation) was considered a preferred weaning method, which indicates a lack of understanding and systematic approach to weaning amongst the nurses in the Intensive Care Unit. Nurses had very little knowledge on weaning indexes such as the Rapid Shallow Breathing Index (RSBI), or methods of weaning, including the use of daily spontaneous breathing trials (SBT).

Many nurses are said to depend on knowledge gained through their relationships with colleagues, patients and policies, what people have taught them or what they have learned through routine (Hewitt-Taylor et al, 2012: 356). Furthermore, they do not regard their role as one where they research information and participate in decision-making.

5.6 RECOMMENDATIONS OF THE STUDY

5.6.1 Recommendations for clinical practice

- As the ICU environment requires skilful, knowledgeable, competent and experienced nursing staff, provision can be made to deploy trained staff to use research in practice and make them aware of evidence based guidelines within their specialty.
- Ensure adequate staffing based on skills and qualifications, not cost constraints, as inadequate skills and experience of the staff can lead to poor patient outcomes and increased mortality.

- As many as 55.0% of respondents agreed that nurse-led weaning reduces the patient's number of ventilated days, days spent in ICU and cost of care. An evidence based weaning protocol can be developed to assist nurses and address issues such as: criteria to assess weaning readiness; respiratory, cardiac and neurological parameters; the spontaneous breathing trial; recognising the signs and symptoms of weaning failure

5.6.2 Recommendations for nursing education

- The fact that a significant number of ICU nurses displayed a gap in knowledge with the total score for >50% for weaning protocols being only 35.14% at site A, and the total score for >50% at site B, raises the need for education in ICU regarding weaning the mechanically ventilated patient.

- Although findings indicate that ICU nurses have some knowledge about weaning the mechanically ventilated patient, it does not translate into evidence based practice. It is important to ensure continuous education of nurses to give priority to managing the mechanically ventilated patient in ICU.

- Expose young nurses to evidence based practice in undergraduate training to underpin why research plays an integral role in nursing education and practice.

- Training of more preceptors or clinical facilitators to train younger nurses and support them through education in order to prevent lack of knowledge and also to encourage them to be sufficiently confident to implement EBP in daily practice.

- Involvement of younger nurses in evidence based care and a culture in which using research is the norm.

- Primary ICU nurses, who make up the majority of the workforce, need to be given the opportunities to refresh their skills through short courses and seminars and attend conferences hosted by the international council for Critical Care nurses. This will give them the confidence to put evidence based research into practice.

5.6.3 Recommendations for future research

- Based on the finding, there may be an opportunity for a comparable study using a stratified sample, i.e. proportions of trained nurses, shift leaders and clinical preceptors to address differences between Intensive Care trained and experienced nurses to see if any differences exist and to identify further barriers to the implementation of evidence based practice.

- Due to the homogeneity of the sample, findings may be of interest to other public sector ICU's, clinical practice and education of Intensive Care nurses.

- Few studies were found on weaning the mechanically ventilated patient in South Africa. A follow up on this research could include a bigger population of nurses as well as clinical facilitators, unit managers and preceptors to compare and contrast knowledge of weaning the mechanically ventilated patient amongst educators.

- The instrument used in this study is being used for the first time and due to evidence based practice continually evolving, may have to be revised and encountered problems corrected to pave the way for further research.

REFERENCES

Alspach, J.G. Core Curriculum for Critical Care Nursing. 2006. 6th Ed. Saunders Elsevier.

Altmann, T.K. An evaluation of the seminal work of Patricia Benner: Theory or philosophy? 2007. Contemporary Nurse, vol. 25, pp. 114-123.

Bersten, A.D. & Soni, N. Oh's Intensive Care Manual. 2003. 5th Ed. Butterworth Heinmann.

Boles, J.M., Blon, J., Connors, A., Herridge, M., Marsh, B., Melot, C., Pearl, R. , Silverman, H., Stanchina, M., Viellard-Baron, A., Welte, T. 2007. European Respiratory Journal, vol. 25, no. 5, pp. 1033-1056.

Brochard L, Rauss A., Benito S., et al. 1994. Comparison of three methods of gradual withdrawal from ventilatory support during weaning from mechanical ventilation. American Journal of Respiratory Critical Care medicine, vol. 150, pp. 896 – 903.

Brook, A.D., Ahrens, T.S., Schaiff, R., Prentice, D., Sherman, G., Shannon, W. and Kollef, M. 1999. Effect of a nursing implemented sedation protocol on the duration of mechanical ventilation. Critical Care Medicine, vol. 27, no. 12, pp. 2709-2615.

Brysiewicz, P. & Bengu, B.R. 2010. The experiences of nurses in providing psychosocial support to families of critically ill trauma patients in intensive care units, vol. 26, no. 2, pp. 42-51.

Blackwood, B., Alderdice, S., Burns, K., Cardwell, C., Lavery, G. and O'Halloran, P. 2009. Review Protocol. Protocolized versus non protocolized weaning for reducing the duration of mechanical ventilation in critically ill adult patients: Cochrane Review Protocol. Journal of Advanced Nursing, vol 65, pp. 957-964.

