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INVESTIGATING THE EFFECT OF AN INTERVENTION ON TRACHEAL CUFF PRESSURE MONITORING IN THE CRITICAL CARE ENVIRONMENT OF AN ACADEMIC HOSPITAL IN GAUTENG

by

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Declaration

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I, **Lucy Mashishi Dolo,** hereby declare that this research study entitled **Investigating the effect of an intervention on tracheal cuff pressure monitoring in the critical care environment of an academic hospital in Gauteng** is my own work and that all sources consulted or quoted have been indicated and acknowledged by means of complete references and that this work has not been submitted for any other degree at any other institution.

_____ _____

LM Dolo **Date**

DEDICATION

I dedicate this work to Almighty God whose presence I felt at all times and who I knew held my hand with every step I took.

Also to my children, especially Kabelo, who unfailingly supported me on this incredible journey.

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Glory be to God, for without Him this dissertation would not have been intiated or completed. He was and still is my pillar and strength. I thank Him for placing all the right people in the right places at the right time.

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ABSTRACT

Tracheal cuff pressure monitoring plays a significant role in the care of patients in the critical care environment. Most patients in critical care environment are intubated with cuffed tubes via the ore or the naso-tracheal route, or a tracheostomy is performed. The purpose of the tracheal cuff is to maintain a seal between the tube and the tracheal wall, to prevent volume loss and ensure effective mechanical ventilation. Nurse practitioners in the critical care environment play a vital role in monitoring tracheal cuff pressure, which is often neglected in clinical practice.

Purpose: To investigate the effect of an intervention on tracheal cuff pressure monitoring in the critical care environment of an academic hospital in Gauteng.

Design and methods: A quantitative prospective non-experimental comparative design, with a collaborative qualitative method. The study had a pre and post intervention phase to compare the effect on an intervention.

Findings: The study findings during the pre-intervention phase revealed inconsistency in the monitoring, night time monitoring poor and the found and the adjusted pressure documentation poor. Most pressures found to be non-compliant and serious non-compliant. The post-intervention results revealed an improvement in the night monitoring, but pressures were still found to be high. The consistency in the frequency of monitoring remains poor. Recording of the found and adjusted pressure had a small improvement.

Conclusion: Inconsistent cuff pressure monitoring is done in the critical care environment. Comparing the continuous pressure monitoring, it shows that the frequency of monitoring need to be re-looked. Continuous in-service training may have an effect on the practice and the use of reminders can have an impact in the practice. Frequent clinical audits need to be conducted in order to evaluate practice and have plans for improvement.

Clinical relevance: If the practice of tracheal cuff pressure monitoring can be done according to the revised guidelines, there might be an improved outcome of patients in the critical care environment and reduced costs.

Key concepts: Critical care environment, critical care professionals, clinical audit, tracheal cuff pressure monitoring.

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LIST OF ABBREVIATIONS

CCE	Critical care environment
ICU	Intensive care unit
VAP	Ventilator Associated Pneumonia
ETT	Endotracheal tube
ISO	International Standardisation Organisation
NGT	Nominal Group Technique

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CHAPTER 1
ORIENTATION TO THE STUDY

1.1 INTRODUCTION AND BACKGROUND

Tracheal tube cuff pressure monitoring is a key element when nursing the mechanically ventilated critically ill patient. Tracheal cuffs are inflatable, made of micro-thin polyurethane material and designed to allow positive pressure ventilation of the critically ill patient without the loss of tidal volume (Perrie 2010:D4:2). The purpose of the tracheal cuff is to create a seal between the tracheal tube and the tracheal wall. When the tracheal cuff is inflated it seals and reduces the risk of tidal volume loss through air leaks or microaspiration (aspiration of pharyngeal or gastric contents) (Monahan et al. 2007:615; Proehl 2009:26). In addition Perrie (2010:D4:2) note the ideal tracheal cuff pressure ought to be maintained between 20-22 mmHg or be 27-30 cmH_2O to prevent tissue injury. Some authors recommend tracheal cuff pressures of between 20-30 cmH_2O (Ferrer & Torres 2008:1; Morris, Zoumalan, Roccaforte & Amin 2007:638; Sole et al. 2011:110). The mean tracheal capillary pressure is about 22 mmHg (29.92 cmH_20); therefore, tracheal cuff pressure should not exceed this upper limit. A common challenge in the critical care environment (CCE) is tracheal cuff overinflation or underinflation (Marino 2007:497).

Overinflation (>30 cmH_2O) of tracheal cuff pressure may have catastrophic consequences which include tracheoesophageal fistula, tracheal rupture, tracheal ischaemic lesions which leads to tracheal necrosis, tracheal stenosis, recurrent laryngeal nerve palsy and post-extubation stridor, and laryngeal oedema (Jordan, van Rooyen & Venter 2012:13; Rose & Redl 2008:429; Zand; Nekooeian & Rohani 2008:223). In a survey conducted by Raynham, Lubbe and Fagan (2009:645) in South Africa to investigate the morbidity caused by tracheal stenosis (which is due to overinflated tracheal cuffs), it was found that tracheal cuff pressures are monitored randomly, and secondly that monitoring differed from one hospital to another. It was found tracheal cuff pressures are monitored randomly in the intensive care units (ICUs) in hospitals and secondly monitoring and best practice nursing care differ from one hospital to another. However, as Sole et al. (2011:109) note, tracheal cuff pressure deflates over time (from between 6 to 12 hours) and therefore 4- to 12-hourly monitoring and appropriate adjustment are

required. Smeltzer et al. (2010:648) also advise tracheal cuff pressures should be monitored every 6 to 8 hours while Perrie (2010:D4:4) asserts that, according to the developed Best Practice Guideline, it should be monitored at least once during a shift which translates to twice in a 24-hour period, on admission in the CCE with cuffed tracheal tube, on admission from theatre in the CCE with cuffed tracheal tube, following re-intubation, following procedures like scan and when there is suspicion of tracheal cuff leakage. As mentioned, Raynham et al. (2009:645) discovered this was unfortunately not the case in some South African hospitals.

Complications due to tracheal cuff underinflation (<20 cmH_2O) are mainly air leaks where some of the air forced by positive pressure ventilation into the lungs flows around the cuff into the upper airways, which may result in insufficient ventilation and microaspiration of secretions. Underinflated tracheal cuffs also result in microaspiration of secretions, which in turn causes ventilator-associated pneumonia (VAP). Ventilator-associated pneumonia is a common nosocomial infection in critically ill patients that is associated with poor clinical and economic outcomes, including longer duration of mechanical ventilation, longer hospital stay, increased mortality, and increased hospital charges (Dave et al. 2010:538; Hofstetter et al. 2010:1; Jordan et al. 2012:13; Rose & Redl 2008:429).

In a study done on tracheal cuff leaks, Akca (2007:1624-25) wanted to find out whether ideal tracheal cuff pressure management could prevent VAP. The author investigated elements such as the elevation of the head of bed, subglottic continuous suctioning of secretions, oropharyngeal decontamination, and the use of antiseptic impregnated endotracheal tubes. Monitoring and control of tracheal cuff pressures every six hours were found the most appropriate intervention in preventing VAP. This finding concurred with the best practice nursing care with regards to tracheal cuff pressure monitoring followed at the academic hospital where this study was conducted.

All commercially available tracheal tubes have a pilot balloon that is pneumatically connected to the cuff. The pilot balloon inflates as the tracheal cuff is inflated. A standard practice was observed where healthcare practitioners in the United Kingdom (UK) squeezed the pilot balloon to estimate the tracheal cuff pressure (Faris et al.2007:869).However, this practice is inaccurate and therefore not recommended (Perrie 2010:3; Smeltzer et al. 2010:646; Klingbeil et al. 2008:A38). According to Perrie (2010:D4:2) and Rose and Redl (2008:428), three inexpensive methods can be used in the critical care environment to monitor tracheal cuff pressure.

These methods include:

- the minimal leak technique (MLT);
- minimal occlusion volume (MOV); and
- using equipment such as the sphygmomanometer or aneroid manometer.

Correct recording of the tracheal cuff pressure is important. To prove visibility of tracheal cuff deflation, exact pressure during measurement should be recorded as well as the adjusted measurement if it was done. Recognising the importance of monitoring tracheal cuff pressure and delineating best practices, Perrie (2010:D4:4) developed Best Practice Guidelines for the Critical Care Society of Southern Africa. The author makes two recommendations: tracheal cuff pressure should ideally be maintained between 27–30 cmH_2O, and should be monitored and documented in the following instances:

- once in every shift;
- as soon as possible following intubation;
- when a patient returns from theatre following general anaesthesia using nitrous oxide with cuffed tracheal tube, as nitrous oxide can affect the cuff texture;
- following hypothermic procedures; and
- when a patient has been transferred from another unit, hospital and operating theatre into the CCE with a cuffed tracheal tube. The tube can migrate and affect the cuff pressure during patient transfer.

Monitoring and adjusting tracheal cuff pressures by nurse practitioners in the critical care environment is a vital component of everyday nursing care to prevent complications due to over- and underinflated tracheal cuffs. Perrie`s Best Practice Guideline (2010; view Annexure E) have been implemented in the critical care environment of the academic hospital where the current study was conducted. In addition, the nurse practitioners have received in-service training over a period of two years relating to the best practice guidelines as well as the best practice guidelines relating to the prevention of VAP. The nurse practitioners are required to monitor and document tracheal cuff pressures every six hours on the critical care flow chart simultaneously to the implementation and documentation of the VAP bundle (view Annexure F).

At the time of study, there were six clinical facilitators in the critical care environment at the specific academic hospital. The total of critical beds were 64 (view Table 3.1). In the CCE various practices

were observed which was not in line with current best practice guidelines. It was further observed that tracheal cuff pressure monitoring was done in a haphazard manner without realising the negative impact such inconsistent measuring can have on the patient's health. There was no consistency in the frequency of monitoring or evidence of tracheal cuff deflation if the cuff was overinflated on the flow charts in the critical care environment. Patients returning from theatre are often admitted with overinflated tracheal cuffs, but there is no documentation of the found pressure on the flowchart, only the adjusted measurement is recorded.

Patients were readmitted to the CCE for surgical interventions relating to the complications of overinflated tracheal cuffs. In addition, a consequence of the ineffective tracheal cuff pressure monitoring by nurse practitioners (this was not in line with best practice guidelines) affected the quality of patient care which led to litigation, proved costly to the academic hospital and negatively affected the image of nursing. The researcher's concerns were shared by the unit managers, physicians involved in the critical care environment, and the head of the Department of Critical Care of the academic hospital. This concern is emphasised by Jordan et al. (2012:14) who conducted a study on endotracheal tube cuff pressure management in six adult intensive care units in the public and private healthcare sector in the Nelson Mandela Metropole, Eastern Cape, South Africa. These authors also found in their survey that 52% of the respondents monitor tracheal cuff pressures every 6-12 hours, whilst more frequent monitoring of (every 2-4 hours) was performed by 32% and 15% of whom assessed cuff pressure when a leak occurred, and 1% never performed monitoring. They also find a significant difference between the public and private sectors as the private sector ascribed to more frequent monitoring (every 4-6 hours). In the public sector, monitoring was more typically performed (6-12 hour intervals) or when there was a leakage.

The aim of the current study was therefore to investigate the effect of an intervention on tracheal cuff pressure monitoring in the critical care environment of the academic hospital in Gauteng.

1.2 PROBLEM STATEMENT

Tracheal cuff pressure monitoring is one of the responsibilities of the nurse practitioner caring for mechanically ventilated critically ill/injured patients in the critical care environment (Jordan et al. 2012:13; Perrie 2010:D4:1). Tracheal cuff pressures should be measured and adjusted at least once per 12-hour shift to ensure an ideal pressure of 27–30 cmH_2O is maintained (Perrie 2010:D4:2). In the

academic hospital the monitoring of the tracheal cuff pressures is suggested to be done at least every six hours which concurs with the VAP bundle checklist and is indicated as such by Sole et al. (2011:109). As mentioned, the over- and underinflation of tracheal cuffs can result in serious complications for the patient; it can also increase the risk for patient morbidity and mortality and add to hospital costs as confirmed by both Rose and Redl (2008:429) and Jordan et al. (2012:13). For these reasons, the researcher determined the execution of tracheal cuff pressure monitoring a problematic issue in this academic hospital. She observed in the CCE of the academic hospital that best practices relating to tracheal cuff pressure monitoring was not implemented. As a shift leader, the researcher rechecked tracheal cuff pressures on numerous occasions and found both over- and underinflated tracheal cuffs. Her concern about the nurse practitioners not following the implementation of the current best practice guidelines suggested in the CCE of the academic hospital was shared by physicians and the hospital management. The physicians were troubled about the associated morbidity and mortality while the hospital management's concern pertained to the increased costs involved.

Seven patients, of whom three died, were readmitted to one of the intensive care units in the CCE of the academic hospital for tracheal injury repair following injuries due to tracheal tube overinflation between January and November 2011 (The Hospital 2011). Using a national database available in the United States of America (USA), Bhatti et al. (2010:31) investigated the costs involved following tracheal cuff related injuries. The authors found patients with tracheal cuff injuries were hospitalised for an average of 6.3 days more; the additional costs averaged $11.025 more for the total 6.3 days. The case manager of a private hospital group in South Africa determined the average cost of tracheal repair to be approximately R400 000-00 for the whole procedure including hospital stay (Case manager personal communication 2012). Perrie (2010:D4:4) developed Best Practice Guidelines for Tracheal Pressure Monitoring for the Critical Care Society of Southern Africa. Because these guidelines are available, nurse practitioners working in the critical care environment of an academic hospital need to follow them to provide quality healthcare by preventing complications like tracheal stenosis and VAP.

1.3 RESEARCH QUESTION

The research question for this study was:

What is the effect of an intervention on tracheal cuff pressure monitoring in the critical care environment of an academic hospital?

1.4 AIM AND OBJECTIVES

The aim of the study was to investigate the effect of an intervention on tracheal cuff pressure monitoring in the critical care environment of an academic hospital in Gauteng. To address the aim, the following objectives relating to tracheal cuff pressure monitoring in the critical care environment was delineated (view Annexure A):

- **Phase 1**: To prepare for the audit.
- **Phase 2**: To investigate the current practices of tracheal cuff pressure monitoring.
- **Phase 3**: To collaboratively plan and implement interventions for change:
  - ✓ Step 1: Diffusion and dissemination of the results
  - ✓ Step 2: Decision on the intervention
  - ✓ Step 3: Intervention
- **Phase 4**: To reinvestigate for change in practice (Post-intervention audit)

1.5 SIGNIFICANCE OF THE STUDY

The study may be of benefit to critically ill/injured patients with tracheal cuffed tubes in the critical care environment of an academic hospital in Gauteng. If nurse practitioners in the critical care environment follow the best practice guidelines for tracheal care monitoring, it can reduce the risk of complications like tracheal stenosis, tracheosophageal fistulae and VAP (Jordan et al. 2012:13)

The results of the clinical audit may raise awareness about the disordered manner in which the available best practice guidelines relating to tracheal cuff pressure monitoring in the critical care environment are currently implemented. Through collaboration the clinical facilitators may facilitate the accurate implementation of best practice guidelines of tracheal cuff pressure monitoring which may in turn decrease the length of stay of patients and thereby decreasing their hospital costs. The view of Muller, Bezuidenhout and Jooste (2012:47) that leadership and influence may assist in the investigation of tracheal cuff pressure monitoring, is supported by Ransom et al. (2008:71). Using the audit cycle may in future enable the nurses to address similar clinical practices in the critical care environment.

1.6 KEY CONCEPT

For simplicity and consistency throughout the context of this study, the key concepts were defined.

1.6.1 Aneroid

An 'aneroid' is an instrument that "*does not contain a liquid nor a column of liquid mercury*". It is a manometer used to measure the pressure of the endotracheal tube cuff and it is calibrated in cmH_2O (*Mosby's medical dictionary* 2009). The *Concise Oxford English dictionary* (2006) defines an 'aneroid' as denoting a barometer measuring air pressure "by the action of the air in deforming the elastic lid of an evacuated box".

In this study the aneroid is used to monitor tracheal cuff pressure on patients with cuffed tracheal tubes in the CCE of the academic hospital in Gauteng.

1.6.2 Audit cycle

The 'audit cycle' is a process that "*seeks to improve patient care and the implementation of change in practice if needed*" (Dixon 2010:3). The definition was adopted for the study.

1.6.2.1 Clinical audit

The National Institute for Health and Clinical Excellence (NICE 2002:41) defines a 'clinical audit' as "*a quality improvement process that seeks to improve patient care and outcomes through systematic review of care against explicit criteria and the review of change*".

In this study the key concept 'clinical audit' refers to auditing the practice of tracheal cuff pressure monitoring in the CCE of the academic hospital in Gauteng.

1.6.2.2 Concurrent clinical audit

A 'concurrent clinical audit' is performed during on-going care (NICE 2002:41).

In this study using the key concept 'concurrent clinical audit' refers to the audit conducted using patients information from the ICU flowcharts, and the random monitoring of tracheal cuff pressure of patients who are still intubated in the CCE at the time of data collection.

1.6.3 Critical care environment

According to the dictionary definition, the 'critical care environment' is a specialised section of the hospital that contains equipment, medical and nursing staff, and monitoring devices necessary to provide intensive care (*Mosby's medical dictionary* 2009).

In this study the five (5) adult ICUs, one (1) high care unit and one (1) emergency unit in the academic hospital in Gauteng form part of the critical care environment.

1.6.4 Critical care professionals

According to *Mosby's medical dictionary* (2009), 'critical care professionals' are healthcare professionals who are "*specially trained in a unit equipped with various technologically sophisticated machines and devices for treating and monitoring the condition of the patient"*.

In this study the critical care professionals referred to are professional nurses who work with critically ill patients in the CCE of the academic hospital in Gauteng, who possess a nursing qualification or experience in critical care nursing.

1.6.5 Endotracheal tube

The 'endotracheal tube' is a large "*bore catheter inserted through the mouth or nose into the trachea to a point above the bifurcation of the trachea proximal to the bronchi*" (*Mosby's medical dictionary* 2009). An endotracheal tube with a balloon at the end *"may be inflated to tighten the fit in the lumen to prevent gastric contents from passing into the lungs and gas leaking back from the lungs*" (*Mosby's medical dictionary* 2009).

In this study the tracheal tube referred to is the cuffed tube attached to a pilot balloon used for adult intubation to maintain an airway.

1.6.6 Tracheal cuff pressure monitoring

Tracheal cuff pressure monitoring includes the implementation and documentation of the Best Practice Guidelines for the Critical Care Society of Southern Africa developed by Perrie (2010:D4:4) (view Annexure E) in the critical care environment. It includes the monitoring of cuff pressures, adjustment thereof if necessary, and documenting it accordingly every six hours (Patel 2010:28; Perrie 2010:D4; The Hospital VAP checklist 2013 (view Annexure F).

In this study tracheal cuff pressure monitoring relates to time of monitoring, frequency, documentation of the found and adjusted pressure, maintaining pressures of between 25-30cmh20, monitoring on admission from theatre with cuffed tracheal tube, following procedures, re-intubation or when there is cuff leakage in the CCE of the academic hospital in Gauteng.

1.7 RESEARCH METHODOLOGY

Rajsekar, Philominathan and Chinnathambi (2006:2) regard the research methodology as the systematic way in which a research problem is solved. Polit and Beck (2008:765) agree with the aforementioned authors by stating that research methodology is the specific methods used by the researcher to structure a study and gather information on the topic. The current researcher found that the audit cycle was a suitable methodology for this study As cited by Patel 2010:30 (Hughes 2008, Aazh et al. 2009) clinical audits are referred to as the cycles of activities that intend to lead to improvements in the clinical practice. The audit cycle is used as the evidence obtained can be systematic and be used objectively to evaluate the audit criteria (International Organisation for Standardisation (ISO) 9001 2008). because it provides a "*systematic and documented process for obtaining evidence and objectively evaluate the extent to which the audit criteria are fulfilled"* (ISO 9001 2008).