Blackwood, B., Alderdice, F., Burns, K., Cardwell, C., Lavery, G., and O'Halloran, P. 2011. Use of weaning protocols for reducing duration of mechanical ventilation in critically ill adult patients: Cochrane Systematic Review and Meta-Analysis (CD006914). British Medical Journal, vol. 5, pp. 1-14.

Burns, S.M. 2004. The Science of weaning: when and how? Critical Care Nurse Clinics of North America, vol. 16, no. 1, pp. 379-386.

Burns, S. M., Fisher, C.,Tribble, S., Lewis, R., Merrel, P., Conway, M.R., and Bleck, T.P. 2010. Multifactor Clinical Score and Outcome of Mechanical Ventilation Weaning Trials: Burns Wean Assessment Program. American Journal of Critical Care, vol. 19, no. 5, pp. 431-438.

Canadian Nurses Association: Sourced online at: http://www.cna-aiic.ca.

Carlson, K.K. 2009. Advanced Critical Care Nursing. American Association of Critical Care Nurses. Missouri, Saunders and Elsevier.

Christensen, M. 2009. Advancing practice in critical care: a model of knowledge integration. British Association of Critical Care Nurses, Nursing in Critical Care, vol. 14, no. 2, pp. 86-94.

Creswell, J.W. 2009. Research Design: Qualitative, Quantitative and Mixed Methods Approaches. 3rd Ed. California: SAGE Publications Inc.

Crocker, C. 2009. Weaning from ventilation – current state of the science and art. British Association of Critical Care Nurses, Nursing in Critical Care, vol. 14, no. 4, pp. 185-190.

Crocker, C. 2002. Nurse led weaning from ventilator and respiratory support. Intensive and Critical Care Nursing, vol. 18, pp. 272-279.

Crocker, C. & Kinnear, W. 2007. Weaning from ventilation: does a care bundle approach work? Intensive and Critical Care Nursing, vol. 24, pp. 180-186.

Crocker, C. & Scholes, J. 2009. The importance of knowing the patient in weaning from mechanical ventilation. Nursing in Critical Care, vol. 14, no. 6, pp. 289-298.

De Vos, A.S., Strydon, H. Fouche, C.B. and Delport, C.S.L. 2011. Research at Grass Roots. 4th Ed. Pretoria: Van Schaik Publishers.

Dracup, K. & Bryan-Brown, W.C. 2004. From Novice to Expert to Mentor: shaping the future . American Journal of Critical Care, vol. 3, no. 6, pp. 448-450.

Eckerblad, J., Eriksson, H., Karner, A., Edell-Gustafsson, U. 2009. Nurses' conceptions of facilitative strategies of weaning patients from mechanical ventilation – a phenomenographic study. Intensive and Critical Care Nursing, vol. 25, pp. 225-232.

El-Khatib, M.F.& Bou-Khalil, P. 2008. Clinical Review: Liberation from Mechanical Ventilation. Critical Care, vol.12, no. 4, pp. 1-11.

Epstein, S.K. 2009. Weaning from ventilatory support. Current Opinion in Critical Care, vol. 15, pp. 36-43.

Ely, W.E., Meade, M., Haponik,E.F., Kollef, M.H., Cook, D.,Gordon, G.H., & Stoller, J.K. 2001. Mechanical ventilator weaning protocols driven by non physician healthcare professionals. Evidence based clinical practice guidelines. Chest, vol.120, no. 6, pp. 454S-461S.

Esteban A, Frutos F, Tobin MJ, et al. 1995. A comparison of four methods of weaning patients from mechanical ventilation. Spanish Lung Failure Collaborative Group. New England Journal of Medicine, vol 332, no. 6, pp. 345 – 350.

Girard, T, D., and Wesley, E. 2008. Protocol-Driven Ventilator Weaning: Reviewing the Evidence. Clinics in Chest Medicine, vol. 29, pp. 241-252.

Goodman, S. 2006. Implementing a Protocol for Weaning Patients off mechanical ventilation. British Association of Critical Care Nurses, vol. 11, no. 1, pp. 23-32.

Grap, M.J., Strickland, D., Tormey, L., Keane, K., Lubin, S.Emerson, J., Winfield, S. Dalby, P., Townes, R. & Sessler, C.N. 2003. Collaborative Practice: Development, implementation and evaluation of a weaning protocol for patients receiving mechanical ventilation. American Journal of Critical Care. vol. 12, no. 5, pp. 454-460.

Haas, C.F. and Loik, Paul, S. 2012. Ventilator Discontinuation Protocols. Respiratory Care, vol. 57, no.10, pp. 1649-1662.

Hansen, B.S., and Severinsson, E. 2007. Intensive care nurses' perceptions of protocol directed weaning - a qualitative study. Intensive and Critical Care Nursing, vol. 23, pp. 196-205.

Hansen, B, S., Fjaelberg, W.T.M., Nilsen, O.B., Lossius, H.M. & Soreide, E. 2008. Mechanical ventilation in the ICU – is there a gap between the time available and time used for nurse led weaning? Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine, vol. 16, no. 17. [Online]. Available at: http://www.sjtrem.com/content/16/17.

Hatchett, C., Langley, G., Schmollgruber, S. 2010. Psychological sequelae following ICU admission at a level 1 academic South African hospital. South African Journal of Critical Care, vol. 26, no. 2, pp. 52- 58.

Hess, R. 2011. Ventilator Discontinuation. Why are we still Weaning? American Journal of Respiratory and Critical Care Medicine, vol. 184, pp. 392-393.

Hewitt-Taylor, J., Heaslip, V., Rowe, N. 2012. Applying research to practice: exploring the barriers. British Journal of Nursing, vol. 21, no.6, pp. 356-359.

Hewitt-Taylor, J. 2004. Clinical guidelines and care protocols. Intensive and Critical Care Nursing, vol. 20, pp. 45-52.

Kollef, M., Levy, N.T., Ahrens, T.S., Schaiff, R., Prentice, D., and Sherman, G. 1998. The use of Continuous IV Sedation is Associated with Prolongation of Mechanical Ventilation. Chest, vol. 114, no.2.

Kollef, M.H., Shapiro, S.D., Silver, P., St John, R.E., Prentice, D., Sauer, S., Baker, K., Ahrens, T.S., Shannon, W. & Baker-Clinkscale, D. 1997. A randomized controlled trial of protocol directed versus physician directed weaning from mechanical ventilation. Critical Care Medicine, vol. 25, no. 4, pp. 567-574.

Knebel, A.R. 1991. Weaning from mechanical ventilation. Current controversies. Heart and Lung, vol. 20, no. 4, pp. 321-31.

Kohr, L.M., Hickey, P.A., and Curley, M.A.Q. 2012. Building a Nursing Productivity Measure based on the Synergy Model: First Steps. American Journal of Critical Care, vol. 21, no. 6, pp 420-431.

Kress, J.P., Pohlman, A.S., O'Connor, M.F., and Hall, J.B. 2000. Interruption of Sedative Infusions in Critically ill Patients Undergoing Mechanical Ventilation, vol. 342, no. 20., pp. 1471-1477.

Lavelle, C. & Dowling, M. 2011. The factors which influence nurses when weaning patients from mechanical ventilation: Findings from a qualitative study. Intensive and Critical Care Nursing, vol. 27, no. 1, pp. 244-252.

Lynn, R. 1986. Determination and Quantification of Content Validity. Nursing Research, vol.35, no.6, pp.382-385.

MacIntyre, N.R. 2001. Evidence Based Guidelines for Weaning and Discontinuing Ventilator Support. A Collective Task Force Facilitated by the American College of Chest Physicians; the American Association for Respiratory Care; and the American College of Critical Care Medicine.Chest, vol 120, no. 6, pp 375S-395S.

MacIntyre, N.R. 2004. Evidence based ventilator weaning and discontinuation. Respiratory Care, vol. 49, no. 7, pp. 830-835.

Manthous, C.A., Schmidt, G.A., and Hall, J. 1998. Liberation from Mechanical Ventilation. A Decade of Progress. Chest, vol 114, no. 3. pp 886-901.

Martensson,I,E. & Fridlund, B. 2002. Factors influencing the patient during weaning from mechanical ventilation: A national survey. Intensive and Critical Care Nursing, vol. 18, pp. 219-229.

Marelich, G.P., Murin, S., Battistella, F., Inciardi, J., Vierra, T., and Roby, M. 2000. Protocol Weaning of Mechanical Ventilation in Medical and Surgical Patients by Respiratory Care Practitioners and Nurses. Effect on Weaning Time and Incidence of Ventilator Associated Pneumonia, vol. 118, pp. 459-467.

Meltzer, S.L., & Huckabay, L.M. 2004. Critical Care Nurses' Perceptions of Futile Care and its Effect on Burnout. Amercian Journal of Critical Care, vol. 13, pp. 202-208.

Morton, P.G. & Fontaine, D.K. 2013. Critical Care Nursing. 10th Ed. USA: Wolters Kluwer Health, Lippincott Williams & Wilkins.

Messmer, P.R. , Jones, S.G., and Taylor, B. 2004. Enhancing knowledge and self-confidence of novice nurses: the shadow-a nurse ICU program, Nursing Education Perspectives, vol. 25, no. 3. pp 131-136.

Newmarch, C. 2006. Caring for the mechanically ventilated patient: part two. Nursing Standard, vol. 20, no. 18, pp. 55-64.

Penuelas, O., Frutas-Vivar,F. ,Fernandez, C., Anzueto, A.,Epstein, S.K., Apesteguia, C. et al. 2011. Characteristics and outcomes of ventilated patients according to time to liberation from mechanical ventilation. American Journal of Respiratory Critical Care Medicine, vol. 184, pp. 430-437.