In this study the researcher sought to investigate the effect of an intervention on tracheal cuff pressure monitoring and to collaboratively with the clinical facilitators plan interventions to inform the implementation of best practice guidelines. The endeavour to collaborate the researcher with the clinical facilitators in the planning of data collection and interventions is supported by Gardner et al. (2009:1).

As it has been proven to provide a method for improving quality in the clinical practice, the audit cycle was appropriate for use in this study (Healthcare Quality Improvement Partnership 2012:11-17; Dixon & Pearce 2011:1-36; NICE 2002:54). In Figure 1.1 the audit process model adopted and adapted from Amarakone and Panesar (2006:171) and Hamer and Collison (1999:134) used in this study is illustrated.

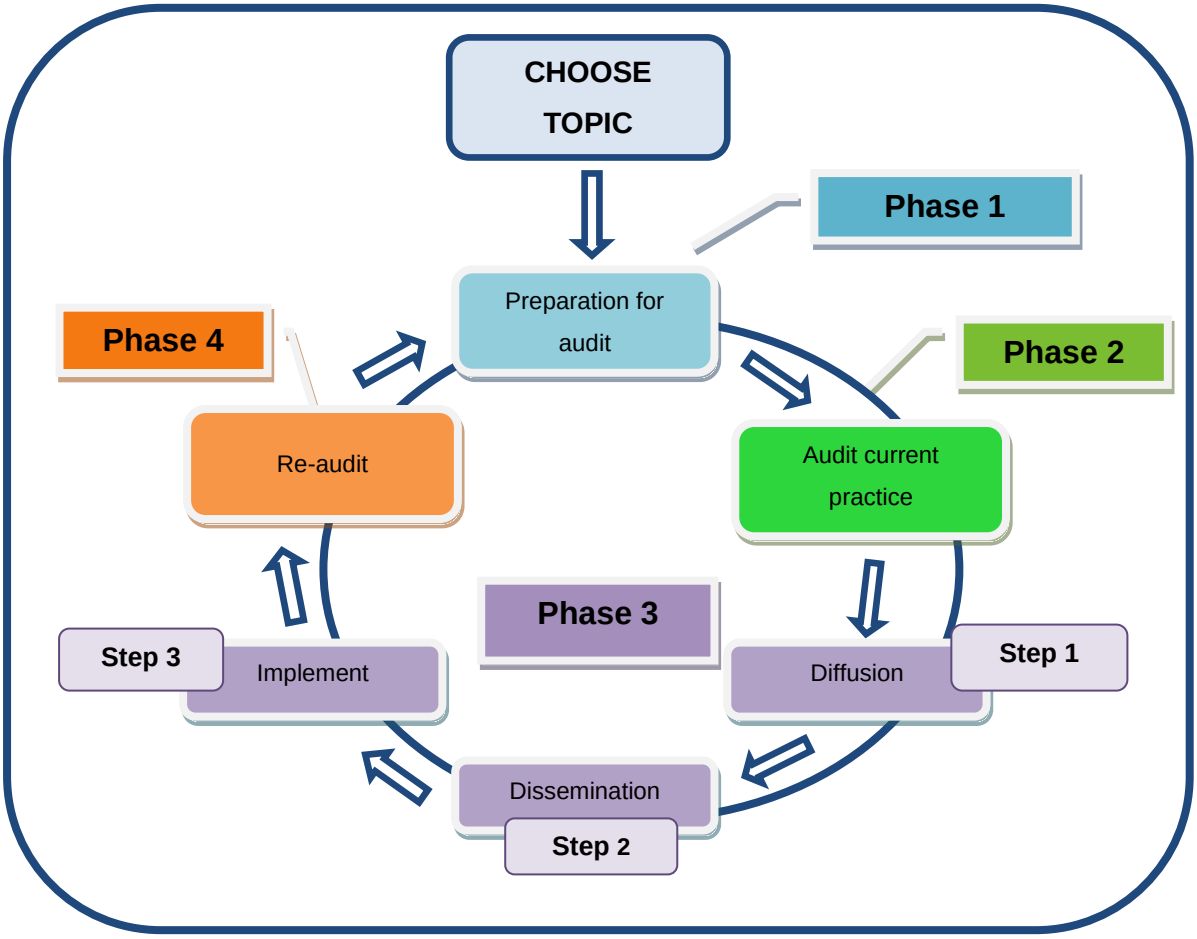

Figure 1.1: The audit process cycle ***(adopted and adapted from Hamer & Collison 1999:134;Amarakone & Panesar 2006:171)***

All components (which are the components in Figure 1.1 Preparation for the audit, audit current practice, intervention and re-audit the practice) of the audit cycle and its related application to the study are depicted in Figure 1.1. The discussion of the application of each component is discussed in Phases 1 to 4 (view Table 1.1).

1.8 DESIGN AND METHODS

The study was conducted in four phases:

- **Phase 1**: Preparation
- **Phase 2**: Pre-intervention
- **Phase 3**: Intervention
- **Phase 4**: Post-intervention

The research design and methods used for each of the four phases of the study are summarised in Table 1.1.

Table 1.1: Summary of research design and methods

Phase 1: **Preparation**					
Objective: **To prepare for the audit**					
Population	**Sampling**	**Sample size**	**Data collection**	**Data analysis**	**Validity and reliability**
• The clinical facilitators of the academic hospital who were involved in training and development of the nurse practitioners at the academic hospital in Gauteng.	• Non-probability study as not all clinical facilitators might have received training or been part of the data collection process. • All clinical facilitators were given a chance to be selected (Brink, van der Walt & van Rensburg 2006:131).	• Five clinical facilitators from the academic hospital.	• Information session was held. • Clinical facilitators were informed about the use of the clinical audit checklist, VAP bundle checklist, and the Best Practice Guideline. • Data quality depends on the training of data collectors to ensure reliability of the data and to make adjustments (Dixon & Pearse 2011:27).	• Five clinical facilitators attended the information session in preparation for the clinical audit.	• The five clinical facilitators were trained to ensure they were knowledgeable to use the clinical audit checklist. • Their training ensured quality of data collection and reliability (De Vos et al. 2011:47; Dixon & Pearse 2011:27).

Phase 2: Pre-intervention audit					
Objective: To investigate current practices using a clinical audit checklist					
Population	**Sampling**	**Sample size**	**Data collection**	**Data analysis**	**Validity and reliability**
• Flow charts of patients who met the inclusion criteria, namely, patients who were mechanically ventilated and had had cuffed tracheal tubes in the previous 24 hours in the critical care environment of the academic hospital in Gauteng (Wong 2009:E3).	• Non-probability sampling as not every element in the population can be selected in the sample (Polit & Beck 2010:275).	• Thirty-nine (N=39) flow charts of the patients who were mechanically ventilated and intubated with cuffed tracheal tubes in the previous 24 hours (Wong 2009:E3). • The researcher did monitoring with the aneroid manometer on thirty-four patients (n=34).	• Clinical audit checklist used as a guide to collect data from the flow charts of patients who were intubated with cuffed trachea tubes in the previous 24 hours. • Data were collected by means of a structured plan as it enhanced the objectivity of the data and eliminated bias (Botma et al. 2010:131). • A structured plan is also designed to produce numeric information (Polit & Beck 2010:433) • The researcher did the measurement on all patients intubated with cuffed tracheal tubes at the time of data collection using the same aneroid manometer, namely, the Mallinckrodt HI-Lo hand pressure gauge made in Germany, for all the patients.	• Quantitative analysis of data collected with the use of the clinical audit checklist. • Numbers and percentages were used to analyse data. • Inferential statistical analysis was used to estimate the parameter from the sample (Polit & Beck 2010:583).	• To ensure validity and reliability, the same clinical audit checklist as well as the same aneroid manometer was used for all patients. • Content-related validity was ensured during the design of the clinical audit checklist by involving experts (the Head of Critical Care and the statistician). They gave valuable input for the design (Gerrish & Lacey 2010:336).

• **Phase 3: Intervention**					
• **Objective**: Based on current practices, to collaboratively plan and implement interventions for change					
Population	**Sampling**	**Sample size**	**Data collection**	**Data analysis**	**Trustworthiness**
• Nurse practitioners working with patients who had cuffed tracheal tubes in the critical care environment of the academic hospital.	• Non-probability sampling as not all nurse practitioners rendering care to these patients would be included as participants in the group.	• The researcher gave verbal feedback to thirty-six (n=36) nurse practitioners in different critical care areas. • Not all nurse practitioners could be reached but the information was to be shared with other practitioners (Ivers et al. 2012:2). • Eleven (n=11) nurse practitioners formed part of the nominal group to collaboratively agree on an intervention (Lloyd 2011:107; O`Connor et al. 2013:2-4). • In-service training was given to seventy-two (n=72) nurse practitioners in different critical care areas.	• Process of diffusion whereby verbal feedback was given to nurse practitioners (Ivers et al. 2012:2). • The nominal group technique (NGT) was also used to disseminate the results and collaboratively plan an intervention (Lloyd 2011:107). • In-service training was used as a method of intervention as it could have a significant impact on or improve outcomes such as behaviour (Strait, Lima & Furco 2009:106-107). • Posters were placed at different critical care areas as reminders to enforce learning (Kools, et al. 2005:104). • (View Annexure 3.1).	• This was achieved by the number of nurse practitioners who received feedback, the number of nominal group participants and the number of nurse practitioners who received in-service training.	• Trustworthiness refers to the methodological soundness and adequacy of the study (Holloway & Wheeler 2010:302). • Polit and Beck (2008:768) state it is the degree of confidence qualitative researchers have in their data. • The collaborative decisions were undertaken with trust as every participant had a chance to voice their opinions. • Polit and Beck (2008:539) list the criteria for trustworthiness as the following: o *credibility,* o *dependability,* o *confirmability,* o *transferability* o *authenticity.*

Phase 4: Post-intervention					
Objective: Following the implemented interventions to reinvestigate practices using the clinical audit checklist					
Population	**Sampling**	**Sample size**	**Data collection**	**Data analysis**	**Validity and reliability**
• Patients in the critical care areas of the academic hospital in Gauteng.	• Flow charts of patients who were intubated with cuffed tracheal tubes and were mechanically ventilated over the previous 24 hours. • Tracheal cuff pressure monitoring of patients who were intubated at the time of the audit.	• It depended on the number of flow charts of patients who had been intubated with cuffed tracheal tubes for the previous 24 hours. • The two sets of data rendered a total of thirty (n=30) patients whose flow charts were audited. • Thirty (n=30) flow charts were audited. • The researcher did the monitoring on twenty-three (n=23) patients who were intubated with cuffed tracheal tubes at the time of data collection.	• The clinical audit checklist used in the pre-test was used. • The same aneroid manometer as used during pre-test was used again.	• Numbers and percentages were used to objectively analyse the data.	• This was ensured throughout the data collection process as the facilitators were instructed to ask for assistance and help when clarity was needed. • The same clinical audit checklist of the same patients was used. • The same aneroid manometer was used for all patients. • All other manometers were removed from patients' bedsides and emergency trolleys to prevent manipulation. • The audit was also unannounced.

The research design and methods used for each phase are discussed in-depth in Chapter 3.

1.9 ETHICAL CONSIDERATIONS

Before commencing with the research, ethical approval was be obtained in the form of ethical clearance certificates from the Faculty of Health Science Research Ethics Committee of the University of Pretoria (view Annexure A1) as well as from the academic hospital where the study was conducted (view Annexure A2). Permission to gain access to the research site, participants and critical care flow charts was obtained from the management of the academic hospital (view Annexure A2). The name of the particular hospital was not used and the nurse practitioners also patients remained anonymous. This was done to guarantee confidentiality was maintained and the participants' rights were protected.

The participants' right to self-determination, privacy, autonomy, confidentiality, full disclosure about the study, and protection from discomfort and harm were ensured throughout the study (Burns & Grove 2009:190-199). All the participants were requested to sign informed consent forms before participating in the study. A participant information leaflet (view Annexure B) accompanied the informed consent form. All the participants were informed that it was their right to choose to participate or decline participation; they were assured they could withdraw from the study at any stage without prejudice and without stating a reason (Holloway & Wheeler 2010:59). The researcher made herself available for questions at all times during the data collection period. No names of patients were documented on the clinical audit checklist (view Annexure H) during data collection.

Data collection took place with minimal disruption of the clinical practice. The researcher consulted the clinical facilitators on the best time to collect data. No participant was coerced in any way to participate and in this study refers to the clinical facilitators. The researcher refrained from using the names of the participants in any documentation to protect their anonymity. Before commencing with the study, the researcher as well as the facilitators involved in the nominal group set confidentiality as one of the ground rules of the day. All data generated were kept securely in an undisclosed location after data collection for the remainder of the research process. The data will be kept for a period of 15 years as stipulated by the Research Ethics Committee of the University of Pretoria. View Chapter 3 for further discussion.

1.10 LAYOUT OF THE STUDY

The layout of this study is as follows:

- Chapter 1: Orientation to the study
- Chapter 2: Literature review
- Chapter 3: Research methodology
- Chapter 4: Results and discussions
- Chapter 5: Conclusions, limitations and recommendations

1.11 SUMMARY

Tracheal cuff pressure monitoring plays a significant role in the care of critically ill or injured patients in the critical care environment. Continuous in-service education and the use of reminders can lead to a change in healthcare workers' attitude and behaviour towards the importance of the correct and timely monitoring of tracheal cuff pressure. An increase in the frequency of monitoring and maintaining the pressures of between 25–30 cmH_2O can improve the quality of care of these patients in the critical care areas of the academic hospital. The documentation of the found and adjusted pressure could assist in the visibility of tracheal cuff deflation. The effective monitoring, of all patients in the CCE of the academic hospital with cuffed tracheal tubes could assist in the prevention of complications that result from over- or underinflation of the tracheal cuffs.

CHAPTER 2
LITERATURE REVIEW

2.1 INTRODUCTION

Chapter 1 provided an orientation to the study. In Chapter 2 a literature review is presented which focuses on the quality of patient care and best practice guidelines. The role of the professional nurses in quality patient care is emphasised with specific attention paid to the documenting and monitoring of tracheal cuff pressures in everyday practice. The focal point of the literature review is on tracheal cuff pressure monitoring.

In Section 2.2 the anatomical structures of the airway are discussed. Section 2.3 of this chapter provides a brief discussion on airway management. Section 2.4 outlines the ideal tracheal cuff pressure. Mechanical ventilation is addressed and discussed in Section 2.5 and clarity on different modes is given. In Section 2.6 the focus is on complications of tracheal cuffs. Section 2.7 outlines what is meant by quality care while Section 2.8 explains best practice guidelines. Section 2.9 outlines obtaining the evidence through the utilisation of the clinical audit, the importance of practitioner involvement, and the importance of management and leadership responsibility. The conclusion to this chapter is given in Section 2.10.

2.2 ANATOMICAL STRUCTURES OF THE AIRWAY

A patent airway is important in the care of patients in the critical care environment (CCE) to achieve effective mechanical ventilation. Patients are admitted in the critical care environment following major elective surgery, respiratory failure, and major trauma. Black and Hawks (2009:1541) as well as Marino (2007:278) draw attention to the importance of making sure that the airway of a patient in the critical care environment is unobstructed and open. Measures must therefore be taken in the CCE to protect the patient's airway; but to be able to execute the measures to protect the airway, it is vital to understand the anatomy of the human airway. As described in the following Sections 2.2.1 and 2.2.2, the airway comprises of an upper and a lower part.

2.2.1 Upper airway

The upper airway consists of the nose and sinuses, the pharynx and the larynx (Monahan et al. 2007:565; Peate & Nair 2011:330). The upper part of the nose is supported by bone and the lower part by cartilage. The external openings to the nose are the nostrils. The primary function of the nose is smell and it is the passage through which air travels on its way in and out of the lungs. Air is humidified by the nose (Monahan et al. 2007:565; Peate & Nair 2011:330). The pharynx (or throat) is divided into the nasopharynx, oropharynx and laryngopharynx (Marieb & Hoehn 2007:837). It is the only opening between the nose, mouth and lungs; hence, any obstruction of the pharynx by either foreign body or tissue swelling can lead to the cessation of ventilation. The laryngopharynx opens into the larynx and oesophagus (Monahan et al. 2007: 565; Peate & Nair 2011: 3310).

The larynx, known as the voice box, connects the pharynx to the trachea (commonly known as the windpipe). The larynx is made up of cartilage, muscle and ligaments and houses the vocal cords (Marieb & Hoehn 2007:838; Peate & Nair 2011:331). The larynx has the laryngeal nerve, which is stimulated by the presence of foreign particles, other irritants and dry mucous membrane. The authors further alludes that damage to the laryngeal nerve will result in paralysis of the laryngeal muscles, then foreign materials can enter the lungs.

2.2.2 Lower airway

The lower airway consists of the trachea, bronchi and bronchioles (Monahan et al. 2007:566; Peate & Nair 2011:322). The trachea or windpipe is the continuation of the air passage below the larynx. The trachea is about 15 cm long; at the lower end the trachea connects the larynx to both the right and left main-stem bronchi. Meiring et al. (2010:272) describe the trachea “extends from the lower border of the cricoid cartilage to the level of the fourth thoracic vertebra where it bifurcates into left and right bronchi”. The point at which the trachea bifurcates into the two bronchi is known as the carina (Marieb & Hoehn 2007:838). The carina has cough receptors which can be easily stimulated by tubes such as suction catheters and endotracheal tubes (Monahan et al. 2007:566). The trachea and bronchi are supported by incomplete cartilaginous rings that prevent airway collapse when the pressure in the thorax becomes negative. The trachea shares a small muscle with the oesophagus at the point where the cartilaginous rings of the trachea are incomplete, this prevent airway collapse when the pressure in the thorax is negative. This is the potential site for the development of a tracheoesophageal fistula. Thus, if there is

an inconsistent monitoring or a lack of monitoring the cuffed endotracheal or tracheostomy tubes, it may lead to fistulae (Monahan et al. 2007:566; Peate & Nair 2011:332).

"The right and left main bronchi are formed by the division of the trachea at the level of T7 in an erect position, and each bronchus runs obliquely in the mediastinum before plunging into the medial depression called the hilus of the lung on each side" (Marieb & Hoehn 2007:838). The right bronchus, which is wider and also shorter than the left, extends nearly vertically from the trachea. As further explained by Marieb and Hoehn (2007:838) and Meiring et al. (2010:273), the structure of the bronchi and trachea are similar except that the cartilaginous rings of the bronchi are complete while that of the trachea, as mentioned, are incomplete at the point where it shares the small muscle with the oesophagus. In the lungs each primary bronchus subdivides into secondary bronchi (three secondary bronchi on the right and two on the left) each supplying one lung lobe. The secondary bronchi again branch in the lungs to form tertiary bronchi; ten for each lung. The bronchi terminate into bronchopulmonary segments of the lung where smaller branches known as bronchioles are formed (Marieb & Hoehn 2007:839; Meiring et al. 2010:273).

Aspiration or tube displacement occurs in the right main bronchus because of its anatomical features, as it is wider and shorter than the left bronchus and it also extends more vertical from the trachea. It is therefore critical to secure the tracheal tube so that proper ventilation can be maintained and tube migration be prevented (Monahan et al. 2007:567; Peate & Nair 2011:333). The bronchioles are passages which are smaller than 1 mm in diameter; the tiniest are smaller than 0.5 mm in diameter and are called terminal bronchioles (Marieb & Hoehn 2007:839). The bronchioles which contain no cartilage for support, divide into terminal bronchioles and respiratory bronchioles. The respiratory bronchiole eventually ends in alveolar ducts which terminate in the alveoli (Meiring et al. 2010:273).

2.3 AIRWAY MANAGEMENT

The free movement of air through the upper and lower airways result in adequate ventilation. In many disorders the airway becomes narrowed or blocked as a result of disease, bronchoconstriction, a foreign body or secretions (Smeltzer et al. 2010:645). Airway management is required in the critical care environment when patients are unable to maintain and protect their own airway or when they require either short- or long-term mechanical ventilation. In such cases an artificial airway has to be performed using an endotracheal tube or, alternatively, a tracheostomy has to be performed (Black &

Hawks 2009:1639; Proehl 2009:70; Smeltzer et al. 2010:653). Griesdale, Henderson and Green (2011:181-182) assert an appropriate airway assessment should be done as most intubations in the critically ill are “urgent” rather than “emergent”. In the opinion of these authors, there is usually sufficient time to assess and optimise the patient’s condition before reaching a final decision on whether endotracheal intubation or a tracheostomy is needed.