Perren, A., & Brouchard, L. 2013. Review. Managing the apparent and hidden difficulties in weaning from mechanical ventilation. Intensive Care Medicine, vol.

Pettersson, S., Melaniuk-Bose, M. & Edell-Gustafsson, U. 2012. Anaesthetists' perceptions of facilitative weaning strategies from mechanical ventilator in the intensive care unit. Intensive and Critical Care Nursing, vol. 28, pp. 168-175.

Polit, D.F. & Beck, C.T. (2010). Essentials of Nursing Research. 7th Ed. Missouri: Wolters Kluwer Health, Lippincott Williams & Wilkins.

Plani, N., Becker, P. & van Aswegen, H. 2013. The use of weaning and extubation protocol to facilitate effective weaning and extubation in patient's suffering from traumatic injuries: a non-randomized experimental trial comparing a prospective to retrospective cohort. Physiotherapy Theory and Practice, vol. 29, no. 3, pp. 211-221.

Republic of South Africa (RSA) 2005. Nursing Act No. 33 of 2005. Pretoria. Government Printer.

Republic of South Africa (RSA) 2004: National Health Act No 61 of 2003. Pretoria. Government Printer.

Rose, L. Nelson, S., Johnston, L. & Presneill, J. 2007. Decisions made by critical care nurses during mechanical ventilation and weaning in an Australian intensive care unit. American Journal of Critical Care, vol.16, no. 5, pp. 434-443.

Rose, L., Blackwood, B., Burns, S., Frazier, S.K. & Egerod, I. 2011. International perspectives on the influence of structure and process of weaning from mechanical ventilation. American Journal of Critical Care, vol. 20, no. 1, pp. e10-e18.

Rose, L. & Nelson, S. 2006. Issues in weaning from mechanical ventilation: Literature Review. Journal of Advanced Nursing, vol. 54, no. 1, pp. 73-85.

Rose, L. 2011. Interprofessional collaboration in the ICU: how to define? British Association of Critical Care Nurses, vol. 16, no. 1, pp. 5-10.

Rumke, A.L., and Zimmerman, B.A. 2010. Implementation of a Multidisciplinary Ventilator-Weaning and Sedation Protocol in a Community Intensive Care Unit. Dimmensions of Critical Care Nursing, vol. 29, no. 1, pp. 40-49.

Sackett, D. L., Straus, S. E., Richardson, W. S., Rosenberg, W., & Haynes, R. B. 2000. Evidence-based medicine: how to practice and teach EBM (2nd ed.). Edinburgh, Churchill Livingstone.

Siela, D., Twibell, K.R., and Keller, V. 2009. The Shortage of Nurses and Nursing Faculty. Critical Care Nurse, vol 19, no. 1, pp. 66-77.

South African Nursing Council (SANC) 1997. Regulations for a course in clinical nursing science leading to registration of an additional qualification. Regulation R212 of February 1993 as amended by regulation 74 of January 1997. Pretoria. SANC.

Taylor, F. A comparative study examining the decision-making processes of medical and nursing staff in weaning patients from mechanical ventilation. 2006. Intensive and Critical Care Nursing, vol. 22, pp. 253-263.

Tonnelier, A., Tonnelier, J., Nowak, E., Gut-Gobert, C., Gwenael, P., Renault, A., Boles, J. & L'Her, E. 2011. Clinical Relevance of Classification According to Weaning Difficulty. Journal of Respiratory Care, vol. 56, no. 5, pp. 583-590.

Twibell, R., Siela, D. & Mahmoodi, M. 2003. Subjective perceptions and physiological variables during weaning from mechanical ventilation. American Journal of Critical Care, vol. 12, no. 2, pp. 101-111.

Thille, A.W., Cortes-Puch, I., and Esteban, A. 2013. Weaning from the ventilator and extubation in the ICU. Current Opinion in Critical Care, vol 19, no. 1, pp. 57-64.

Tobin, M., Laghi, F. and Jubran, A.2012. Ventilatory failure, ventilator support, and ventilator weaning. Comprehensive Physiology, vol. 2, pp. 2871- 2921.

Vivar, F., and Esteban, A. 2003. When to wean from a ventilator: An evidence based strategy. Cleveland Clinic Journal of Medicine, vol. 70, no. 5, pp. 389-400

Villa, G., Manara, D. & Palese, A. 2011. Nurses' near decision making process of postoperative patients' cardiosurgical weaning and extubation in an Italian environment. Intensive and Critical Care Nursing, vol. 28, pp. 41-49.

Wang, K., Zhang, B., Chunyan, L., and Wang, C. Qualitative analysis of patients’ intensive care experience during mechanical ventilation. Journal of Clinical Nursing, vol. 18, pp. 183-190.

Williams, G., Bost, N., Chaboyer, W., Fulbrook, P., Alberto, L., Thornsteindottier, R., and Chan, D. 2011. Critical Care nursing organizations and activities: a third worldwide review, International Nursing Review, vol. 59, pp. 73-80.