Endotracheal and tracheostomy tubes have a cuff towards the end of the tube to maintain a seal between the tracheal wall and the tube for effective mechanical ventilation. The cuff also prevents the macroaspiration of secretions which may ultimately result in lung infection (Black & Hawks 2009:1639; Proehl 2009:70; Smeltzer et al. 2010:645; Wiegand 2011:225).

2.3.1 Endotracheal intubation

Endotracheal intubation involves passing an endotracheal tube through the mouth or nose of the patient into the trachea. This is a means of providing an artificial airway for patients who cannot maintain their airway. The tube is passed through the oral route. The advantages of using this route include reduced damage to the nostrils and minimising the risk of sinusitis caused when using the nasal route (Smeltzer et al. 2010:646). On the hand, the disadvantages of oral tubes include poor oral care, suppressed cough reflex, irritation or trauma to the tracheal lining, an increased incidence of vocal cord paralysis, discomfort for the patient, and patients may bite the tube resulting in obstruction of the airway (Smeltzer et al. 2010:653). Although nasal intubation may be perceived as a more secure and comfortable method (the tube does not move as much as in the mouth and it allows for better mouth care) it is not the preferred method because of the risk of sinusitis (Black & Hawks 2009:1640; Urden, Stacey & Lough 2006:591).

Endotracheal tubes may cause complications due to the pressure exerted by the cuff on the tracheal wall and they therefore may not be used for longer than three weeks, but by this time a tracheostomy is in any case considered as noted by Smeltzer et al. (2010:646). A tracheostomy is performed to help prevent infection when tracheal pressure is low and macroaspiration of secretions occur. Tube obstruction as another complication is mentioned by both Urden et al. (2006:591) and Jordan et al. (2012:13) but the latter also indicate tube displacement can occur because of the movement of the tube by the patient`s tongue. The authors are also supported by Yildirim, Uzonkoy, Cigdem, Ganidagli and Ozgonul (2011:1886), who states sinusitis as another complication when patients had nasal intubation.

The authors further alludes that tracheal cuff overinflation may result in tracheoesophageal fistula, laryngeal or tracheal stenosis. Abscesses in the cricoid cartilage may also result due to infection.

Other minor complications are observed like post-intubation sore throat which can be caused by the pressure exerted by the tracheal cuff during surgery (Tan et al. 2011:791). Post-intubation sore throat is said to be a common side effect of general anaesthesia and may also result from ischaemia of the tracheal mucosa (Sengupta et al. 2004:1471).

2.3.2 Tracheostomy

A tracheostomy is a surgical procedure in which an opening is made into the trachea; it may be temporary or permanent depending on the condition or indication it is performed for (Marino 2007:495; Urden et al. 2006:594). Conditions or indications that necessitate a tracheostomy to be performed include when there is inability to perform endotracheal intubation, for example, severe laryngeal trauma, epiglotitis, neoplasm, space abscess or foreign body in the pharynx that prevents endotracheal intubation and also where there is a need for definitive airway after cricothyrotomy (Monahan et al. 2007:617; Proehl 2009:7). The advantages of a tracheostomy is that it provides the best route for long-term airway maintenance because it prevents the oral, nasal, pharyngeal and laryngeal complications, which are sometimes associated with the endotracheal intubation like the aspiration of oral or gastric contents (Smeltzer et al. 2010:648).

Being a surgical procedure, effective aftercare is extremely important for a patient with a tracheostomy . In the course of care, early as well as late complications can be encountered. The early complications include bleeding, pneumothorax, air embolism, aspiration, and recurrent laryngeal nerve damage. But, in the ongoing course of care some complications can occur later which include airway obstruction due to the accumulation of secretions, protrusion of the cuff over the opening of the tube, infection, rupturing of the innominate artery, tracheoesophageal fistula, tracheal dilation, tracheal ischaemia and necrosis, and tracheal stenosis may occur after the removal of the tube (Smeltzer et al. 2010:649). Tracheostomies may be cuffed or uncuffed, and an inflated cuff permits mechanical ventilation and deters secretions from the upper airway leaking into the lower airway (Marino 2007:617; Urden et al. 2006:594; Wiegand 2011:97).

Endotracheal and tracheostomy tubes have a cuff towards the end to maintain a seal between the tracheal wall and the tube for effective mechanical ventilation and to prevent the macroaspiration of secretions (Black & Hawks 2009:1541; Proehl 2009:70; Smetzer et al. 2010:653; Wiegand 2011:225). In the next Section the different types of tracheal cuffs are briefly described.

2.3.3 Types of tracheal cuffs

Dave et al. (2010:548-9) and Bent and Toschlog (2012:1-4) describe the cuff materials and shapes currently available:

- **Polyurethane cuffs:** These are characterised by a thinner wall that creates a stronger seal at safe cuff inflation pressures. The structure of the trachea is said to be non-uniform, not cylindrical, irregular and also D-shaped. When a cuff with redundant polyurethane material is inflated, tiny channels are created that encourage pooling or collection of secretions within folds.
- **Polyvinylchloride cuffs:** The tubes made from polyvinylchloride show much more and faster fluid leakage than cuffs made of polyurethane.
- **Guayule latex cuffs:** Tracheal cuff shapes are classified as cylindrical, which is characterised by longitudinal folds especially in high-volume low-pressure cuffs.
- **Tapered shaped cuffs:** They have reduced folds and channels; hence, they offer a sealing zone thus minimising fluid leakage past the tube. The influence of the cuff shape on fluid leakage is particularly evident among polyvinylchloride cuffs.
- **Foam cuff tracheostomy tube:** As described by Urden et al. (2006:594), this is a type of tube on the market that has a cuff made of foam that is self-inflating. The tube is deflated during insertion, and then the pilot port is opened to atmospheric pressure and the cuff self inflates.

The cuff design is intended to prevent injury to the trachea from overinflated cuffs. These cuffs are used for patients who may have airway erosion or tracheomalacia (Black & Hawks 2009:1544). Once inflated, the foam cuff conforms to the size and shape of the patient's trachea thereby reducing the pressure against the tracheal wall. The pilot port is left open to atmospheric pressure or attached to a mechanical ventilator tube which allows the cuff to inflate and deflate with the cycling of the ventilator. Routine maintenance of the foam cuff tracheostomy tube includes aspirating the tube every eight hours to measure the cuff volume, to remove condensation from the cuff area, and to assess the integrity of the cuff (Urden et al. 2006:596).

2.3.4 Cuff design

The way in which tracheal cuffs are designed determines their function. Spiegel (2010:53-4) and Wiegand (2011:88) describe the two different cuff designs and their function as follows:

- **High-pressure low-volume cuffs** are made of non-disposable silicone. The cuff has a small diameter at rest and a low residual volume which is said to be the amount of air that can be withdrawn from the cuff after it has been allowed to equilibrate with atmospheric pressure. The aforementioned authors observe that, to get sufficient sealing, the high-pressure low-volume cuff requires a high intracuff pressure to overcome the low compliance of the cuff. The cuff makes a small area of contact with the trachea and deforms the trachea to a circular shape. The authors agree there is the possibility of ischaemic damage to the mucosal wall due to prolonged use. The cuffs may inflate in a noncircular fashion and cause the endotracheal tube to injure the trachea. The advantages of high-pressure low-volume cuffs are their reusability, the overall low cost, low incidences of sore throat and they provide better protection against aspiration.
- **A high-volume low-pressure cuff** as described by Spiegel (2010:53) and Wiegand (2011:88) comprises a thin compliant wall which adapts and conforms easily to the irregular borders of the tracheal wall when inflated. The advantage in using these cuffs is that if the wall of the cuff is not stretched, the intracuff pressure will correlate closely with the tracheal mucosal pressure. Spiegel (2010:53) and Wiegand (2011:88) are in agreement that when compared to high-pressure low-volume cuffs, the high-volume low-pressure cuffs are associated with fewer complications. In a study Chadha et al. (2011:30) investigated whether cuff pressure modulation did reduce endotracheal tube injury. Their finding proved there was a reduced risk of tracheal damage when tubes with a high-volume low-pressure are used. According to Spiegel (2010:52), the ideal tracheal cuff is to be maintained at a pressure of 20–30 cmH_2O.

2.3.5 Ideal cuff pressure

The purpose of the tracheal cuff is to maintain a seal between the tracheal wall and the tube. Once the seal is maintained, effective ventilation is ensured as air leakage around the tube is prevented and thus microaspiration of secretions from the subglottic area is also prevented (Spiegel 2010:53). Furthermore, Black and Hawks' (2009:1639) observation that the tracheal cuff is the major source of complications associated with artificial airways is supported by Perrie (2010:D4:2). Proper monitoring is therefore

essential. Perrie (2010:D4:4) recommends that the tracheal cuff pressure should be maintained between 27–30 cmH_2O and it should be monitored every 8 hours or once per shift using the easy-to-use hand held aneroid manometer. Spiegel (2010:52), Black and Hawks (2009:1639) and Proehl (2009:27) recommend pressures between 20–30 cmH_2O. The general complications associated with cuff pressure are a sore throat, dysphagia, hoarseness and bronchospasm (Yildirim et al. 2011:399). Tracheal cuffs cause complications if they are too high, above 30 cmH_2O, because if they then obstruct the mucosal blood flow of the tracheal wall. As much as there are complications related to overinflated tracheal cuffs, underinflated cuffs also cause problems as they cannot maintain a seal resulting in macroaspiration of secretions and ineffective mechanical ventilation (Fletcher, Ruffell & Young 2008:260; Perrie 2010:D4:2; Sole et al. 2011:111).

2.3.5.1 Tracheal cuff pressure monitoring

There are different methods of tracheal cuff pressure monitoring as outlined by Perrie (2010:D4:3) in the Best Practice Guidelines for the Critical Care Society of Southern Africa (view Annexure E).This guideline recommends following the intermittent method using the minimal leak technique which is followed by direct cuff pressure measurement using an aneroid manometer.

In their study, 'Evaluation of an intervention to maintain endotracheal tube cuff pressure within therapeutic range', Sole et al. (2011:110) used continuous measurement, another method to monitor tracheal cuff pressure. The authors proved the visibility of cuff deflation, and that tracheal cuff pressure deflates over a period of time (between 4–12 hours) after adjustment. The authors emphasise it was an experimental design whereby continuous monitoring of the cuff was done on ventilated patients and the cuff pressure was adjusted to a minimum of 22 cmH_2O. The continuous measurement of the pressure was obtained by using the pressure transducer and a 15 cm extension 3-way stopcock was attached to the pilot balloon. The transducer was connected to the portable monitor that was connected to a laptop for recording. Any changes in pressure were recorded as well as activities like turning, suctioning and also coughing. Cuff pressures were adjusted when very high and the alarms went off and also when low and patients were losing their tidal volumes. There was evidence of cuff deflation even during quiet resting times or with no activities. This study of Sole et al. (2011:110) supports Perrie`s Best Practice Guidelines (2010:D4:4) on the frequency of monitoring as well as to record the present pressure of the tracheal cuff and the adjusted measurement.

Another method of tracheal cuff pressure monitoring is digital or manual palpation of the pilot balloon. However, authors like Morris et al. (2007:640), Faris et al. (2007:896-871) as well as Ferrer and Torres (2008:2) are in agreement that this has proven to be an unreliable practice as it can result in either overinflation of the cuff or deflation. To prove that digital palpation is an unreliable measure, Faris et al. (2007:869-71) did a study where a 10 ml syringe was used as a model of the trachea. A size 8.0 tracheostomy tube was inserted into the syringe and inflated. Nine models were used. Different pressures were used: underinflated at 10 cmH_2O; correctly inflated as 15-25 cmH_2O and overinflated from 40, 50, 60 and 70 cmH_2O. The models were hidden and only the pilot balloon was visible outside for palpation. Testers were asked to palpate the pilot balloon from model one to nine to state the three outcomes: whether the cuff pressure was too high, too low or normal. Their results showed a 39% error in estimating whether the pressure was low, high or correctly inflated by digital palpation.

Thus, based on the Perries's Best Practice Guideline (2010:D4:4) and the findings from the previous studies, critical care practitioners cannot rely on digital palpation but should preferably use aneroid manometers or continuous monitoring.

2.4 MECHANICAL VENTILATION

Airway management is needed when the critically ill patient requires mechanical ventilation. Patients in the critical care environment are mechanically ventilated and it forms an integral part of care in the CCE (Black & Hawks 2009:1541; Marino 2007:278; Smeltzer et al. 2010:651-652). A mechanical ventilator is a positive or negative pressure device that can maintain ventilation and oxygen delivery possibly for prolonged periods in the CCE (Black & Hawks 2009:164). In normal respiration the contraction of the diaphragm and respiratory muscles create negative pressure in the chest; a vacuum is thus created and the air flows in. During mechanical ventilation, positive pressure forces air into the lungs. It is therefore critical to keep the alveoli open which is necessary for gas exchange (Black & Hawks 2009:1641; Monahan et al. 2007:702-703; Smeltzer et al. 2010:652; Wiegand 2011:262).

In general, the indications for mechanical ventilation as outlined by Black and Hawks (2009:164), Smeltzer et al. (2010:652), Proehl (2009:27) and Wiegand (2011:262) are as follows:

- a continuous decrease in PaO_2 (partial pressure of oxygen)
- an increase in carbon dioxide levels

- persistent respiratory acidosis
- in conditions such as thoracic or abdominal surgery; drug overdose; neuromuscular disorders; inhalation injuries; chronic obstructive pulmonary disease; multiple trauma; shock; multisystem failure, and coma. These conditions may lead to respiratory failure and the need for mechanical ventilation.

The goals of continuous mechanical ventilation include the maintenance of adequate ventilation, the delivery of adequate concentrations of FiO_2 (oxygen with medical air) to deliver adequate tidal volumes in order to maintain adequate minute ventilation and oxygenation, and also to lessen the work of breathing and prevent complications (Black & Hawks 2009:1641-1642).Mechanical ventilators are classified according to the method by which they support ventilation (Bersten & Soni 2009:355-357; Black & Hawks 2009:1642; Marino 2007:461-462; Smeltzer et al. 2010:651). All these authors describe three main types of mechanical ventilators used in the critical care environment.

2.4.1 Types of mechanical ventilators

There are mainly three types of ventilators which will be discussed in Sections 2.4.1.1 to 2.4.1.3.

2.4.1.1 Negative pressure ventilators

Negative pressure ventilators exert a negative pressure on the external chest by decreasing the pressure in the thorax during inspiration: it allows air to flow into the lungs. These ventilators are indicated for use mainly in chronic respiratory failure conditions associated with neuromuscular conditions like poliomyelitis, muscular dystrophy, and myasthenia gravis but are contraindicated for patients who are unstable. There are several types of negative pressure ventilators, for example, the iron lung and body wrap (Bersten & Soni 2009:355; Marino 2007:457; Smeltzer et al. 2010:651; Wiegand 2011:261).

2.4.1.2 Positive pressure ventilators

Positive pressure ventilation is the mainstay of mechanical ventilation. Positive pressure ventilators inflate the lungs by exerting positive pressure on the airway thus pushing air in and forcing the alveoli to expand during inspiration (Smeltzer et al. 2010:651). Positive pressure ventilation is indicated in cases where oxygenation failure and/or acute ventilator insufficiency are experienced. . Positive pressure ventilators are used to reduce intracranial pressure and also to reduce the work of breathing (Wiegand

2011:262). However, if intubation is required to overcome upper-airway obstruction, ventilator support may be needed. For effective mechanical ventilation an endotracheal tube or tracheostomy is necessary (Black & Hawks 2009:1639; Proehl 2009:70; Smeltzer et al. 2010:682; Wiegand 2011:262).

2.4.1.3 Non-invasive positive pressure ventilation

However, non-invasive mechanical ventilation is still the recommended treatment to avoid unnecessary airway invasion because it eliminates the risks of infection associated with cuffed tracheal tubes (Smeltzer et al. 2010:653). In support, Urden et al. (2006:604) add the advantages of non-invasive mechanical ventilation include minimising the rate of nosocomial pneumonia and increasing the patient's comfort. According to Smeltzer et al. (2010:653), it is a positive pressure ventilation method given via a face mask that cover the mouth and nose, nasal masks or making use of other devices that seal around the nares to maintain the prescribed pressure. Non-invasive positive pressure ventilation is indicated in acute or chronic respiratory failure; acute pulmonary oedema; chronic obstructive airway disease; chronic heart failure or a sleep-related disorder, and where invasive ventilation is not required (Smeltzer et al. 2010:654).

Contraindications of non-invasive positive pressure ventilation, according to Smeltzer et.al (2010:655), include patients with respiratory arrest, serious dysrhythmias, cognitive impairment, head or facial trauma, status asthmaticus, and haemodynamic instability. These patients need to be intubated for effective mechanical ventilation, a tracheostomy should be performed or, for some patients, an artificial airway has to be created by either oral or nasotracheal intubation. A tracheostomy has to be performed post major elective surgery (like open heart surgery) and in cases of major trauma, severe respiratory distress or failure, and the patients' airways have to be maintained.

As explained earlier in this chapter, endotracheal and tracheostomy tubes have a cuff towards the end of the tube to maintain a seal between the tracheal wall and the tube for effective mechanical ventilation. Additionally, to prevent volume loss and macroaspiration of secretions which can result in ventilator associated pneumonia (Black & Hawks 2009:1639; Proehl 2009:70; Smeltzer et al. 2010:653; Wiegand 2011:225).

2.5 COMPLICATIONS OF TRACHEAL CUFFS

There is impairment to the tracheal blood flow when the tracheal cuff pressure is above 30 cmH_2O and this may lead to ischaemia and ulceration (Yildirim et al. 2011:399). Clinical complications related to tracheal cuff overinflation noted by Sole et al. (2011:111) and supported by Nseir et al.(2007:1) as well as other authors include:

- **A mild sore throat:** A mild sore throat may result from the pressure created by the tracheal cuff but it usually resolves after few days following extubation (Yilridim et.al 2011:399).
- **Tracheal stenosis:** Although patients survive periods of ventilation in critical care units, injury is often sustained to the airway. The cuff of the endotracheal tube has been implicated as the main cause of tracheal injury and is confirmed by Raynham et al. (2009:645) who conducted a survey on tracheal cuff pressure monitoring as prevention to tracheal stenosis in the critical care areas of a South African hospital. Svider et al. (2013:33) state endotracheal intubation and tracheostomies are the most common causes of laryngotracheal stenosis. Injury resulting from traumatic endotracheal intubation due to an endotracheal tube that is too large, cuff pressures which is too high, gastroeosophageal reflux, infection, the delay in changing the tracheostomy tube, an incorrectly placed tube or an intense inflammatory response to foreign material in the airway is supported by Monahan et al. (2007:618).
- **Tracheoesophageal fistula:** This is the connection between the oesophagus and the trachea which may result from the necrosis that is sited posteriorly (Muniappan et al. 2013:1141). It is theses authors' opinion that tracheoesophageal fistulas presenting for surgical correction are typically a result of tracheal post-intubation injury.
- **Tracheomalacia:** It refers to the weakness of the trachea to the extent that the airway is susceptible to collapse (Kandaswamy et al. 2013:340). The authors state the condition is characterised by the weakening of the supporting structures of the tracheal and bronchial walls resulting in expiratory collapse that leads to the symptoms of airway obstruction. According to Muzumdar et al. (2013:163) and Kandaswamy et al. (2013:340), tracheomalacia it is associated with prolonged intensive care stay, gastroeosophageal reflux and obesity.
- **Tracheal rupture:** Tracheal rupture can occur spontaneously or it may be due to trauma or can be iatrogenically induced (Gorosh et al. 2014:31). Tracheal rupture occurs due to persistently high pressures on the tracheal wall. A tracheal cuff that remains above 30 cmH_2O can be harmful to the tracheal wall and induce tracheal rupture (Perrie 2010:D4:2).