Appendix I

Group: Ref number:

INTENSIVE CARE NURSE QUESTIONNAIRE

INTENSIVE CARE NURSES' KNOWLEDGE OF EVIDENCE BASED GUIDELINES REGARDING WEANING THE MECHANICALLY VENTILATED PATIENT

SECTION A: DEMOGRAPHIC DATA

Please read each item below and write your answer or mark an x in the appropriate block. Do not write your name, as the questionnaire is anonymous.

1. **Age** ☐

2. **Sex**

Male	Female

3. **Years working in ICU**

<5	5-10	10-20	20+

4. **Do you have a qualification in intensive care nursing?**

Degree	Diploma	None

5. **Indicate your current position in the critical care unit**

Primary registered nurse	Shift leader	Clinical facilitator	Unit Manager

Some of the internationally proposed strategies for weaning the patient from mechanical ventilation are listed below. Please read the following Interventions and answer the questions as instructed.

SECTION B: FACTORS PREDICTING WEANING FAILURE

6. (Circle the ONE correct answer below that could predict weaning failure)

a. A caloric regime providing nutrition and avoiding hyper metabolism (serum albumin > 2.5).
b. Pain is controlled and patient received night sedation.
c. Adequate respiratory muscle strength.
d. Sufficient oxygenation (PaO_2/ FIO_2 ≥150–300 mm Hg, PEEP ≤5 cm H_2O, FIO_2 0.4 - 0.5, and pH 7.25).
e. Patient is fatigued (decreased tidal volume <5ml/Kg, decreased $P0_2$, $Sa0_2$, increased $PC0_2$).
f. Patient is on low dose vasopressors.
g. Systolic BP<180 and >90.
h. Respiratory rate is 20 breaths per minute.
i. Hb 8-10g/dL
j. Temperature < 38°C

SECTION C: BASIC FACTS ABOUT WEANING

Please indicate to what extent you agree/disagree with each of the statements below by placing an X in the appropriate block.

	1	2	3	4	5

7. Weaning the critically ill patient from mechanical ventilation should always be done slowly and gradually.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
8. Long term mechanical ventilation (LTMV) is when a patient is ventilated for 72 hours or less.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
9. Non physician led (i.e. nurse led) weaning reduces the patient's number of ventilator days, days spent in ICU and cost of care.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
10. Patients are at risk of reintubation if weaning takes place too quickly	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
11. Weaning patients more quickly results in fewer complications like VAP (ventilator associated pneumonia).	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
12. The use of protocols shows no significant reduction in the time patients receive mechanical ventilation.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
13. A patient who requires prolonged ventilatory support is not considered ventilator dependent until at least 3 attempts at weaning have failed.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree

SECTION D: WEANING METHODS

Please indicate to what extent you agree/disagree with each of the statements below by placing an X in the appropriate block.

	1	2	3	4	5
14. Guidelines for reducing ventilator support may be abrupt, for example a spontaneous breathing trial on a T-piece, or gradual, such as intermittent mechanical ventilation with reductions in ventilator rate.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
15. Pressure support and T-piece trials used at several intervals daily are the least frequently used methods of weaning.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
16. The physician should be notified the patient is ready for extubation when he/she passes a daily spontaneous 2 hour breathing trial on CPAP 5cm H_2O.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
17. A spontaneous breathing trial of 30 to 60 minutes on CPAP, 5cm H_2O, pressure support 6 cm H_2O is considered an indicator for extubation	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
18. Respiratory muscle rest does not occur during the mandatory breath delivery of SIMV.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
19. SIMV is the preferred weaning mode available	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
20. T-piece and pressure support ventilation are superior to SIMV as methods of weaning	Strongly disagree	Disagree	Neutral	Agree	Strongly agree

SECTION E: SPONTANEOUS BREATHING TRIAL

Please indicate to what extent you agree/disagree with each of the statements below by placing an X in the appropriate block.

	1	2	3	4	5
21. Patients who are managed with SBT who can breathe without the assistance of the ventilator, are extubated more quickly than patients who are weaned via gradual reductions in support.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
22. Once daily SBT's or pressure support are inferior modes to intermittent mandatory ventilation.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
23. Multiple ventilator manipulations should be made in an effort to wean or train the patient.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
24. Spontaneous breathing trials can safely be performed by using a T-piece, continuous positive airway pressure (CPAP) without pressure support, or with pressure support up to 7cm H_2O and for durations of 30 mins to 2 hours.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
25. A failed trial can precipitate respiratory muscle fatigue and complete recovery from fatigue can take longer than 24 hours.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
26. Multiple daily breathing trials offer no advantage over a once-daily trial	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
27. Poor cough strength and greater secretions predict extubation failure.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
28. Some of the factors contributing to the failure of a spontaneous breathing trial include electrolyte imbalances, bronchospasm, patient positioning and malnutrition.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree

SECTION F: PREDICTORS FOR WEANING AND WEANING INDEX

Indicate the correct answer from 1-3 below by circling your choice:

29. **Laboratory tests used to assess metabolic factors when weaning include:**

1. a, c, d
2. b, c, d
3. a, d, e

a) Paco2, base excess
b) C-reactive protein
c) Serum K, serum phosphate, serum magnesium
d) Serum Na, serum calcium
e) Urea

Please indicate to what extent you agree/disagree with each of the statements below by placing an X in the appropriate block.