- **Ventilator-associated pneumonia (VAP):** A tracheal cuff underinflated below 20 cmH_2O where there is macroaspiration of secretions from the subglottic area can cause problems such as infection, ventilator-associated pneumonia (VAP) and also risk effectiveness of mechanical ventilation (Chopra et al. 2009:270; Lizy et al. 2011:421; Zolfaghari & Wyncoll 2011:1). Furthermore, in their study on tracheal cuff pressure monitoring Ferrer and Torres (2008:1) investigated poor monitoring as the cause of VAP. The authors claim that among the pathogenic mechanisms responsible for ventilator-associated pneumonia, oropharyngeal colonisation by pathogenic microorganisms and macroaspiration of subglottic secretions around the tracheal tube play an important role.

Failure in monitoring tracheal cuffs on mechanically ventilated patients in the critical care environment may lead to poor quality care. It is the responsibility of nurse practitioners in the CCE to deliver the required care that patients deserve by doing the right things right. Quality care means rendering the correct, appropriate care effectively, efficiently, and timely.

2.6 QUALITY CARE

The delivery of quality healthcare is not only the responsibility of the individual but is also a team effort. Matthews and Whelan (1993:79) cite the World Health Organization's (WHO) (1986) definition of quality, namely that quality is "the comparison of how the level of care actually provided, compares with that which is defined as the wanted level of care.

In order to be able to make a comparison of care, nurse practitioners must have an understanding of what the patient's expectations of care are so that they can meet or exceed these expectations. Patients expect service that is appropriate, easy to access, affordable, rendered by skilled personnel, non-discriminatory and which they experience as being effective for them Ransom et al (2008:72).

Healthcare professionals are actively involved in continuous quality improvement and clinical guidelines derived from evidence-based clinical practice are constantly developed. The purpose of these guidelines is to assist healthcare professionals with making decisions about appropriate healthcare interventions for specific clinical situations (Muller et al. 2008:500-501).Specifically nurses play a vital role at the patient's bedside providing day-to-day care; therefore, for nurse practitioners to buy-in they must become involved.

2.6.1 Involving nurse practitioners

Since one of the principles of the quality aspect relates to the involvement of people, nurse practitioners working with patients who are mechanically ventilated and have cuffed tracheal tubes need to be involved. This will assist them in taking ownership for changes being planned and implemented Ransom et al.(2008:71-72). In any organisation, management and leadership play an important role in quality improvement.

2.6.2 Leadership and management commitment

The leadership and commitment of the management towards ongoing quality improvement assist in the implementation of the intended intervention. The benefits of a research study need to be clearly understood by the management as this will encourage them to give support related to time, the allocation of personnel during the data collection process and the provision of material resources (Ransom et al. 2008:71). Since one of the quality principles includes strong leadership, the hospital clinical facilitators play an important role in ensuring safe practices with the continued in-service education they provide at the selected academic hospital. With their leadership role and influence, and their involvement in the implementation of best practices in the academic hospital, they will collaborate with the researcher with planning and intervention Ransom et al. 2008:71.It is further alluded by Bowie, Bradley and Rushmer (2010:43) that involvement of the stakeholders, who in this study refers to the clinical facilitators of the academic hospital, will offer support, advice and facilitation which will ease planning and intervention.

In this study, clinical facilitators together with the researcher formed part of the audit team that was responsible for the data collection process. Based on their knowledge and experience in the CCE, the participation of clinical facilitators benefitted the data collection process.

2.7 BEST PRACTICE GUIDELINES

Deaton (2012:263) supports the statement of Davies et al. (2006:1) that Best Practice Guidelines is the summary of the most up-to-date research on various clinical topics. The Best Practice Guidelines contains recommendations that are useful in helping healthcare providers practice evidence-based care aimed at improving patients' health outcomes. When Best Practice Guidelines recommendations are

implemented in a healthcare setting, the evaluation of its impact needs to be linked with the changes in nursing practice and improvements in patient outcomes. Measures used to evaluate have to be reliable and valid so that conclusions about the relationship between implementation and outcomes are clearly established. The evaluation measures need to be feasible, acceptable and also meaningful to patients and healthcare professionals alike (Davies et al. 2006:2; Deaton 2012:263). Polit and Beck (2012:31) agree that recommendations are useful in helping healthcare providers practice and improve evidence-informed care.

They also confirm that Best Practice Guidelines evaluates and summarises the evidence available on a particular condition with the aim of assisting providers to make the best possible decisions for patients (Davies et al. 2006: 1-2; Polit & Beck 2012:31). Furthermore Polit and Beck (2012:31) state in modern times more and more organisations are adopting or developing 'care bundles'. These authors explain 'care bundles' is a concept which was developed by the Institute for Healthcare Initiatives (IHI). It encompasses a set of interventions to "treat or prevent a specific cluster of symptoms" According to Polit and Beck (2012:31) there is growing evidence that a combination or bundle of strategies produces better outcomes than using a single strategy.

2.7.1 Nurse practitioners responsibility

The National Performance Committee (2000) cited by Harris and Associates (2006:354) define best practice as the cooperative way in which organisations and their employees undertake business activities in all key processes, and their use of benchmarking which is expected to lead to sustainable world class positive outcomes. In the case of this study the 'organisation' pertained to the CCE of the academic hospital, and the `employees` are nurse practitioners in the CCE of the academic hospital, who are responsible for tracheal cuff pressure monitoring which will result in quality care for patients with cuffed tracheal tubes.

2.7.2 Quality care of patients with cuffed tracheal tubes

Quality care of patients with cuffed tracheal tubes can be maintained by the following:

- ***Ensure a patent airway by suctioning:*** patients lose their cough reflex and they should be suctioned only when needed to prevent hypoxemia or injury to the bronchial or lung tissue (Black &

Hawks 2009:1645). The oropharynx needs to be suctioned before the tracheal suctioning to remove the secretions above the cuff (Urden et al. 2006:594)

- ***Cuff management*:** because the tracheal cuff is the major source of complications associated with artificial airways, monitoring is necessary. Maintain the cuff pressure between 24–30 cmH_2O (Urden et al. 2006:595) and monitor every 4–8 hours. Perrie (2010:D4:4) recommends pressure between 27–30 cmH_2O; it should be monitored 8-hourly or once per shift, and the right procedures must be followed. Smeltzer et al. (2009:658) recommends pressure monitoring every 6–8 hours. The purpose of cuff inflation after intubation is to prevent air leakage, ensure effective ventilation and to reduce the leakage of inhalation anaesthetics (Liu, Zhang, Gong, Li, Wang, Fu, Zhang & Hang 2010:1133).
- ***Tube holders:*** to be loosened at least once a day and provide skin care as recommended (Urden et al. 2006:596).
- ***Oral care:*** every 4 hours and moisten the lips to prevent cracking that may result in stomatitis (Urden et al. 2006:596).
- ***Humidification:*** of the supplied oxygen to help liquefy the secretions so that they are easily removed (Smeltzer et al. 2010:658).
- ***Prevent trauma and infection:*** The tube has to be positioned so as to prevent minimal pooling or distortion of the tube in the trachea (Urden et al. 2006:596).
- ***Promote optimal communication:*** by assessing the level of consciousness and make sure the oral cavity is not obstructed. Encourage the patient to write – if able to – with the strong or dominant hand (Smeltzer et al. 2009:659).
- ***Proper documentation:*** of the tracheal cuff pressure must be kept, meaning the found and adjusted pressure must be recorded (Perrie 2010:D4:4).

Factors that facilitate guideline implementation include learning through group interaction, positive staff attitudes and beliefs, and also leadership support (Berk, Callaly & Hyland 2003:252).The authors are further supported by Zidarov, Thomas and Poissant (2013:2) who proclaim that implementation of new knowledge takes place at individual, group and organisational level.

2.7.3 Best evidence

Best evidence is the scientific evidence derived from research where the aim of the research is to generate new knowledge and provide results that are generalisable, challenge the current practice, and

inform policy and service delivery. The research findings are methodologically appropriate and rigorous (Polit & Beck 2012:25). Findings of best evidence should answer questions of efficacy, safety and cost-effectiveness. It is a professional responsibility to ensure that the care provided to patients is based on the best available evidence and that there is confidence in the evidence (Deaton 2012:263; Polit & Beck 2012:25).

2.7.4 Evidence-based care

Evidence-based care is an approach that makes use of the "best available evidence in the delivery of care to individuals, groups or communities, and involving the clinician`s experience and expertise knowledge to make a clinical decision about a preferred assessment or a treatment intervention"(Deaton 2012:263). It is essential to make use of best data available to make the best possible decisions on the care of patients and to carry out the appropriate interventions (Deaton 2012:263; Polit & Beck 2012:23; Specht 2013:146).

Translating the research evidence into practice may involve the use of clinical guidelines; hence, the availability of best practice guidelines on tracheal cuff pressure monitoring is of great importance. Education, facilitators and change agents are also important factors in the practice of evidence-based care. What is extremely important before using the guideline, is examining how to use it and its applicability to the population (Specht 2013:146). Research findings support the fact that the implementation of evidence-based practice may result in a higher quality of care as well as decreased costs of care through the reduction in mortality, morbidity and medical errors (Specht 2013:146; Zidarov et.al 2013:2).

2.7.5 Sources of evidence

Deaton (2012:263) and Specht (2013:146) agree the evidence comes from a variety of sources and includes research evidence, clinical expertise, and the beliefs and values of the patient or the clinician. It is further based on previous experiences, on information gathered from patient and also on the patient's preferences.

Specht (2013:147) observes the barriers to adopting evidence-based practice include the lack of available time, the lack of access to current research literature, limited resources, an organisational

culture that is non-receptive, and the limited decision-making authority of staff to implement change. As a healthcare professional one should translate the best practice guidelines (Perrie`s Best Practice Guidelines 2010:4) into practice to ensure quality of care. To monitor the quality of care, determine the conformance to the set standard or to find out why the standard is not followed, a clinical audit has to be performed as proof of evidence of the current practice. In the current study a clinical audit was performed on tracheal cuff pressure monitoring in the CCE of the academic hospital in Gauteng.

2.8 CLINICAL AUDIT

An audit is a key component of clinical governance, and it is aimed at ensuring that the patients receive high standard of care which is of best quality (Dilnawaz, Mazhar & Shaikh 2012:358). It is concerned with examining practice through the collection of local and timely information. A clinical audit leads to informed awareness of how things actually are and promotes learning (Travaglia & Debono 2009:3).It is a quality improvement process that seeks to improve patient care and outcomes. An audit should review the clinical performance against the set standard (Best Practice Guideline) to improve quality patient care; it is used to confirm that the current quality of care is consistent with best practice and also demonstrate that the quality of care has improved by acting on shortcomings (Bowie, Bradley & Rushmer 2010:42; Travaglia & Debono 2009:3; Dilnawaz, Mazhar & Shaikh 2012:358).

Travaglia and Debono (2009:10) outline the purpose of clinical audit as to:

- improve the quality of healthcare services by reviewing the care rendered systematically against the set criteria.
- ensure adequate documentation of the care that is provided to the patients through the nursing process.
- direct attention to the design and utilising the charting record.
- encourage the use of the problem-oriented nursing system.
- support the integral part of nursing by objectivity.
- facilitation of cooperative planning and delivery of client care.
- increase the priority for a results- or outcome-oriented performance evaluation programme.
- enrich and provide direction to in-service education effects.
- identify ways to improve patient care.
- provide meaningful ways for nurses to participate and also achieve their career growth.

The audit should be mandatory as it is a key component of clinical governance and it is aimed at ensuring that patients receive high standards of care Dilnawaz et.al. (2012:358).Graham (2009:387) states the advantages of the concurrent audit is that it involves staff through reflection on their current practice; it serves as an educational tool if properly carried out; it can provide direct feedback and, finally, it provides a structured framework for gathering information. However, when conducting a concurrent audit one is required to take note of the disadvantages: it is time consuming, costly to implement and also the results can change as the patients are still hospitalised. In Table 2.1 the differences between a clinical audit and a research study adopted from the Healthcare Audit Criteria and Guideline (2008:14) are summarised.

Table 2.1: Differences between clinical audit and research

Clinical audit	Research
Answers the question: "Are we following best practice?	Creates new knowledge about what works and what does not work
Measures against standards	Based on hypothesis.
It is a cyclical series for reviews	It is a series of once-off projects.
Usually small sample over a short-term frame	Carried out on a large scale over a prolonged period of time
Routine data are collected	Complex data are collected
Pragmatic in choosing sample size	May involve patients receiving completely new treatment
Never involves a patient receiving a completely new treatment	May involve experiments on patients
Findings include activities of local clinicians and teams	Findings include activities of clinical practice
Does not require ethical approval	Usually requires ethical approval

2.9 SUMMARY

As evidenced in literature it is essential for nurse practitioners when monitoring tracheal cuff pressure of patients in the critical care environment to follow the guidelines to prevent complications, improve patient outcomes and save costs. The ideal cuff pressure, airway management, best practices and recommended guidelines as well as the complications related to non-conformance were addressed and the purpose and importance of conformance to guidelines were highlighted in this chapter.

CHAPTER 3
RESEARCH METHODOLOGY

3.1 INTRODUCTION

The previous chapter provided an in-depth discussion of an artificial airway, the purpose of tracheal cuffs, and the ideal tracheal cuff pressure and monitoring based on the Best Practice Guidelines. The complications of poor tracheal cuff pressure monitoring were briefly discussed. Mechanical ventilation was outlined and quality improvement and the principles were explained. The audit process, which the researcher found to be suitable for this research, was also explained.

This chapter documents the research design and the methodology followed during the monitoring of the tracheal cuff pressure of patients in the CCE of the academic hospital in Gauteng. The objective of the study was to investigate the effect of an intervention on tracheal cuff pressure monitoring in the CCE of the academic hospital in Gauteng.

3.2 RESEARCH METHODOLOGY

The research methodology is a systematic way to solve a problem; it is the end result of a series of decisions that are made concerning how best to implement the study (Burns & Grove 2009:219; Polit & Beck 2011:741; Rajsekar, Philominathan & Chinnathambi 2006:2). The researcher found the audit cycle the suitable methodology for this study because it would provide a systematic and documented process for obtaining evidence and objectively evaluate the extent to which the audit criteria are fulfilled (ISO 9001:2008; Patel 2010:31). As noted by Dilnawaz et al. (2012:358), a clinical audit measures practice against standards and performance. Graham (2009:377) states a clinical audit is an essential part of quality assurance and it is built on the following two main principles: a commitment to do better and the acceptance of the concept of best practice or evidence-based practice. A clinical audit provides the opportunity for practitioners to monitor their own service delivery by collecting information on time which leads to informed awareness of how things are (Bowie, Bradley & Rushmer 2010:42).In addition,

the audit cycle is defined as a process that "seeks to improve patient care and the implementation of change in practice if needed" (Dixon 2010:3).

In this study the researcher sought to investigate the effect of an intervention on tracheal cuff pressure monitoring in the academic hospital. The intent was to collaboratively plan interventions with clinical facilitators of this hospital .As confirmed by Gardner et al.(2009:1) that collaboration between clinical facilitators is needed if interventions are to be planned. The involvement of clinical facilitators as stakeholders is supported by Kirchner et al. (2012:63-67) who claim that although their involvement may be costly, it is essential to achieve the highest quality care. The audit cycle was used as it had proven to provide a method to improve quality in the clinical practice (National Health Institute for Clinical Excellence 2002:54; Patel 2010:30; Amarakone & Paneser 2006:71).

3.3 THE SETTING

The CCE of the academic hospital where the audit was conducted is presented below (View table 3.1).

Table 3.1: Available beds in the Critical care environment *(June to October 2012)*

Critical care environment	Number of critical care beds
Neurosurgery	8
Trauma & Surgical	12
Medical	10
Cardiothoracic	6
Coronary	8
High care unit	16
Emergency unit	2
Total	**62**

3.4 AIM AND OBJECTIVES

The aim of the study was to investigate the effect of an intervention on tracheal cuff pressure monitoring in the critical care environment of an academic hospital in Gauteng. To address the aim, the following objectives relating to tracheal cuff pressure monitoring in the critical care environment was delineated (view Annexure A).

- **Phase 1**: To prepare for the audit.
- **Phase 2**: To investigate the current practices of tracheal cuff pressure monitoring.
- **Phase 3**: To collaboratively plan and implement interventions for change:
    - ✓ Step 1: Diffusion and dissemination of the results.
    - ✓ Step 2: Decision on the intervention
    - ✓ Step 3: Intervention
- **Phase 4**: To reinvestigate for change in practice (post-intervention audit).

3.5 OVERALL RESEARCH DESIGN

The mixed method design is defined as the class of research where the researcher mixes or combines quantitative and qualitative research approaches, techniques, language or even concepts into one study to answer the research question in a satisfactory manner. The different approaches can be used either during the data collection or the data analysis processes. A researcher should have a solid purpose to support his or her choice of choosing the mixed method approach (Johnson & Onwuegbuzie 2004 as cited by Botma et al. 2010:255,256). This method was suitable for the purpose of the current study because it allowed for the systematic gathering of data and documenting of evidence on the study topic. It further allowed for the planning of interventions in collaboration with the clinical facilitators to inform the implementation of best practice guidelines, and for the objective evaluation of the extent to which the audit criteria (the audit process model adopted and adapted from Amarakone and Panesar (2006:171) were fulfilled.

The methods of data collection may be used to complement each other. As alluded by Bryman (2006:97) that 'complementing' in this instance means when one method, for example the quantitative method where a concurrent audit is used to collect the data. The qualitative method is used to answer the research question or elaborate on it for the purpose of obtaining more clarity and vice versa. In this study, the data were collected quantitatively by making use of the clinical audit tool and are presented in graphs and numbers in Chapter 4. The qualitative approach comprised of the nominal group technique (NGT) where experts used their ideas and experience to decide on interventions; these interventions were planned and implemented. Hence, the quantitative and qualitative research approaches to data collection complemented each other through evaluation, clarification and reimplementation to answer the research question. The research designs used in Phases 2 to 4 are discussed in Sections 3.5.2 and 3.5.5. Each component of the audit cycle and its related application to

this study is depicted in Figure 1.1 page 10. The discussion of the application of each component is presented in Phases 1 to 4 (view Section 3.5).

3.6 RESEARCH METHODS

The four phases in which this study was conducted were:

- **Phase 1**: Preparation for the study
- **Phase 2**: Pre-intervention audit
- **Phase 3**: Collaborative intervention
- **Phase 4**: Post-intervention

3.6.1 Phase 1: Preparation for the study

During Phase 1 the researcher invited the five clinical facilitators of the academic hospital to attend an information session. Invitation letters were sent two weeks before the session to each of the five clinical facilitators. The information session was held on the 19/09/2013 from 07:30-08:15. The researcher discussed the study, the importance thereof, and the role of the clinical facilitators during the study. The clinical audit process was also discussed. The clinical facilitators were asked whether they were interested in participating in the study and the participation leaflet and informed consent document were explained (view Annexure C). Once the clinical facilitators indicated they voluntarily wished to participate and had signed the informed consent, consensus was reached not to inform the unit managers and nurse practitioners on the specific time frames during which the clinical audits (Phases 2 and 4) would be conducted as this could give rise to the Hawthorne effect (Polit & Beck 2008:264).

During Phase 2 the researcher educated and trained the clinical facilitators on the use of the audit tool. As prescribed by Dixon and Pearce (2011:27) and the ISO (9001 2008) emphasis was placed on the following aspects:

- the rationale for the study was to enhance the implementation of best practices and it was not a competition between the different units;
- the clinical facilitators would not conduct the pre-intervention or post-intervention in the unit where they facilitated to prevent bias;

- the researcher would conduct the first two audits together with the clinical facilitators to ensure consistency in the use of the clinical audit tool;
- the clinical audit should not interfere with patient care: the quality of the date depended on the training of data collectors and they should be trained before being assigned to collect data to allow for testing the reliability of the data collection and making the necessary adjustments to resolve any problems.