	1	2	3	4	5
30. The psychological well-being of the patient and presence of relatives may affect weaning	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
31. PaO_2/FIO_2 ratio should be ≥ 200 mm Hg before you can wean the patient	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
32. The patient should have a spontaneous tidal volume > 5ml/kg, PaO_2 > 60 mm Hg, PCO_2 < 40mm Hg or baseline, with minute ventilation <10L/min, low positive end expiratory pressure (PEEP at 5cm H_20) and a FIO_2 <40% prior to weaning	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
33. A patient with a copious amount of thick secretions will improve with extubation .	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
34. A patient on Dobutamine > 5µg/kg/min with hemodynamic instability can be weaned	Strongly disagree	Disagree	Neutral	Agree	Strongly agree

SECTION F: PREDICTORS FOR WEANING AND WEANING INDEX CONT.

Please indicate to what extent you agree/disagree with each of the statements below by placing an X in the appropriate block.

	1	2	3	4	5
35. Prior to weaning, the patient needs to initiate an inspiratory effort.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
36. A RSBI (rapid shallow breathing index) (calculated by frequency (*f*) divided by the tidal volume (VT)) <105 is an indicator for weaning.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree

SECTION G: WEANING PROTOCOLS AND SEDATION

Please indicate to what extent you agree/disagree with each of the statements below by placing an X in the appropriate block.

	1	2	3	4	5
37. The implementation of weaning protocols by nurses and physiotherapists leads to extubation more rapidly than physician-only directed weaning.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
38. Propofol is often used in ICU because of its rapid onset and offset of sedation.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
39. Reducing patient anxiety and ensuring a good night's sleep prior to weaning by using sedatives, is recommended.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
40. Daily interruption of sedation and sedation goals should be used reduce the duration of mechanical ventilation and length of stay in the ICU.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree

ABBREVIATIONS

SIMV:	synchronized intermittent mandatory ventilation
CPAP:	Continuous positive airway pressure
RSBI:	Rapid shallow breathing index
ICU:	Intensive care unit
SBT:	Spontaneous breathing trial
FIO_2:	Fraction of inspired oxygen
LTMV:	Long term mechanical ventilation

Thanks for your time and co-operation in answering this questionnaire

APPENDIX II

INTENSIVE CARE NURSES' KNOWLEDGE OF EVIDENCE BASED GUIDELINES REGARDING WEANING THE MECHANICALLY VENTILATED PATIENT.

EXPERT GROUP INFORMATION LETTER

Dear colleague,

My name is Jacquie Fischer. I am currently registered as a student at the University of the Witwatersrand for the degree of Master of Science in Nursing (Intensive Care). I am conducting a research project to evaluate and describe intensive care nurses' knowledge of evidence-based guidelines regarding weaning the mechanically ventilated patient. Weaning implies the gradual withdrawal of mechanical ventilation and resumption of spontaneous breathing.

The use of nurse led protocols have proven more effective than without in reducing length of mechanical ventilation, preventing and minimizing complications such as ventilator associated pneumonia (VAP), lung injury, self extubation, increased hospital costs and increased mortality. Little is known about nurses' knowledge of such guidelines, and therefore further research is needed.

I invite you as an **expert in the field of intensive care nursing, as well as nursing education and clinical training**, to be part of an expert group in assisting to validate a data collection instrument (a self-administered questionnaire). A focus group will be held to discuss instrument content validity and appropriateness to the South African context. Forty questions known in the literature to result in better patient outcomes regarding weaning will be discussed. Questions are in the form of forced choice (respondents select a single response from a list of options) and Likert scales (agree/disagree). Different categories include: Demographic data (age, experience etc.; Factors predicting weaning failure; Basic facts about weaning; Weaning methods; Spontaneous breathing trial; Predictors for weaning & weaning index; Weaning protocols and sedation. Participation in the validation process is entirely voluntary. If you consent to be part of the expert group, please complete the attached consent form and return it to me in the addressed and stamped envelope enclosed.

While you will derive no benefit from participation in this study, it is hoped that the results will clarify the educational needs of intensive care nurses' regarding weaning. The appropriate people and research committees of the University of the Witwatersrand and your health care institution will be asked to approve this study. If you want any information regarding your **rights as a research respondent, or complaints regarding this research study**, you may contact Mrs. Anisa Keshava, Secretary of the University of the Witwatersrand, Human Research Ethics Committee (HREC), which is an independent committee established to help protect the rights of research respondents at (011) 717 2229.

Thank you for taking the time to read this information letter. Please contact me on the following number: 0783517580, should you require further information.

Yours sincerely,

Jacquie Fischer (MSc Nursing student)   Date: ____________________

APPENDIX III

INTENSIVE CARE NURSES' KNOWLEDGE OF EVIDENCE BASED GUIDELINES REGARDING WEANING THE MECHANICALLY VENTILATED PATIENT.

EXPERT GROUP CONSENT FORM

I ____________________________________ (name) give permission to be included in the study. I have read and understood the content of the information sheet and I have been given the opportunity to ask questions I might have regarding the procedure and my consent to my being included in the study.

____

Date

APPENDIX IV

Jacquie Fischer
Department of Nursing Education
Faculty of Health Sciences
University of the Witwatersrand
7 York Road
Parktown
2193

The Chief Executive Officer
Charlotte Maxeke Academic Hospital
Private Bag X 39
Johannesburg 2000

Dear Mrs. Gladys Mogopodi-Bogoshi

Re: REQUEST TO CONDUCT RESEARCH AT THE CHARLOTTE MAXEKE JOHANNESBURG ACADEMIC HOSPITAL

At present, I am a registered student at the University of the Witwatersrand in the Department of Nursing. I hereby ask for permission to undertake research at Charlotte Maxeke Johannesburg Academic Hospital. The title of my research is**:** *"Intensive Care Nurses' Knowledge of Evidenced Based Guidelines Regarding Weaning the Mechanically Ventilated Patient".*

Evidence based nursing is a current practice worldwide and while there is no one guideline that can predict with accuracy patient readiness to wean, the use of nurse and allied health care professional led weaning protocols have proven more effective than without in reducing length of mechanical ventilation. This, in turn helps prevent and minimize complications such as ventilator associated pneumonia (VAP), lung injury, self extubation, airway trauma, increased hospital costs and increased mortality. The evidence based guidelines have been proven to increase positive outcomes for mechanically ventilated patients and intensive care nurses are in the best position to put these guidelines into practice, as they are in contact with the patient, providing bedside nursing care 24 hours a day. Therefore intensive care nurses need to have knowledge of these guidelines to be able to put them into practice.

The aim of this study is to evaluate and describe intensive care nurses' knowledge of weaning the mechanically ventilated patient and highlight possible barriers that prevent the implementation of evidence based guidelines in order to make recommendations regarding nursing practice, education and further research. I assure you that the institution's name and personnel involved in the study will not be divulged in the research report. Informed consent will be obtained from all respondents and a copy of the research report will be available to you if so requested. I hope to conduct my research at the ICU units once my proposed study has been approved by the Committee for Research on Human Subjects of the University of Witwatersrand.

Yours sincerely,

____

Jacquie Fischer MSc Nursing student Date ___________________

APPENDIX V

INTENSIVE CARE NURSES' KNOWLEDGE OF EVIDENCE BASED GUIDELINES REGARDING WEANING THE MECHANICALLY VENTILATED PATIENT.

RESPONDENT INFORMATION LETTER

Dear colleague,

My name is Jacquie Fischer. I am currently registered as a student at the University of the Witwatersrand for the degree of Master of Science in Nursing (Intensive Care). I am conducting a research project and would like your consent to participate in my study. The purpose of this study is to evaluate and describe intensive care nurses' knowledge of evidence based guidelines regarding weaning the mechanically ventilated patient. The study will include registered with a degree or diploma in intensive care nursing, with different levels of experience, working in selected intensive care units in public hospitals.

Should you consent to participate in the study, I will ask you to sign a consent form. I will then ask you to complete a questionnaire, consisting of thirty-five questions known in the literature to result in better patient outcomes regarding weaning. Questions are both closed ended questions and Likert scales (agree/disagree). Categories include: demographic data; factors predicting weaning failure; basic facts about weaning; weaning methods; spontaneous breathing trial; predictors for weaning, and weaning protocols and sedation. This should not take you more than 20 minutes to complete. I will obtain permission from your unit manager for you to complete the questionnaire in "on duty" time, and I will personally bring you the questionnaire.

Completed questionnaires will be placed in sealed unmarked envelopes. Your participation is voluntary and you may choose not to participate, or to withdraw from the study at any time. Anonymity and confidentiality is guaranteed. No names or identifying information will be asked of you. Only my supervisor and I will have access to the completed questionnaires. Results will be reported in general terms and no identifying information will be reported. Results of the study will be made available if you so wish.

While you will not benefit directly from participation in this study, it is hoped that it will help to clarify the educational needs of nurses with regard to weaning. The appropriate people and research committees of the University of the Witwatersrand and your health care institution will be asked to approve this study. If you want any information regarding your **rights as a research respondent or complaints regarding this research study**, you may contact Mrs Anisa Keshava, Secretary of the University of the Witwatersrand, Human Research Ethics Committee (HREC), which is an independent committee established to help protect the rights of research respondents at (011) 717 2229. Should you wish to contact me, or require any further information, please do not hesitate to contact me on cell number 0783517580 or jacquielouisefischer@gmail.com. Thank you for taking the time to read this information letter.