Commitment by management and support such as resource allocation, which in this case was the academic hospital clinical facilitators, are essential for effective audit implementation (Johnson et al. (2000*)* cited by Berk, Callaly & Hyland 2003:252). This is supported by Cooper and Benjamin (2003:50) who assert ensuring the support of colleagues and establishing good communication with other disciplines are very important. De Vos, Strydom, Fouche and Delport (2011:478) state conversations with key informants help researchers to understand what the former has to offer; such communications also articulate the benefits of potential participants. A collaborative relationship with the representatives benefits the researcher with planning the project, identifying problems and assists with the intervention.

Dixon and Pearce (2011:27-28) clearly outline the factors important in the preparation for the training of data collectors which in this case were the five clinical facilitators of the academic hospital:

- **Identify the amount of time available and the timing*:*** For this study invitations regarding the date and time for the information session were sent to each of the five clinical facilitators two weeks before the session.
- **Decide on the objectives and activities**: This includes what the data collectors need to know what to do and should include the importance of the clinical audit, role of the facilitators, data to be collected, clinical audit design, the process of data collection, how to complete audit forms, and whom to contact if there are any problems as well as how to make contact with them.
- **Develop the teaching plan and identify the activities that will be used*:*** Also present and discuss the background to the audit using the same Power Point presentation. A discussion was held with the clinical facilitators who were data collectors, to clarify uncertainties and answer questions.(view Annexure I1).
- **Decide on the mode for delivering the training**: This was done by means of a Power Point presentation in the staff development lecture room.

- **Identify and arrange for the resources needed**: The lecture room was used; the facilitator brought her own laptop; there was enough space, good light; a power source as well as a whiteboard and board markers. Copies of the audit tool were also made available (view Annexure H for the clinical audit tool, Annexure F for the hospital VAP checklist and the Best Practice Guideline of tracheal cuff pressure monitoring (view Annexure E).
- **Decide who will be the trainer:** The researcher did the training.
- **Decide what materials will be provided to data collectors**: The clinical facilitators were provided with copies of the clinical audit tool, the VAP bundle checklist and Perrie`s Best Practice Guidelines to refer to after the information session.

3.6.2 Phase 2: Pre-intervention audit

The objective was to investigate current practices relating to tracheal cuff pressure monitoring using a clinical audit tool and random monitoring by the researcher using the aneroid manometer.

3.6.2.1 *Research design*

A concurrent audit was used to evaluate the tracheal cuff pressure monitoring in the CCE of the academic hospital in Gauteng. This evaluation audit was done using the charts on which the tracheal cuff pressure monitoring for the previous 24 hours was shown. Wong (2009:E3) confirms obtaining such data for the previous period of 24 hours gives a good reflection of what the practice is currently like.

3.6.2.2 *Research methods*

The research methods of Phase 2 will be discussed in terms of the population, data collection, data analysis and validity and reliability.

⇨ Unit of analysis

The unit of analysis included the critical care flow charts of patients who were intubated with cuffed tracheal tubes and mechanically ventilated the previous 24 hours. The random monitoring of tracheal cuff pressure by the researcher using the aneroid manometer on patients who were still intubated at the time of data collection is supported by Botma et al. (2010:123).

⇨ Sampling and sample size

Non-probability sampling was used. Non-probability sampling is described by Burns and Grove (2009:474) and Polit and Beck (2010:275) as a non-random method by which every element in the population has the opportunity to be selected in the sample. These authors warn that non-probability sampling decreases representativeness, but Brink et al. (2006:131) argue this method is convenient and economical in circumstances where it is impossible to reach all elements of the selected population. The rationale for using non-probability sampling was to give the entire population an opportunity to be included in the study. The information on the flow charts used as the unit of analysis thus had an equal opportunity to be documented to ensure the data from all the units in the CCE were included thereby providing an overview of the practices in the individual units as well as in the critical care environment.

For an overview of the total number of beds in the critical care environment of the academic hospital in Gauteng view Table 3.1. The approximate sample size for each of Phases 2 and 4 was approximately 90 clinical audits totalling 180 clinical audits. Guided by the statistician, two weeks were allocated for each of the two phases for data collection. Thus, in week 1 of Phase 2 a total of 45 audits were done and in week 2 of Phase 2 another 45 was done. The same data collection time was allowed for data gathering for Phase 4 making it a total of 90 audits per phase, thus 180 audits in total.

Dixon and Pearce (2011:8) mention that clinical audit staff members sometimes recommend for local clinical audits to include between 30 or 50 cases but not exceed 50. The reasoning behind it is that if care is not provided in accordance with the clinical audit standards in 30 – 50 cases, there is no need to look for more as this is sufficient proof of the present practice.

The **inclusion criteria** for this phase consisted of the flow charts of all the adult critically ill/injured patients with cuffed tracheal tubes in place in the past 24 hours and still nursed in the critical care units of the academic hospital.

The **exclusion criteria** included the flow charts of critically ill/injured patients with self-inflatory tracheal cuffs in situ.

⇨ Data collection

Data collection included four components, namely the research instrument, pre- and post-intervention, data collection process, and the validity and reliability of the research instrument.

Table 3.1 shows the number of beds in the critical care environment in the academic hospital from June to October 2012 which was the period during which the quantitative data were collected. The number of available beds is important as it is sometimes reduced based on the availability of human resources

⇨ Research instrument

Data were collected by means of a structured plan as it enhanced the objectivity of the data and eliminated bias (Botma et al. 2010:131). The data collection instrument was a clinical audit checklist (view Annexure H) which was developed by the researcher to suit the type of data required. Its development was based on a thorough literature review and in collaboration with experts who included the statistician (Botma et al. 2010:134; Burns & Grove 2005:424). The researcher used the Best Practice Guidelines (Perrie 2010:D4:5) designed for the CCSSA, and the VAP bundle checklist which was designed for the critical care areas of the academic hospital) to guide the development of the clinical audit checklist (view Annexures E and F). In addition, the Head of the Department of Critical Care as well as two intensive care specialists evaluated the clinical audit tool in which suggested changes had been incorporated. The quantitative data collected during the audit check consisted of the written data on the critical care flow charts on the previous 24 hours' monitoring of the tracheal cuff pressure. The researcher did one reading using the handheld aneroid manometer to evaluate the current cuff pressure.

The clinical audit tool (view Annexure H) consisted of three pages. It was divided into the following six Sections:

- **Section A:** Date of Audit
- **Section B:** Demographic information
- **Section C:** Tracheal cuff pressure monitoring: day shift (07h00 – 19h00)
- **Section D:** Tracheal cuff pressure monitoring: night shift (19h00 – 07h00)
- **Section E:** Extraordinary tracheal cuff pressure monitoring
- **Section F:** Tracheal cuff pressure monitoring: Researcher

⇨ Data analysis

For the quantitative data collected with the use of the clinical audit tool, frequencies and percentages were used to analyse data. An inferential statistical analysis was used to estimate the parameter from the sample (Polit & Beck 2010:583).

⇨ Validity and reliability

Validity refers to the clinical audit tool as the research instrument and its soundness to measure what it was intended to measure in a correct and accurate way (Polit & Beck 2010:336). The authors further state validity is regarded as a decisive aspect because a clinical audit tool is unable to validly measure a variable if it is inaccurate and inconsistent. Burns and Grove (2009:380) and Polit and Beck (2010:336-342) identify the following aspects of measurement instrument validity and point out that, if applied, it will ensure validity of the clinical audit tool:

- **Face validity** is a subjective assessment and refers to the fact that items in a scale must to be relevant, clear and unmistakable (Burns & Grove 2009:381) to measure what it is intended to measure (Polit & Beck 2010:336). Face validity was ensured by using the inputs from experts as well as the statistician during the development of the tool.
- **Content-related validity** is ensured by asking experts to judge the items of the clinical audit tool to affirm full representation of the items to be measured. According to Burns and Grove (2009:381), content validity is a weak example of validity but useful as a starting point. In this study content validity was obtained during pre-testing of the clinical audit tool through using a literature review as well as involving the clinical facilitators in the critical care environment.
- **Criterion-related validity** ascertains a relationship between the scores on the measurement instrument and an external criterion. According to Burns and Grove (2009:221), criterion-related validity involves a comparison between the score of achievement and the criterion. In the clinical audit tool the criterion was tracheal cuff pressure monitoring as it related to before (pre-test) the intervention and nine to 10 weeks following the intervention (post-test).
- **Construct validity** relates to the extent to which a theoretical construct will be measured (LoBiondo-Wood & Haber 2010:290) and is usually associated with a theoretical perspective (Polit & Beck 2008:299). Construct validity includes both content validity and predictive validity. Construct validity utilises empirical procedures and requires judgement pertaining to the use of the clinical audit tool to ensure that the tool measures what it is supposed to measure.

Polit and Beck (2011:175) agree with Burns and Grove (2009:222) who define reliability as “the degree of consistency of dependability with which an instrument measures an attribute”. Reliability also concerns the accuracy of the audit tool in reflecting true scores. The clinical audit tool therefore has to be consistent and accurate in measuring the items. Polit and Beck (2011:331) support Burns and Grove’s (2009:222) view that stability, internal consistency and equivalence are factors that contribute

to the reliability of the instrument. The aspect linked to ensuring the reliability of the audit tool is its stability to ensure reliability in the test-retest procedure. It implies that similar results are obtained by using the same measure instrument on two separate occasions over a period of time (Burns & Grove 2009:377; Polit & Beck 2011:331). In this study the researcher gave the clinical facilitators clear guidelines on how to audit the critical care flow charts. Internal consistency and reliability reflects how "well items are related to each other when measuring the same trait or construct" (Polit & Beck 2011:333). In this study Cronbach's Alpha coefficient was used to calculate each item to reflect internal consistency and reliability between the items in the audit tool. To further ensure validity, the instrument should measure what it is intended to measure; it is, to which a measurement represents a true value (Botma et al. 2010:174; Burns & Grove 2009:377). The audit tool had to be able to measure current practice of tracheal cuff pressure monitoring in the critical care environment. Clinical facilitators who had experience in the care of patients in the critical care environment were trained on how to complete the audit tool and the academic hospital VAP checklist. They were also informed about the Best Practice Guideline of tracheal cuff pressure monitoring as outlined by Perrie (2010:D4:5) for the Critical Care Society of South Africa.

The critical care environment flow chart was used to collect the data on the monitoring of tracheal cuff pressure which had been recorded over the previous 24 hours. The aneroid manometer (view Annexure I 9.) available in every critical care environment was not used; the researcher used her own manometer. The aneroid manometer was checked by clinical technologists and no calibration was necessary (Personal information clinical technologist 2012).To ensure consistency, the same aneroid manometer was used by the researcher to do the random monitoring. It was tested as per the manufacturer's instructions. As stated by Burns and Grove (2009:377), the stability of the measurement is concerned with its stability of repeated measures of the same attribute with the use of the same scale or instrument over time. The same aneroid manometer (and thus the same clinical audit tool) was used during the data collection processes in Phase 2 and Phase 4.

3.6.3 Phase 3: Collaborative intervention

The objective of this phase was to collaboratively plan and implement interventions for change based on current tracheal cuff pressure monitoring practices. A collaborative relationship with the representatives benefits the researcher with planning the project, identifying problems and assisting with the intervention (Dixon & Pearce 2011:27).

3.6.3.1 *Research design*

For Phase 3 a qualitative descriptive design was used and verbal feedback of Phase 2 results was given. Feedback was used as the strategy to improve professional practice and enhance quality improvement in this study. Feedback could be given either verbally, in a written format or both. It could be given by the researcher conducting the study or either by supervisors or colleagues (Ivers et al. 2012:2). Arrangements need to be made to be able to share the information gathered from the audit; hence, in this study the researcher made appointments in different critical care areas to give feedback (Foy et al. 2005:2; Hysong, Best & Pugh 2006:2; Dixon & Pearce 2012:39; Ivers et al. 2012:2-3).A nominal group technique (NGT) was found to be suitable for the dissemination of Phase 2 results as it indicated what was the present practice of tracheal cuff pressure monitoring. The technique assured an advantage and balanced input from the participants, and they could share and learn from each other's knowledge and experience, prevent domination by one member in the group (Lloyd 2011:107; O'Connor et al. 2013:2-4).

The NGT is seen as a way of removing a communication barrier (if used by the interviewer) and it usually includes an initial period where individuals are given time to think about their own ideas as well as sharing ideas as a group. Each person is given equal opportunity to share ideas without the fear that her or his ideas will not be listened to (Porter 2012:1628). Agreeing with Porter (2012:1628), Fevang et al. (2011:2) add that experts should be used in the group. The participants who formed part of the nominal group were all experienced and knowledgeable in their field of work. They included the nurse practitioners, area managers, operational managers of the critical care areas as well as clinical facilitators of the academic hospital where this study was conducted. The advantages of the NGT includes equality among the members; it focuses on problems, finding workable and sustainable solutions, and prevents premature closure due to its structured method and one participant cannot dominate the discussion or even restrict the group leader to have less influence (Lloyd 2011:108; Porter 2012:1628; O'Connor et al. 2013:3).

3.6.3.2 *Research methods*

The research methods will be discussed in terms of the population, data collection, data analysis and trustworthiness.

⇨ *Population*

The population for Phase 3 comprised of area managers, operational managers and nurse practitioners working in the CCE of the academic hospital.

⇨ Sampling

Non-probability sampling was used as not all nurse practitioners looking after these patients would be included in the nominal group (Polit & Beck 2010:275). Only the nurse practitioners working in the CCE were available for the session, the five hospital clinical facilitators and the available area and operational managers of the CCE were included.

⇨ Data collection

On 5 November 2013 from 09h00 till 11h00 a session was held in the academic hospital staff development lecture room with (11) eleven participants. A week before and the day before the session, the researcher had reminded all critical care areas telephonically about this morning session. Verbal feedback where Phase 2 results were disseminated to nurse practitioners of the CCE of the academic hospital was used (Ivers et.al 2012:2).As alluded by Dearing (2009:503) that "diffusion is the process through which an innovation is communicated through certain channels over-time amongst members". The statement is supported by Zidarof, Thomas and Poissant (2012:2) who further explain that diffusion is a passive process that is controlled or uncontrolled. The researcher gave verbal feedback about Phase 2 results of tracheal cuff pressure monitoring and attendance register was completed (view Annexure I 7 for the attendance register).

The process of dissemination can be used either passively where written reports or feedback is handed out or actively where there is a discussion of the findings (Dearing 2009:504) "Dissemination science is the study of how evidence-based practices, policies or programmes can be communicated to potential adopters"(Dearing 2009:504). The author further alludes that "the potential adopters are those people targeted to make a decision about whether to invest resources in an innovation; an implementer is someone who will actually change his or her behaviour to put an innovation into use". It is further supported by Specht (2013:148) that feedback can be given in a written or verbal method or use both.

The nominal group technique was also used to disseminate the results and collaboratively plan interventions (Lloyd 2011:107).The second external facilitator was taking field notes and the session was recorded. Permission to audio-record the session was granted by all the participants beforehand.

The participants were seated on the chairs in three rows, being the front, second and third. In Figure 3.1 below the six steps of the nominal group technique process according to Lloyd (2011:11) are illustrated.

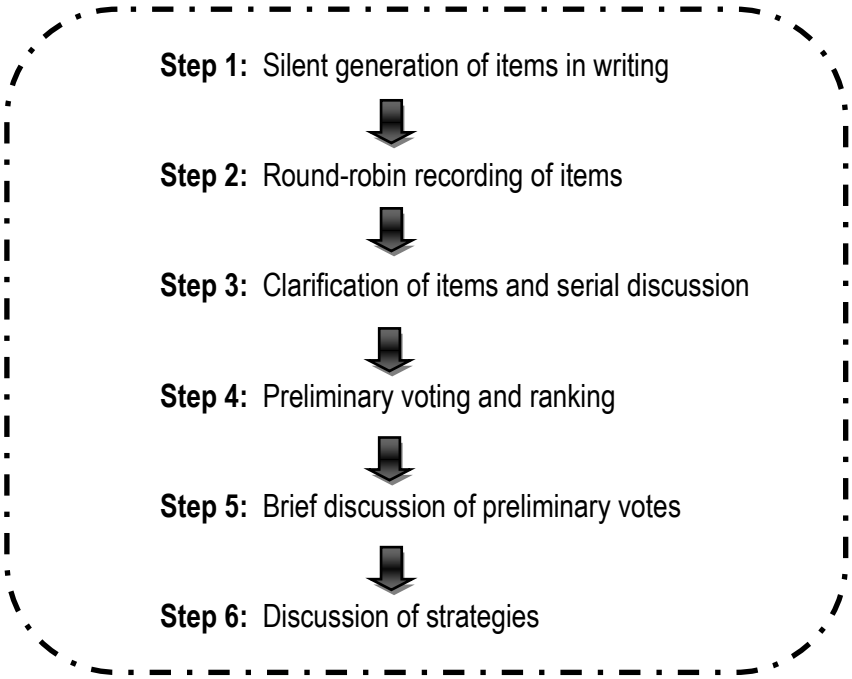

Figure 3.1: Six NGT steps (Lloyd 2011:111)

Each of the steps in the NGT will be discussed briefly, in the next Section.

- **Step 1: Silent generation of items in writing**

The first step of the NGT was for the facilitator to read the research question to the participants: "What is the present practice of tracheal cuff pressure monitoring in the critical care environment of the academic hospital?" This was then followed up by reminding the nominal group that their purpose was to come up with ideas on an intervention by considering the quantitative data derived from the audit report.

The external facilitator took over and facilitated the session further. Every participant was given a worksheet on which the above question was written as well as some paper and pens. The facilitator requested them to write down their individual views and ideas. The participants were given about ten minutes to think and quietly jot down their views and ideas. The facilitator proceeded to the next step when the participants indicated that they were done with the writing (Fevang et al. 2011:2; Lloyd 2011:111).

- **Step 2: Round-robin recording of items**

In step 2 every participant was given a chance to state her or his ideas. These were written on the board by the facilitator. Round-robin recording implies that the facilitator started with the group seated at the front followed by the group behind and then the next group until everybody had had the opportunity to give their views and ideas and it had all been written on the whiteboard. If any of the views or ideas already appeared on the whiteboard, the participants were allowed to pass but to add onto it if they wished to do so. The facilitator ensured that every participant had had a turn to raise their ideas then proceeded to the next step (Lloyd 2011:111; O'Connor et al. 2013:3).

- **Step 3: Clarification of items and serial discussion**

The second external facilitator was taking field notes and the session was recorded. Permission to audio-record the session was granted by all the participants beforehand. During this phase items written on the board were discussed, grouped and summarised. The participants were given a chance to raise and discuss their viewpoints. The participants and facilitator looked at the similarities of the data, grouped them and the facilitator wrote these grouped similarities on the second board. Participants indicated their satisfaction on the grouping and they proceeded to the next step, namely voting (Fevang et al. 2011:3; Lloyd 2011:111; O'Connor et al. 2013:3).

- **Step 4: Preliminary voting and ranking**

At this stage the participants were asked to identify aspects from the list that were important to them. They were requested to list the items on their worksheets in the order which they perceived them to be the 'most important' to the 'least important'. The worksheets were collected from the participants. The participants were asked to vote and prioritise the written lists. They proceeded to the next step (Lloyd 2011:111; Porter 2012:1628).

- **Step 5: Brief discussion of preliminary votes**

During the fifth step a brief discussion was held that focused on aspects that were found to be of great importance. The nominal group participants concentrated on deliberating how their decisions would be implemented – by whom and how. The next step followed when consensus was reached between the facilitator and the participants that the latter were satisfied with the outcome of their discussion (Lloyd 2011:111; O'Connor 2011:3).

- **Step 6: Discussion of strategies**

The final decision on an intervention agreed upon by all NGT participants is summarised next:

- To agree on one standard of monitoring which stipulated the time frames for tracheal cuff monitoring as at 09h00, 14h00, 19h00 and 24h00.
- In-service training needed to be done by the researcher in the critical care areas on tracheal cuff pressure monitoring to the nurse practitioners. The content should include the anatomy and physiology of the airway, ideal cuff pressure, purpose of the cuff, complications that has legal and cost implications, and the agreed upon times of monitoring. The researcher should also demonstrate how to use the aneroid manometer.
- Posters needed to be placed in each critical care area as reminders on how and when to do tracheal cuff monitoring.
- The availability of equipment, namely the aneroid manometer and webcols to be used before and after use for infection control, needed to be addressed.
- Shift leaders had to monitor the staff's compliance with keeping to the set times for monitoring. They also had to remind the staff of it during risk rounds conducted in the critical care areas.
- Feedback had to be given on the staff's compliance to operational managers and assistant managers.
- The cuff pressure had to be recorded onto the flow chart and VAP checklist. The recording of the found and adjusted pressure must be indicated with an arrow.

The facilitator concluded the session and asked the researcher to close the session. The researcher thanked everybody for their time and participation and invited them for refreshments.

⇨ **Intervention**

In defining an intervention, de Vos et al. (2011:475) cite the views of Cozby (2009:205), Newman (2006:26) and Schilling (1997:174) that an intervention is an applied action undertaken by an agent, which is usually in concert with a client or other affected party, to enhance or maintain the functioning or well-being of an individual. In support, Babbie (2010:363) states the aim of investigation in research is to determine the impact of a particular programme which is implemented to solve a particular problem. As noted by Schilling (1997:173) (cited by de Vos et al. 2011:475) there are different types of studies of which one can be a longitudinal study which observes what happens to clients during and after agency contact. In order to change clinical practice, a multifaceted systems approach is involved to overcome

provider-level barriers. Approaches such as reminders and provider education which must be combined with performance measurement and feedback can be implemented (Kettinger 2012:82). The nominal group concluded that one singular standard with regard to the times of monitoring was extremely necessary. In-service education was much needed and should be followed by reminders and continuous feedback to determine whether there was an observable change. All the participants were in agreement that this was an ideal intervention.

⇨**Revised standard**

The hospital standard of tracheal cuff pressure monitoring was revised. A standard, as clarified in the previous chapter, is a written description or a statement of the level of performance with special reference to structure, process and outcome. Quality improvement models were formed in order to improve the quality of care locally and internationally: the International Organisation for Standardization (ISO); Society for Academic Emergency Medicine (SAEM); Balance Scorecard Collaborative (BSC) and Council for Health Service Accreditation of Southern Africa (COHSASA) (Muller et al. 2006:474). The hospital standard was revised (view Annexure G) to stipulate the times of monitoring and recording on the flow chart and VAP bundle checklist. Monitoring and feedback on conformance to the agreed standard was given on an informal basis to the operational managers by the researcher. Although Foy et al. (2005:1–2) posit that audit and feedback may continue to be an unreliable approach to quality improvement until it is known how it can work best, Hysong et al. (2006:2) and Ivers et al. (2012:2–3) confirm audit and feedback has been used in many cases as a strategy for changing the clinical practice behaviours of healthcare professionals.

⇨ **In-service training**

In-service training was used as a method of intervention as it can have great impact on or improve outcomes such as behaviour (Strait et al. 2009:106–7). According to these authors, in-service learning can have a great impact on or improve outcomes such as cognitive, behavioural, and social outcomes. In-service training is a tool that can be used to positively affect learning outcomes such as knowledge, skills and attitudes (Billig & Waterman 2007:19; Hurd 2006:2).

The lecture method can be used to deliver in-service education. To lecture someone is to “go on at some length about an issue with the recipient listening either willingly or unwillingly” (Hughes & Quinn 2013:189). The advantages of the lecture method includes enhancing efficiency, improving learner motivation, acquiring new knowledge and leading to good subject integration (Hughes & Quinn

2013:191). The authors Dunst, Trivette and Deal (2011:181–184) mention that didactic one-time in-service trainings has been found to be not generally effective in behaviour change, but it continues to be the primary way used by practitioners in the United States of America (USA) for continuing education. The current researcher commenced with the in-service training of the nurse practitioners in the critical care areas of the academic hospital from 19 November 2013 to 2 January 2014 (view Annexure **I** 6.0). The content of the in-service training programme included all aspects agreed upon by the nominal group. This training programme was repeated as per appointments with the operational managers of the critical care areas. A total of 72 nurse practitioners received in-service education. Attendance registers were signed as proof of attendance.

⇨ **Posters**

On 8 January 2014 the researcher distributed posters clearly asking the question: "*Is your patient`s tracheal cuff pressure 25–30 cmH_2O?*" in all critical care areas to serve as reminders. The nurse practitioners and operational managers were to decide where to place the posters so that they were clearly visible. Pictures or posters can be used to enforce learning. Pictorial information can enhance readability and improve understanding thereby "enabling the formation of a mental model of the situation" (Kools et al. 2005:104). The use of posters is supported by Altintas et al. (2014:196–199) who state posters have an element of flexibility, space saving, long-term availability and they also improve interaction. Posters were distributed to all participating critical care areas of the academic hospital in Gauteng

- **Data analysis**

The qualitative data analysis on the implementation of the intervention included the feedback received from the nurse practitioners on their positive or negative experience of the in-house training and the contributions made by the nominal group on the successfulness or unsuccessfulness of the intervention. The quantitative data analysis included the information from the clinical audit tool that was used for data collection in phases 2 and 4 of the audit process. The data analysis is detailed in Chapter 4.

- **Trustworthiness**

In qualitative research trustworthiness refers to the methodological soundness and adequacy of a study (Holloway & Wheeler 2010:302; Polit & Beck 2008:39). Polit and Beck (2008:768) define trustworthiness as "the degree of confidence qualitative researchers has in their data". During the

qualitative phase of the current study the criteria for trustworthiness, as identified by Lincoln and Guba (1985) as cited by Polit and Beck (2008:539) were strictly adhered to, namely, credibility, dependability, confirmability, transferability and authenticity.

- **Credibility (truth value)**

According to Lincoln and Guba (1985) as cited by Polit and Beck (2008:539), credibility refers to the confidence in the truth of the data and its interpretation. Credibility involves believability and taking steps to demonstrate credibility to the external readers. It is the opinion of Koch (2006:92**)** that, in order to enhance credibility, the researcher should describe and interpret their experience as researchers. In his study credibility was demonstrated through ensuring audit trails, discussing the nominal group technique in depth, and providing evidence of field notes and transcribed audio notes as advised by Tobin and Begley (2004:392).

- **Dependability (consistency)**

Lincoln and Guba (1985) as cited by Polit and Beck (2008:539) refer to dependability as the stability or reliability of data. In this study dependability was enhanced by clearly communicating the purpose of the nominal group with the participants to gain their willing cooperation before obtaining their consent. The researcher listened attentively to the audio taped data and transcribed the data verbatim. She confirmed the findings with the NGT participants.

- **Conformability (neutrality)**

Lincoln and Guba (1985) as cited by Polit and Beck (2008:539) refer to conformability as the objectivity regarding the accuracy, relevance or meaning of the data. To enhance conformability in Phase 3, the researcher recorded the nominal group discussion, transcribed the data verbatim making sure she transcribed every participant's words correctly including short silences and utterances such as "mmm".

- **Transferability (applicability)**

Koch (2006:92) points out that transferability is dependent upon the degree of similarity between two contexts. Transferability refers to the generalisability of the data, that is, the extent to which the findings can be transferred to other settings or groups (Polit & Beck 2008:539). Although the study does not focus on generalisability, the research findings may be used in other research settings to address similar challenges. Data were collected during the nominal group until data saturation was reached and the group members had agreed on the intervention that would be implemented in the critical care

environment to address change. The researcher further ensured that consensus was reached on the planned intervention.

- **Authenticity**

Authenticity refers to "the extent to which the different realities are fairly and faithfully indicated by the researcher" (Botma et al. 2010:234). The verbatim text indicated authenticity as it conveyed the views of Nurse practitioners with regard to the interventions that should be implemented to address change in the critical care environment concerning the management of tracheal cuff pressure.

3.6.4 Phase 4: Post-intervention

The objective of Phase 4 was to follow the implemented interventions and re-investigate practices using the same clinical audit tool used in Phase 2.

A re-audit was conducted on 9 April 2014 at 07h30 which was 20 weeks post the intervention. The same method of data collection was used as when a previous 24-hour chart audit was conducted on patients who were intubated with cuffed tracheal tubes. The hospital clinical facilitators and the researcher met at the hospital staff development lecture room. The researcher reminded them telephonically on 8 April 2014 about this meeting. As this was 20 weeks post the intervention, the researcher reminded the clinical facilitators on how to use the audit tool and also addressed the challenges of the previous audit like the brand name and tube size. The researcher allocated clinical facilitators to different critical care areas and they were provided with pens and audit tools in A4 envelopes. The researcher used the same aneroid manometer that was used during the pre-intervention phase. The final data collection as per re-audit was done on 17 April 2014 at 07h30. The clinical facilitators were reminded telephonically by the researcher the day before the audit. The same process was followed where the clinical facilitators were provided with audit tools and were allocated to different CCE`s. The researcher used the same aneroid manometer to monitor the tracheal cuff pressure. The hospital clinical facilitators and the researcher once again met at the staff development lecture room. Coffee was served before leaving for their allocated areas. The researcher thanked all clinical facilitators for their support and the dedication they displayed throughout the process, and their eagerness to see change in practice. Audit tools were provided and they all went to respective critical care areas.

The data collected during this phase was coded and together with phase two data was sent to the statistician for analysis and comparison of pre and post intervention results. The details of data analysis are presented in Chapter 4.

3.7 SUMMARY

This chapter gave an outline of the research design and methods that were used in this research project. The clinical audit data of Phases 2 and 4 were coded by the researcher before being sent to the statistician for analysis. The audio-taped data of Phase 3 were transcribed verbatim and the field notes saved for reference (view Annexure D). The next chapter presents the data analysis followed by the results of the study.

CHAPTER 4
RESULTS AND DISCUSSIONS

4.1 INTRODUCTION

Chapter 3 provided a comprehensive overview of the research design and methods used in this study. In this Chapter an in-depth discussion of the research results is provided. The results are discussed in relation to supportive literature available to link the research findings of this study.

4.2 CRITICAL CARE ENVIRONMENT

The critical care environment (CCE) in which the data were collected during Phases 2 and 4 consisted of five (5) intensive care units, one (1) high care unit and one (1) emergency unit of the academic hospital in Gauteng. At the time of the study the total number of intensive care beds in the CCE was 62 (population), of which only 43 (69.4%) beds were available to admit patients who met the inclusion criteria and whose flow charts could be audited (view Section 3.5.2). Nineteen (19) beds were temporarily closed in the critical care environment due to financial and human resource constraints. Forty-three (N = 43) beds were available to admit patients whose documents could be audited during Phases 2 and 4 of the study.

A summary of the total number of beds in each of the seven (7) critical care areas of the critical care environment in the hospital is provided in Table 4.1.

Table 4.1: Summary of beds in the critical care environment

Critical care area	Total beds	Available beds
Cardiothoracic ICU	6	6
Coronary ICU	8	5
Medical ICU	10	6
Neurosurgery ICU	8	6
Trauma and Surgery ICU	12	6
High Care	16	12
Emergency Department	2	2
Total	**62**	**43**

The study was conducted in four phases:

- **Phase 1:** Preparation for the audit
- **Phase 2:** Investigate the current practices (pre-intervention)
- **Phase 3:** Collaboratively plan and implement interventions for change (Step 1: Share results; Step 2: Plan interventions; Step 3: Implement interventions)
- **Phase 4:** Re-investigate practices (post-intervention)

The four phases of the study guide the discussion of the results (view Sections 4.3 to 4.7).

4.3 PHASE 1: PREPARATION FOR THE AUDIT

Objective

To prepare for the audit

Timeframe

19 September 2013 for 45 minutes

Information session: PowerPoint presentation

Supporting Annexures

Annexures supporting Phase 1 include: B1, I1, I2, I3, E, F and H

During Phase 1, the researcher formally invited all five (5) clinical facilitators involved in the academic hospital to an information session relating to the study. All five (5) clinical facilitators responded positively and attended the session on 19 September2013 (view Annexure I.1). The five (5) clinical facilitators were all professional nurses, permanently employed by the academic hospital, and involved in the provision of in-service training throughout the hospital in collaboration with multi-disciplinary team members. Of the five (N = 5) clinical facilitators that attended the session, four (n = 4; [80%]) had a post-basic qualification in Critical Care Nursing Science: General (view Table 4.2). Their post-basic qualification was important as their input will be beneficial for the intervention.

A total of five clinical facilitators all allocated in the clinical department formed part of the information session.

Table 4.2: Summary: Post-basic qualifications of clinical facilitators

Participants	Certificate: critical care	Years' experience as registered nurse	Years' experience in speciality area	Additional qualifications
1	Medical Surgical Nursing Science Critical Care: General	29 years	29 years	N/A
2	Medical Surgical Nursing Science Critical Care: General	20 years	15 years	N/A
3	Medical Surgical Nursing Science Critical Care: General	19 years	14 years	• Nursing Education • Nursing Management • Medical Surgical Nursing: Emergency Degree
4	Medical Surgical Nursing Science Critical Care: General	29 years	29 years	• Nursing Education Diploma
5	N/A	37 years	25 years	• Nursing Management Diploma

The researcher used a PowerPoint presentation to introduce the research topic, explain the research problem identified, and link it to current practices in the critical care environment (view Annexure I1). The rationale for involving the clinical facilitators was emphasised. The researcher reflected that if she involved the clinical facilitators, they would be given an opportunity to be involved and learn about auditing practice as well as collaboratively plan and implement an intervention to address current practices in the academic hospital. The clinical facilitators were invited to play a role in the data collection (Phases 2 and 4), planning the intervention (Phase 3), and then to sustain the project through in-service training in the future as their ownership of the project could be enhanced. A discussion on ideal tracheal cuff pressure as well as the complications of over- and under-inflated tracheal cuffs was included. The Best Practice Guideline on tracheal cuff pressure monitoring (view Annexure E), the tertiary hospital VAP checklist (view Annexure F), and the clinical audit checklist (view Annexure H) were explained in detail. All five (N = 5) clinical facilitators were excited and volunteered their time to participate. The rigour of the study was thus increased.

The researcher discussed the participant information leaflet and informed consent document with the clinical facilitators (view Annexure B1). They were then given time to ask questions and clear up uncertainties with the researcher. All five (5) clinical facilitators voluntarily signed the informed consent and completed the demographic information Section (view Annexure B1 and Table 4.2).

The clinical facilitators were then asked to suggest possible dates and times for data collection to ensure that the activities do not disrupt their work schedule and patient care. As per advice from the statistician, data were collected on two different days with an interval of a week or two (view Section A of the clinical audit tool). The rationale for allowing an interval of a week or two was to decrease bias as the Nurse practitioners were unsure of the date and time of the second set of data collection.

4.3.1 CONCLUSION: PHASE 1

The researcher held an information session with the five hospital clinical facilitators. The importance of their involvement in the audit and their role were clarified. The researcher subsequently did a PowerPoint presentation on tracheal cuff pressure monitoring for the clinical facilitators. Informed consent and participant leaflets as well as the demographic information of their qualifications were completed. The researcher introduced and explained the following:

- the clinical audit tool;
- Best Practice Guideline of tracheal cuff pressure monitoring;
- the hospital tracheal cuff pressure monitoring standard; and
- the hospital VAP checklist.

The dates for data collection were scheduled by the clinical facilitators of the hospital which are reflected in Phases 2 and 4 respectively.

4.4 PHASE 2: INVESTIGATE CURRENT PRACTICE (PRE-INTERVENTION)

Objective

To investigate current practices relating to tracheal cuff pressure monitoring in the critical care environment

Timeframe

8 October 2013 from 08h30 to 10h00

15 October 2013 from 07h15 to 09h30

Supporting Annexures

Annexures supporting Phase 2: H and I9

Before commencing Phase 2 (pre-intervention) and 30 minutes before they departed for data collection, the researcher met with the five (5) clinical facilitators who received training during an information session. The researcher supplied each clinical facilitator with a pen and 10 clinical audit tools in an envelope, and she allocated the clinical facilitators to the respective areas in the CCE. The clinical facilitators were allowed to ask questions to ensure clarity before commencing with the data collection in Phase 2.

Consensus was reached on the role of the clinical facilitators and the researcher to ensure the data were collected by all in the same way throughout the collection process.

- **Clinical facilitators:**
  - ✓ Each clinical facilitator was allocated a specific area in the critical care environment.
  - ✓ Each clinical facilitator received an envelope with 10 clinical audit tools.
  - ✓ The clinical facilitator introduced herself to the operational manager and explained the purpose of the visit.
  - ✓ The clinical facilitator then removed all aneroid manometers from the bedside trollies to prevent the nurses from checking and correcting tracheal cuff pressures.
  - ✓ The clinical facilitator then checked each patient in the allocated area to determine whether the patient met the inclusion criteria (view Chapter 3, Section 3.5.2).
  - ✓ If a patient met the inclusion criteria, the clinical facilitator documented the bed number and information required on the clinical audit tool.
  - ✓ The envelope and completed clinical audit tools were placed in the office of the operational manager.

- **The researcher:**
  - ✓ Before data collection, the researcher obtained a new aneroid manometer (a Mallinckrodt Hi-Lo Hand Pressure Gauge made in Germany) for collecting data relating to the current tracheal cuff pressure. The aneroid manometer was calibrated according to the instructions provided (view Annexure I9) to ensure reliability and validity of the study findings.
  - ✓ During data collection, the researcher collected the envelope containing the completed clinical audit tools (obtained from the clinical facilitators) from the office of the operational manager.

- ✓ Based on the documented bed number indicated in Section A of the clinical audit tool, she then measured the cuff pressure independently using the same new aneroid manometer throughout and documented the findings on the clinical audit tool (view Section F of Annexure H).

Two sets of data were collected on different dates as per advice of the statistician. The first set of data was collected on 8 October 2013 from 08h30 to 10h30. The second set of data was collected a week later on 15 October 2013 from 07h15 to 09h30. The researcher accompanied one (1) clinical facilitator to ensure the latter understood the data collection process by using the clinical audit tool thereby ensuring data quality. The researcher asked the clinical facilitators to communicate with her telephonically in case they needed clarity on the data collection process and/or clinical audit checklist. The audit was unannounced and all the areas in the critical care environment were audited simultaneously to prevent data contamination.

The results of the first and second set of data collected were combined and discussed simultaneously (view Table 4.3). The first set of data was collected on 8 October 2013 from patients that were intubated and mechanically ventilated for at least the previous 24 hours (n = 17). In the Cardiothoracic ICU there were two patients (n = 2; [11.7%]); the Coronary ICU had nil (n = 0; [0%]); the Medical ICU had six (n = 6; [35.2 %]); in the Neurosurgery ICU there were two (n = 2; [11.7%]); the Trauma and Surgery ICU also had two (n = 2; [11.7%]); in the High Care there were also two (n = 2 [11.7%]) and in the Emergency Department there were three (n = 3; [17.6%]) patients. The Medical ICU had the highest number of patients. There were no patients who met the inclusion criteria in the Coronary ICU at the time of data collection. The researcher did the monitoring on all patients that were intubated at the time of data collection which were 14 (n= 14; [82.3%]). (View Table 4.3 for the summary).

The second set of data was collected on 15 October 2013 between 07h15 and 09h30 (n = 22) from the ICU flow charts of patients that were ventilated the previous 24 hours. Cardiothoracic ICU had two (n = 2; [9.09%]) patients; the Coronary ICU had nil (n = 0; [0%]); the Medical ICU had four (n = 4; [18.18%]); in the Neurosurgery ICU the patient count was four (n = 4; [18.18%]); in the Trauma and Surgery ICU there were six (n = 6; [27.2%]); in High Care nil (n = 0; [0%]) and in the Emergency Department six (n = 6; [27.2%]). The Trauma and Surgery ICU and the Emergency Department had the highest number of patients; the Coronary ICU and High Care both had no patients that met the inclusion criteria. The researcher completed the measurement on 20 (n = 20; [90.9%]) patients. Two (n = 2; [9.09%]) patients

were already extubated and therefore the tracheal cuff pressure could not be monitored during the time of data collection.