Yours sincerely,

Jacquie Fischer (Msc Nursing student) Date: ____________________

APPENDIX VI

INTENSIVE CARE NURSES' KNOWLEDGE OF EVIDENCE BASED GUIDELINES REGARDING WEANING THE MECHANICALLY VENTILATED PATIENT.

RESPONDENT CONSENT FORM

I ____________________________________ (name) give permission to be included in the study. I have read and understood the content of the information sheet and I have been given the opportunity to ask questions I might have regarding the procedure and my consent to my being included in the study.

____________________________ ________________________________

Date Signature

____

Witness

APPENDIX VII

Jacquie Fischer
Department of Nursing Education
Faculty of Health Sciences
University of the Witwatersrand
7 York Road
Parktown
2193

R68 Old Potchefstroom Road
PO Bertsham
Johannesburg
2013

The Chief Executive Officer
Chris Hani Baragwanath Academic Hospital

Dear Mr. Sandile Mfenyana

At present, I am a registered student at the University of the Witwatersrand in the Department of Nursing. I hereby ask for permission to undertake research at Charlotte Maxeke Johannesburg Academic Hospital. The title of my research is**:** *"Intensive Care Nurses' Knowledge of Evidenced Based Guidelines Regarding Weaning the Mechanically Ventilated Patient"*.

Evidence based nursing is a current practice worldwide and while there is no one guideline that can predict with accuracy patient readiness to wean, the use of nurse and allied health care professional led weaning protocols have proven more effective than without in reducing length of mechanical ventilation. This, in turn helps prevent and minimize complications such as ventilator associated pneumonia (VAP), lung injury, self extubation, airway trauma, increased hospital costs and increased mortality. The evidence based guidelines have been proven to increase positive outcomes for mechanically ventilated patients and intensive care nurses are in the best position to put these guidelines into practice, as they are in contact with the patient, providing bedside nursing care 24 hours a day. Therefore intensive care nurses need to have knowledge of these guidelines to be able to put them into practice.

The aim of this study is to evaluate and describe intensive care nurses' knowledge of weaning the mechanically ventilated patient and highlight possible barriers that prevent the implementation of evidence based guidelines in order to make recommendations regarding nursing practice, education and further research. I assure you that the institution's name and personnel involved in the study will not be divulged in the research report. Informed consent will be obtained from all respondents and a copy of the research report will be available to you if so requested.

I hope to conduct my research at the ICU units once my proposed study has been approved by the Committee for Research on Human Subjects of the University of Witwatersrand.

Yours sincerely,

____

Jacquie Fischer MSc Nursing student Date ________________________

APPENDIX VIII

R14/49 Ms Jacquie Fischer

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M130732

NAME: (Principal Investigator)	Ms Jacquie Fischer
DEPARTMENT:	Nursing Education Charlotte Maxeke Johanneburg Academic Hospital and Chris Hani Baragwanath Academic Hospital
PROJECT TITLE:	Intensive Care Nurses' Knowledge of Evidence Based Guidelines with regard to Weaning the Mechanically Ventilated Patient
DATE CONSIDERED:	26/07/2013
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Shelley Schmollgruber
APPROVED BY:	Professor PE Cleaton-Jones, Chairperson, HREC (Medical)
DATE OF APPROVAL:	26/08/2013

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 Secretary in Room 10004, 10th floor, Senate House, University.
I/we fully understand the conditions under which I am/we are authorized 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 the application to the Committee. **I agree to submit a yearly progress report**.

Principal Investigator Signature ____________ Date ____________

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

APPENDIX IX

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

MEDICAL ADVISORY COMMITTEE

CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL

PERMISSION TO CONDUCT RESEARCH

Date: 25th November 2013

TITLE OF PROJECT: Intensive Care Nurses' Knowledge of Evidence Based Guidelines with regard to Weaning the Mechanically Ventilated Patient

UNIVERSITY: Witwatersrand

Principal Investigator: Ms Jacquie Fischer

Department: Nursing Education

Supervisor : Shelley Schmollgruber

Permission Head Department (where research conducted): N/A

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

- Permission having been granted by the Committee for Research on Human Subjects 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: 25/11/2013

....
~~Approved~~/Not Approved
Hospital Management
Date: 28/11/13

APPENDIX X

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

CHARLOTTE MAXEKE JOHANNESBURG ACADEMIC HOSPITAL

Enquiries:
Ms. L. Mngomezulu
Tell: (011): 488-3793
Fax: (011): 488-3753
03rd December 2013

Ms. Jacquie Fischer
MSc Nursing student
University of the Witwatersrand

Dear Ms. Fischer

RE: "Intensive care nurses knowledge of evidence base guidelines with regard to weaning the mechanically ventilated patient"

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

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

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

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

Approved / ~~not approved~~

Ms. M.M. Pule
Acting Chief Executive Officer