The first and second set of data collected made up a total of 39 (N = 39) ICU flow charts (view Table 4.3). Four (n = 4; [10.25 %]) were from the Cardiothoracic ICU; the Coronary ICU was nil (0%); the Medical ICU contributed 10 (n = 10; [25.64%]); the Neurosurgery ICU six (n = 6; [15.38 %]); from the Trauma and Surgery ICU there were eight (n = 8; [20.5%]); from High Care two (n = 2; [5.12%]), and from the Emergency Department nine (n = 9; [23.0%]). The researcher monitored the tracheal cuff pressure of 34 (n = 34; [87.1 %]) patients who were intubated at the time of the audit. Five (n = 5; [12.8 %]) were found extubated at the time of the tracheal cuff pressure monitoring conducted by the researcher. None (0%) of the nine (9) patients in the Coronary ICU during data collection met the inclusion criteria. For the summary of the two sets of data collected during Phase 2 view Tables 4.3 and 4.4.

Table 4.3: Summary of data collected: Phase 2

Critical care area	Number of ventilated patients previous 24 hours	Percentage of ventilated patients previous 24 hours (%)	Number of patients monitored by the researcher	Percentage of patients who still had tracheal tubes (%)
Cardiothoracic ICU	4	10.25%	Nil as patients were extubated	0%
Coronary ICU	Nil patients met inclusion criteria	0%	Nil patients met inclusion criteria	0%
Medical ICU	10	25.6%	9 (One patient was extubated)	26.4%
Neurosurgery ICU	6	15.3%	6	17.6%
Trauma and Surgery	8	20.5%	8	23.5%
High Care	2	5.12%	2	5.88%
Emergency Department	9	23.0%	9	26.4%
Total	**39**		**34**	

Table 4.4: Summary of data collected: Phase 4

Critical care area	Number of ventilated patients previous 24 hours	Percentage of ventilated patients previous 24 hours (%)	Number of patients monitored by researcher	Percentage of patients who still had tracheal tubes (%)
Cardiothoracic ICU	4	13.3%	0	0%
Coronary ICU	Nil patients met the inclusion criteria	0%	0	0%
Medical ICU	10	33.3%	8 (Two patients were extubated)	34.7%
Neurosurgery ICU	4	13.3%	3 (One patient was extubated)	13.0%
Trauma and Surgery	10	33.3%	10	43.4%
High Care	Nil patients met the inclusion criteria	0	0	0%
Emergency Department	2	6.6%	2	8.69%
Total	**30**		**23**	

The total number of flow charts audited during the pre- and post-interventions was 69 (N = 69). The discussion that follows relates to the results of the clinical audit tool (view Annexure H). The clinical audit tool was designed by the researcher under direct guidance of the statistician together with inputs from the Head of Critical Care at the academic hospital. The clinical audit tool was divided into six Sections:

- **Section A:** Day of Audit
- **Section B:** Demographic information
- **Section C:** Tracheal cuff pressure monitoring: day shift (07h00 – 19h00)
- **Section D:** Tracheal cuff pressure monitoring: night shift (19h00 – 07h00)
- **Section E:** Extraordinary tracheal cuff pressure monitoring
- **Section F:** Tracheal cuff pressure monitoring: Researcher

Each of the six Sections will be discussed individually except for Sections A and B which will be discussed simultaneously. The date, time, week, gender, age, name of critical care area, ventilator days, type of artificial airway, and the airway brand are not regarded as the variables for tracheal cuff pressure monitoring, but the information was collected on record for the completion of the research (view Annexure H Section V1-V11). Therefore, the discussions of the results of Sections C, D, E and F will be done individually.

4.4.1 Section A: Day of Audit V1-V3

The pre-intervention clinical audit is discussed in terms of the week (V1), date (V2) and time (V3). Data collected during Set 1 was done on 8 October 2013 from 09h00 to 11:00 and a total of 17 flow charts were audited (n = 17). Set 2 of the data was collected on 15 October 2013 from 07h15 to 10h00 and a total of 22 flow charts were audited (n = 22) (view Table 4.3). When combining the two sets of data, the total number of flow charts audited by the clinical facilitators were 39 (N = 39). The researcher measured the tracheal cuff pressure of ventilated patients during the same times when the clinical facilitators collected Set 1 and Set 2 of the data. The researcher measured 34 (n = 34) tracheal cuff pressure measurement in total. Five of the patients (n = 5; [12.8 %]) were extubated in the two time periods when the tracheal cuff pressure was monitored by the researcher.

The data collected will be discussed guided by the Sections in the clinical audit tool (view Annexure H).

4.4.2 Section B: Demographic information: V4 to V6

Section B combined the patients' demographic information from their flow charts that were audited during the pre- and post-intervention phases (Phases 2 and 4 respectively). The total number of audits conducted during the pre- and post-intervention was 69 (N = 69).

⇨ **Critical care environment: V4**

The first variable was the critical care environment (CCE) (V4.1 to V4.7).

The critical care environment referred to the five (5) adult critical care areas, one (1) High Care and one (1) Emergency Department in the academic hospital in Gauteng. A clinical audit of flow charts in these areas was done. The summary of the participating hospital's critical care environment identify the seven (7) critical care areas that were involved in the study (view Table 4.1).

⇨ **Date of admission: V5**

The date of admission was taken as a record for the researcher but not as a variable for tracheal cuff pressure monitoring. The item was used to identify the patients' date of admission in the critical care environment. The date of admission varied from 25 July 2013 to 15 October 2013 in the pre-intervention phase (Phase 2), and from 12 December 2013 to 16 April 2014 in the post-intervention phase (Phase 4).

⇨ Number of ventilated days: V6

This item was used to identify the number of ventilated days as reflected on the flow charts audited (N = 69). Two sets of data were collected and it varied from one (1) day to 107 days. The majority of patients (n = 36; [52.2 %]) were ventilated for one (1) to five (5) days, followed by 16 (n = 16; [23.2 %]) who were ventilated for (6) to (10) days and nine (n = 9; [1.3 %]) were ventilated between (11) to (15) days. One (n = 1; [1.44 %]) patient was ventilated for 107 days. To reduce sources of variability, ventilator days were not taken as a variable for tracheal cuff pressure monitoring. For a summary of all patients in the study view Figure 4.1.

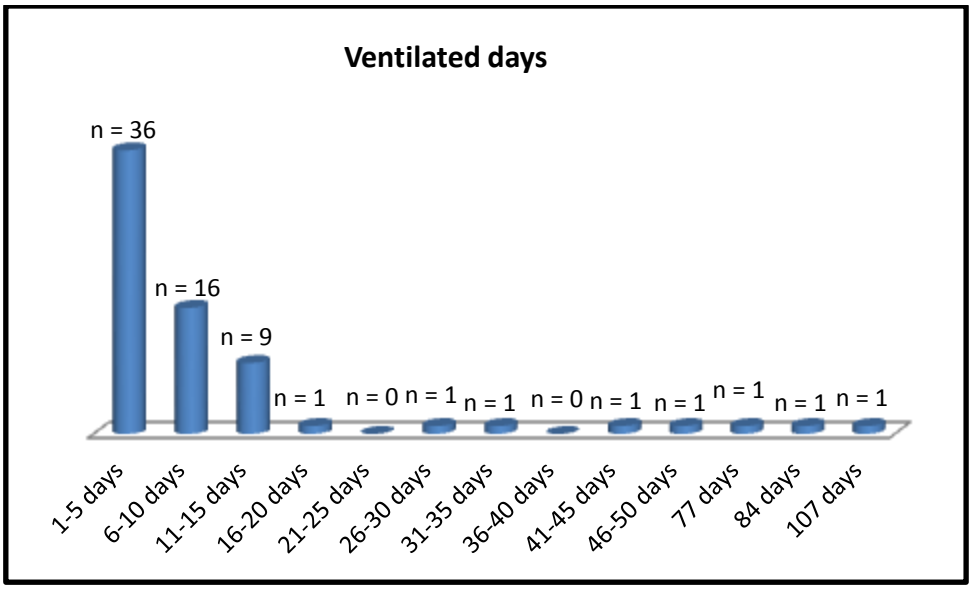

Figure 4.1: Summary of ventilated days (N = 69)

Discussion: The number of ventilated days can affect the outcome of patients in the critical care areas if the monitoring of tracheal cuff pressure is not done. Tracheal cuffs that are underinflated can result in macroaspiration of secretions which can result in VAP (Monahan et al. 2007:615). When patients develop an infection during their stay, it leads to prolonged ventilator days and stay which is costly for the patient and the hospital. Furthermore, overinflated tracheal cuffs can result in major complications like tracheal stenosis and tracheoesophageal fistula (Marino 2007**:**497).

⇨ Gender V7

In order to reduce sources of variability, gender was not taken as a variable for tracheal cuff pressure monitoring, but as an interest for the researcher. A total number of 69 (N = 69) patients' flow charts were audited of which 35 (n = 35; [50.7%]) patients were male and 34 (n = 34; [49.2%]) were female (view Figure 4.7).

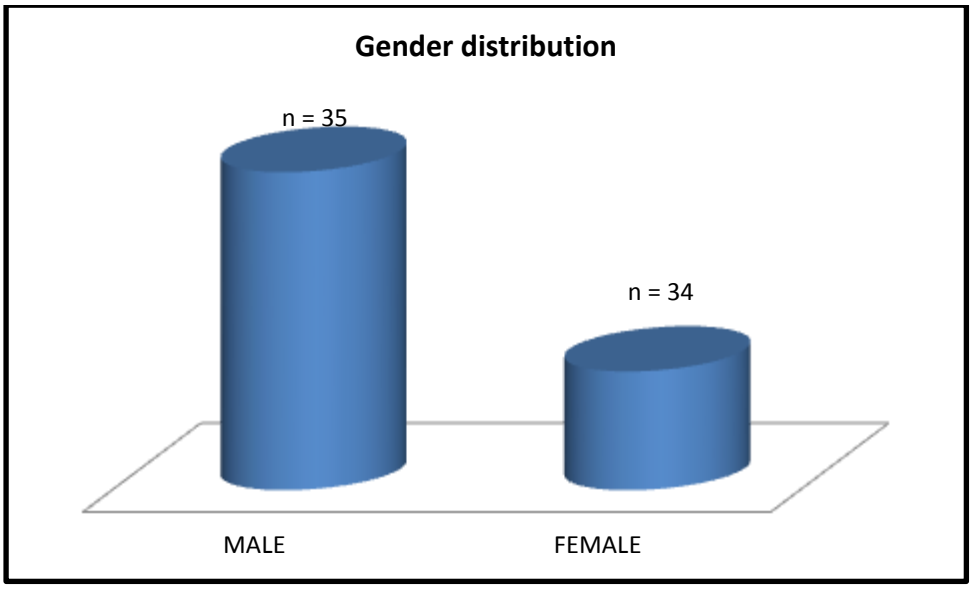

Figure 4.2: Summary of gender distribution of patients (N = 69)

Discussion: A very close gender distribution was found among the patients who were included in this study. Although not used as a variable for tracheal cuff pressure monitoring, the gender of patients could have an impact in the selection of the size of tracheal tube (Proehl 2009:71). According to the author there are recommended tube sizes for both males and females, if a small tube size is used there will be poor seal between the tube and tracheal wall which will result to volume loss.

⇨ **Age: V8**

Question V8 was used to calculate the age of patients whose flow charts were audited in the study. Out of the 68 (N = 69) patients, 68 (n= 68; [98.5%]) patients' date of birth could be traced leaving only one (n = 1; [1.4%]) whose age was unknown. The age of patients would have determined the tracheal tube size. It would indicate whether the patient was an adult or child and for the age ranges of patients in the pre- and post-interventions (view Figure 4.3).

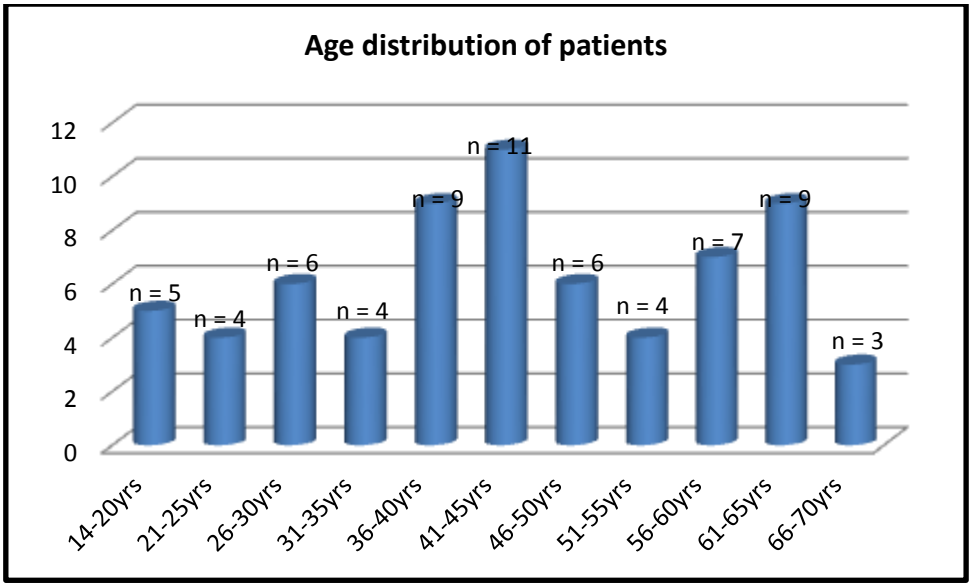

Figure 4.3: Summary of age distribution (N = 69)

Discussion: The majority of patients, namely 11 (n = 11; [16.2%]) were between 41 and 45 years old whereas the age of nine (n = 9; [13%]) was between 36 and 40. A further nine (n = 9; [13%] were between 61 and 65. The lowest number, namely three (n = 3; [4.3%]) was between 66 and 70 years old.

⇨ **Artificial airway: V9**

The question (V9) was used to identify the type of artificial airway used on the patient. Question (V9.1) was used to identify endotracheal tubes as the artificial airway and (V9.2) related to tracheostomy tubes. An endotracheal tube is inserted via the naso- or the orotracheal route or otherwise a tracheostomy is performed (Black & Hawks 2009:1639; Proehl 2009:70; Smeltzer et al. 2010:653). Of the total 69 (N = 69) patients, 62 (n = 62; [89.8%]) had endotracheal tubes and the remaining seven (n = 7; [10.1%]) had tracheostomy tubes. For the summary of the type of artificial airways used in the study view Figure 4.4.

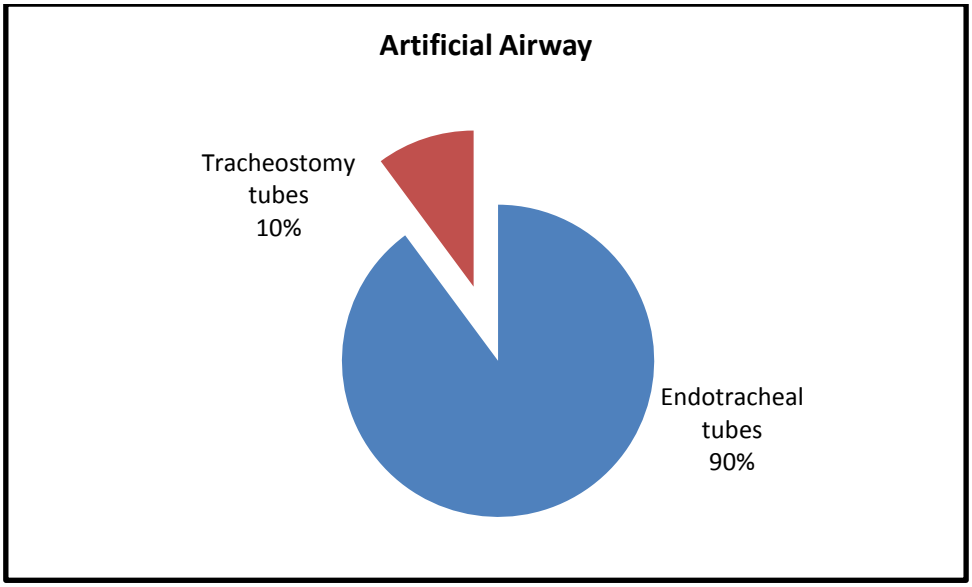

Figure 4.4: Summary of artificial airways used (N = 69)

Discussion: Adult tracheal tubes are cuffed towards the end of the tube. Once inflated these tubes maintain a seal to prevent tidal volume loss and macroaspiration of secretions to ensure effective mechanical ventilation (Wiegand 2011:225). A tracheostomy is performed for patients with prolonged ventilation. As most of the patients' ventilation days were between 1–5 days, 90% of them had endotracheal tubes as artificial airways and 10% had tracheostomies as artificial airways.

⇨ **Artificial airway brand: V10**

The artificial airway brand assisted in determining the suppliers or the manufactures thus assisting with traceability. This posed a challenge during data collection as most endotracheal tubes brand names had already been wiped off. Of the 69 (N = 69) patients, in 63 (n = 63; [91.3%]) of cases the artificial airway brand name was unclear. Two (n = 2; [2.8%]) were from one brand and four (n = 4; [5.79%]) were from a totally different artificial airway brand.

Discussion: Although the knowledge gained from Question V10 does not typically have an influence on the practice of tracheal cuff pressure monitoring in the critical care environment, it was of interest to the researcher to find out whether cuff leakages can be ascribed to manufacturing mistakes which may possibly be traced through frequent monitoring. As stated in Chapter 2 (Section 2.5), it is the responsibility of nurse practitioners in the CCE to deliver correct, appropriate care to their mechanically ventilated patients effectively, efficiently, and timely to ensure quality care. Moreover, as also mentioned in Section 2.5, faulty tracheal cuffs can lead to numerous serious complications. For example, the cuffs maintain a seal between the tracheal wall and the tracheal tube for effective

mechanical ventilation, the prevention of volume loss and macroaspiration of secretions which can result in VAP (Black & Hawks 2009:1639; Proehl 2009:70; Smeltzer et al. 2010:653; Wiegand 2011:225). Therefore, although she agreed the monitoring frequency in this study was insufficient to come to any informed conclusion regarding manufacturing problems, the researcher nevertheless believed she had to explore all possibilities leading to cuff leakages. Due to insufficient data collected on the item, no results could be reported.

⇨Size of tracheal tube*:* V11

The tube size was not used as a variable for monitoring tracheal cuff pressure in the CCE, but for record purposes this data were collected. The most commonly used tracheal tubes in all the critical care areas was 7.5 mm (view Figure 4.5).

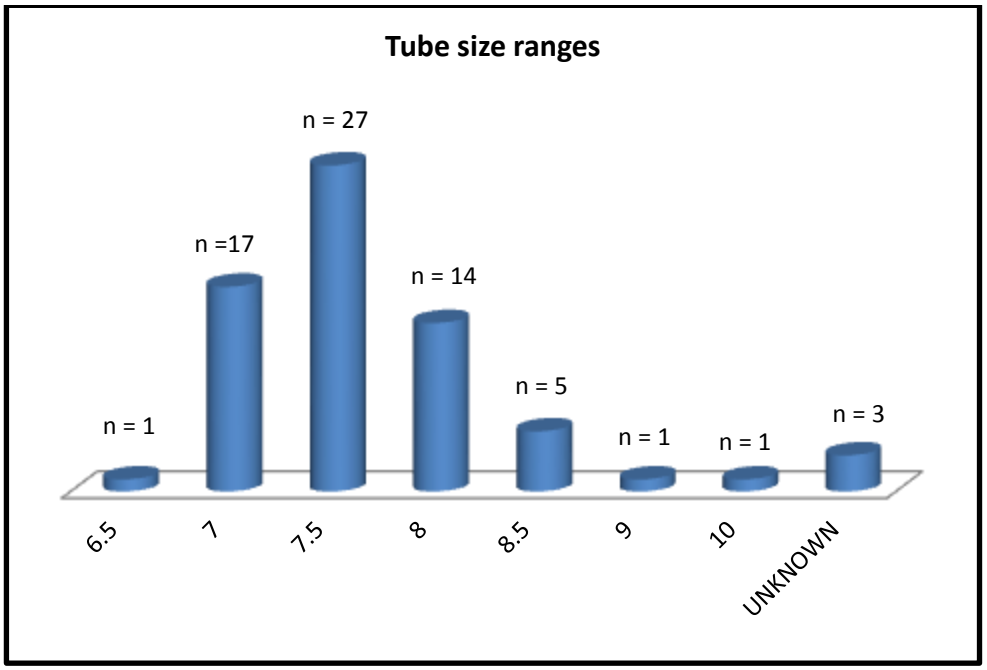

Figure 4.5: Summary of tracheal tube sizes (N = 69)

Discussion: The size of the tracheal tube is important in establishing an artificial airway. According to Proehl (2009:71), the tube sizes for female patients range from 7.0 mm to 8.0 mm and for male patients from 8.0 mm to 9.0 mm. The choice of the correct size could prevent either volume loss or microaspiration of secretions where a small tracheal tube is used. This item was, however, not used as a variable for tracheal cuff pressure monitoring.

4.4.3 Section C: Tracheal cuff pressure monitoring: day shift (07h00 to 19h00) (V 12)

This Section of the clinical audit tool was used to measure the daily compliance with tracheal pressure monitoring in the critical care areas of the CEE in the selected hospital. The flow charts of the patients in the seven (7) critical care areas were used to obtain information on the time of monitoring, the documented pressure and the adjustment made by nurse practitioners on day shift during the previous 24 hours from 07h00 to 19h00.

⇨Routine measurement: V12

Routine measurement will be discussed in terms of V12.1 to V12.3.

⇨Time recorded day shift: V12.1

This was the time recorded on the flow chart that indicated the time the monitoring was done and documented. The exact times of monitoring varied as they were recorded at different times within the 07h00 and 19h00 timeframe. There was no consistency in the time and frequency of monitoring. The results indicate there was a cluster of monitoring between the 07h00 and 10h00 timeframe with the highest number of 15 (n = 15; [21.7%]) at 07h00, followed by 12 (n = 12; [17.3%]). The results also show 16 (n = 16; [23.1%]) where monitoring was not done for the times recorded (view Table 4.5) to assist in determining the timeframes and frequency of monitoring.

Table 4.5: Times recorded pre- and post-intervention day shift (V12.1)

Time of day	Frequency	Percentage (%)	Cumulative frequency	Cumulative percentage (%)
Not done	16	23.19%	16	23.19%
Not applicable	1	1.45%	17	24.64%
07:00:00	15	21.74%	32	46.38%
08:00:00	12	17.39%	44	63.77%
08:40:00	1	1.45%	45	65.22%
09:00:00	5	7.25%	50	72.46%
10:00:00	6	8.7%	56	81.16%
11:00:00	3	4.35%	59	85.51%
12:00:00	2	2.9%	61	88.41%
12:40:00	1	1.45%	62	89.86%
13:00:00	1	1.45%	63	91.3%
15:00:00	2	2.9%	65	94.2%
17:00:00	1	1.45%	66	95.65%
19:00:00	3	4.35%	69	100%

Discussion: According to the study results, the time distribution formed clusters: most of the monitoring was done at the beginning of the shift which was at 07h00 and at 08h00 when normally procedures like bed bathing and tracheal suctioning are done. The results do not show any frequency pattern as it reveals monitoring once per shift. It is clearly indicated that the hospital VAP checklist which

recommends monitoring twice per shift was not followed in this case. This is a huge concern as most of the monitoring was done only once per day shift. Perrie (2010:D4:5) recommends monitoring to be done once per shift or once every 8 hours. Urden et al. (2006:287) recommends 4–8 hourly monitoring and Sole et al. (2011:110) recommends monitoring every 4 to 6 hours.

⇨Recorded tracheal cuff pressure measurement: V12.2

The ideal tracheal cuff pressure is about 27–30 cmH_2O (Perrie 2010:D4:3).Sole et al. (2011:111), Spiegel (2010:52) and Proehl (2009:27) recommend pressures of 20–30 cmH_2O. In this study pressures were classified as compliant when they were between 25–30 cmH_2O, non-compliant were pressures less than 25 cmH_2O and above 30 cmH_2O. Serious non-compliant is where monitoring was not done. Thirty-six (36) patient records (N = 36) were audited during the pre-intervention phase for the day shift of which 23 (n= 23; [63.8%]) were compliant. Of the remaining 13 patient files, four (n = 4; [11.1%]) were non-compliant and 9 (n = 9; [25%]) were serious non-compliant (view Table 4.6).

Table 4.6: Pre-intervention day shift tracheal cuff pressure compliance (V12.3)

1 Compliant: Pressure 25–30 cmH_2O	**23**
2 Non-compliant: Pressure <25 and >30 cmH_2O	**4**
3 Serious non-compliant: No monitoring	**9**
Total	**36**

Discussion: Most tracheal cuff pressures documented on the flow charts were compliant, but there were cases where monitoring was not done. This reveals poor practices of tracheal cuff pressure monitoring. Tracheal cuff pressures that are not monitored can result in complications as they may be either over- or underinflated.

⇨Documentation of the adjusted pressure: V12.3

Cuff pressure deflates over a period of 4–12 hours after adjustment to therapeutic levels of 25–30 cmH_2O (Sole et al. 2011:110). As advocated by Perrie (2010:D4:5), to prove visibility of tracheal cuff deflation and the maintenance of compliant pressures, the found and adjusted pressure should be clearly documented. The pre-intervention results prove poor documentation of the pressures.

Of the 36 (N= 36) flow charts audited, three (n = 3; [8.3%]) documented the adjustment; twenty-four (n = 24; [66.6%]) monitored the pressure but did not document the found adjusted pressure, and nine (n = 9; [25%]) did not monitor the pressure (view Table 4.7).

Table 4.7: Day shift documentation: pre-intervention

1. Yes – adjusted	3
2. Not adjusted	24
3. Not measured	9
Total	**36**

Discussion: The research results reveal that documentation of the found pressure and adjusted pressure was a problem. The pressure was documented with no indication of what the found pressure was. The found pressure can assist in early detection of tracheal cuff leakages which can result in macroaspiration of secretions and cases of VAP; therefore, Perrie (2010:D4:5) only recommends documentation.

4.4.4 Section D: Tracheal cuff pressure monitoring: night shift (19h00 to 07h00) V13

⇨Time recorded: pre- and post-intervention: night shift V13.1

The night time was from 19h00 until 07h00 the following morning. The study results reported within this time period covered the times of monitoring during the night shift. The documented times varied from 19h00 to 06h00. The results reveal a cluster pattern between 19h00 and 20h00: nine (n = 9; [13.04%]) tracheal cuffs were monitored at 19h00 and eight (n = 8; [11.59%]) at 20h00. On 31 (n = 31; 44.92%]) of the patients' flow charts it was indicated that no monitoring was done between 19h00 and 07h00 (view Table 4 8).

Table 4.8: Time recorded pre-and post-intervention: night shift (V13.1)

Time of night	Frequency	Percentage (%)	Cumulative frequency	Cumulative percentage (%)
19:00:00	9	13.04%	9	13.04%
20:00:00	8	11.59%	17	24.63%
21:00:00	5	7.25%	22	31.88%
22:00:00	3	4.35%	25	36.23%
23:00:00	1	1.45%	26	37.68%
00:00:00	1	1.45%	27	39.13%
01:00:00	2	2.9%	29	42.03%
03:00:00	1	1.45%	30	43.48%
04:00:00	3	4.35%	33	47.83%
05:00:00	2	2.9%	35	50.73%
06:00:00	3	4.35%	38	55.08%
Not done	31	44.92 %	69	100%

Table 4.9 present the results of the tracheal cuff pressure compliance on night shift. As indicated in Section 4.4.3(V12.3), compliant pressures were 25-30cmH_20, non-compliant pressures <25 and > 30cmH_20 and serious non-compliant where the monitoring was not done.

Table 4.9: Pre-intervention night shift tracheal cuff pressure compliance

1 Compliant: Pressure 25–30 cmH_2O	14
2 Non-compliant: Pressure <25 and >30 cmH_2O	3
3 Serious non-compliant: No monitoring	21
Total	**38**

Discussion: Based on the results, there is a difference in compliance between the day and night shifts. Of the 38 (N = 38) of the recorded tracheal cuff pressures 14 (n = 14; [36.84%]) had compliant pressures of between 25–30 cmH_2O and three (n = 3; [7.89%]) reported pressures which were less than 25 and above 30 cmH_2O which is classified as non-compliant. The serious non-compliance, indicating no monitoring was done during the night shift, counted 21 (n = 21; [55.2%]) which is much higher than that of the day shift which was nine (n = 9; [25%]).

Table 4.10: Night shift documentation: pre-intervention

1. Yes (adjustment documented)	1
2. No (adjustment not documented)	17
3. Not measured	21
Total	**39**

4.4.5 Section E: Tracheal cuff pressure monitoring: Extraordinary

⇨ **Extraordinary monitoring V14.1-V14.7**

For this Section four items were included and reflect on any extraordinary situations applicable to the patient during the previous 24 hours. As noted by Perrie (2010:D4:5), the patients' tracheal cuff pressure should be monitored on admission, on their return from theatre, after re-intubation, after intubation, when there is suspicion of cuff leakage, and routinely every 8 hours. The extraordinary monitoring was divided into four categories. The number of patients who were classified in the category during the pre-intervention period was nineteen (N = 19); with six (n = 6; [31.5%]) intubated in the critical care area, one (n = 1; [5.26%]) re-intubated, six (n = 6; [31.5%]) from theatre, and eight (n = 8; [42.1%]) new admissions intubated with cuffed tracheal tubes. The data on nine (n = 9; [47.36]) were not clear; hence, these results cannot be reported on.

Table 4.11 provides the different categories of extraordinary monitoring. The categories were classified as those patients who were 1) intubated in the CCE, 2) re-intubated in the CCE, 3) came from theatre being intubated and 4) were admitted other departments being intubated.

Table 4.11: Extraordinary tracheal cuff pressure monitoring (V14)

Intubated (V14.1)	4
Re-intubated (V14.2)	1
Returned from theatre (V14.3)	6
New admission intubated with cuffed tube (V14.4)	8
Total	**19**

Table 4.12 provides the results of compliant tracheal cuff pressures that were recorded during extra-ordinary monitoring.

Table 4.12: Pre-intervention extraordinary tracheal cuff pressure compliance (V14.5)

1 Compliant: Pressure 25–30 cmH_2O	3
2 Non-compliant: Pressure <25 and >30	2
3 Serious non-compliant: Not monitored	14
Total	**19**

Table 4.13 provides information regarding the extraordinary times that were recorded during the pre- and post-intervention phases. This is the time when patients fell into the category of extraordinary monitoring as classified in (V14)

Table 4.13: Extraordinary pre- and post-interventions timing (V14.6)

Time	Frequency	Percentage (%)	Cumulative frequency	Cumulative percentage (%)
Not applicable	62	89.96	62	89.86
01h00:00	2	2.9	64	92.75
12:40:00	1	1.45	65	94.2
16:00:00	1	1.45	66	95.65
17:00:00	1	1.45	67	97.1
19:00:00	1	1.45	68	98.55
21:00:00	1	1.45	69	100

Discussion: Not enough data were available to report on the extraordinary monitoring. The monitoring can have an impact on the tracheal cuff pressure as patients are often admitted with high tracheal cuff

pressures from theatre, cuff pressures not checked post-intubation or following major procedures such as a scan.

Overinflated tracheal cuff pressures can result in complications like a sore throat and tracheal mucosal ischemia or major complications such as tracheosophageal fistula or tracheal stenosis (Jordan et al. 2012:13).

4.4.6 Section F: Tracheal cuff pressure monitoring by researcher (V15)

The researcher did the random measurement of tracheal cuff monitoring with the same aneroid manometer on 34 (N = 34) patients who were intubated with cuffed tracheal tubes and mechanically ventilated at the time of data collection. The researcher did this follow-up measurement after the clinical facilitators had completed the chart audit. She used the newly calibrated easy-to-use hand-held aneroid manometer on all patients who were intubated with tracheal cuffs. The clinical facilitators removed the aneroid manometers from the emergency trollies where they were kept and from the patients' bedsides to prevent manipulation which could contaminate the data. To ensure data quality, the audit was unannounced to prevent the Hawthorne effect (Botma et al. 2010:86).

The researcher monitored nil (n = 0; [0%]) in the Cardiothoracic ICU because the patients were already extubated and also nil (n = 0; [0%]) in the Coronary ICU because the patients did not meet the criteria. She monitored nine (n = 9; [26.47%]) in the Medical ICU and one (n = 1; [2.94%]) was extubated. In the Neurosurgery ICU she monitored six (n = 6; [17.6%]) and eight (n = 8; [23.5%]) in the Trauma and Surgery ICU. Two (n = 2; [5.88%]) in High Care were monitored and in the Emergency Department nine (n = 9; [26.4%]) were monitored. The times of monitoring differed as there were two sets of data collected in this phase. Of the 34 (N = 34) patients only seven (n = 7; [20.58%]) had compliant pressures of between 25–30 cmH_2O. Twenty seven (n = 27; [79.4%]) were non-compliant which means they were below 25 cmH_2O and above 30 cmH_2O. The measurements ranged from 0 cmH_2O (the lowest) and 110 cmH_2O which was the highest. View Table 4.14 and Figure 4.6 which outline the researcher`s monitoring times and measurements.

Table 4.14: Researcher time and tracheal cuff pressure monitoring pre-intervention

Patient no.	Time of monitoring	Tracheal cuff pressure measurement
1	10:10	32 cmH_2O
2	10:15	10 cmH_2O
3	Extubated	Extubated
4	Extubated	Extubated
5	09:12	24 cmH_2O
6	09:15	16 cmH_2O
7	09:25	14 cmH_2O
8	09:55	0 cmH_2O
9	09:58	20 cmH_2O
10	10:45	28 cmH_2O
11.	10:46	10 cmH_2O
12	10:48	20 cmH_2O
13	10:50	10 cmH_2O
14	10:40	30 cmH_2O
15	Extubated	Extubated
16	09:40	36 cmH_2O
17	09:35	30 cmH_2O
18	07:50	14 cmH_2O
19	08:05	0 cmH_2O
20	08:00	28 cmH_2O
21	07:58	25 cmH_2O
22	07:55	30 cmH_2O
23	08:03	30 cmH_2O
24	08:35	100 cmH_2O
25	08:40	20 cmH_2O
26	08:45	14 cmH_2O
27	08:20	16 cmH_2O
28	08:15	110 cmH_2O
29	08:12	20 cmH_2O
30	08:10	4 cmH_2O
31	07:30	14 cmH_2O
32	07:25	10 cmH_2O
33	07:35	20 cmH_2O
34	07:40	16 cmH_2O
35	07:42	40 cmH_2O
36	07:45	36 cmH_2O
37	08:42	20 cmH_2O
38	Extubated	Extubated
39	Extubated	Extubated

Figure 4.6 in page 77 represents the results of tracheal cuff pressure measurements by the researcher using the aneroid manometer on patients that were having cuffed tracheal tubes at the time of the audit.

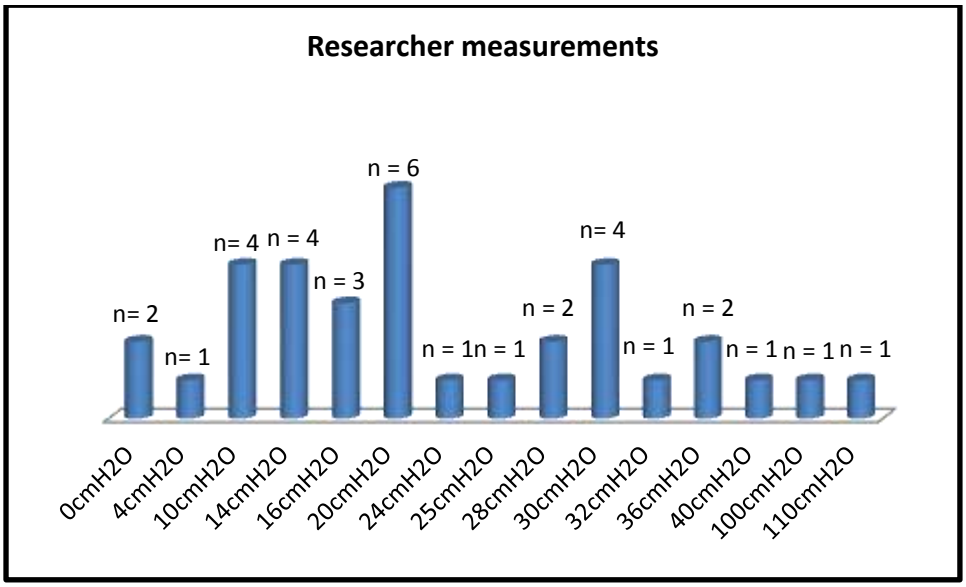

Figure 4.6: Researcher measurements pre-intervention (N = 34)

Discussion: Using the results of previous research studies as their point of departure, Raynham et al. (2009:645) undertook a survey of cuff pressures and monitoring practices in the ICUs in the Groote Schuur Hospital, Tygerberg Hospital as well as two private hospitals in Cape Town. Visits were unannounced to record true clinical practice. Cuff pressures were measured with the aneroid manometer. The availability of cuff pressure monitors in the ICUs was taken into consideration. In the survey a total of 46 (N = 46) patients were intubated. Cuff monitors were available at 29% of the ICU beds and 16% of the beds had access to the manometer kept elsewhere in the unit. The researchers found that cuff pressure monitors were used in 18 (n = 18; [38%]) of the intubated patients surveyed. One teaching hospital had cuff monitors available at 53% of the ICU beds, but at other beds no pressure monitors were available. With the pressures recorded, 30% had excessive cuff pressures ranging from 34–38 cmH_2O.

In a research survey on cuff pressure management conducted in the USA, Lizy et al. (2011:422) found only 3% of nurses monitor cuff pressure only every 8 hours and frequently by means of finger palpation of the pilot balloon. This practice was shown to result in excessive cuff pressures. Jordan et al. (2012:13) from the Nelson Mandela Metropolitan University in South Africa found 52% of the respondents performed cuff pressure monitoring every 6–12 hours while more frequent monitoring (every 2–4 hours) was performed by 32%. With regard to tracheal cuff pressure ranges, 22% of the

respondents indicated correct ranges of 18–22 mmHg(25-30cmH_20). Approximately 33% maintained pressures of between 23–25 mmHg(31-34cmH_20); 43% maintained pressures of 26–30mmHg(35-40cmH_20); 1% maintained pressures of >31 mmHg(42cmH_20), and 1% of the respondents did not know what the correct tracheal pressure should be.

4.4.6.1 Tracheal cuff pressure measurement per unit

The information in Table 4.15 and 4.16 provide the results of the number of patients per CCE, the day and night monitoring, researcher monitoring and the minimum and maximum tracheal cuff pressures of patients in participating CCE`s,

Table 4.15: Pre-intervention tracheal cuff pressure monitoring

Cardiothoracic ICU								
Charts	**Label**	**N**	**Median**	**Mean**	**STD DEV**	**30**	**Minimum pressure**	**Maximum pressure**
4	Day measurement	3	30	30.00	0.000	75.00%	30	30
	Night measurement	3	28	28.67	1.155	25.00%	28	30
	Researcher measurement	0	**Patients extubated**					
Emergency Department								
Charts	**Label**	**N**	**Median**	**Mean**	**STD DEV**	**30**	**Minimum pressure**	**Maximum pressure**
9	Day measurement	5	30	29.60	0.894	44.44%	28	30
	Night measurement	0				0.00%	No monitoring	No monitoring
	Researcher measurement	9	16	21.11	10.398	0.00%	10	40
High Care								
Charts	**Label**	**N**	**Median**	**Mean**	**STD DEV**	**30**	**Minimum pressure**	**Maximum pressure**
2	Day measurement	0				0.00%	**No monitoring**	**No monitoring**
	Night measurement	0				0.00%	**No monitoring**	**No monitoring**
	Researcher measurement	2	33	33.00	4.243	50.00%	30	36
Medical ICU								
Charts	**Label**	**N**	**Median**	**Mean**	**STD DEV**	**30**	**Minimum pressure**	**Maximum pressure**
10	Day measurement	10	30	29.90	0.316	90.00%	29	30
	Night measurement	7	30	30.29	0.756	60.00%	30	32
	Researcher measurement **1 patient extubated**	9	20	27.56	32.059	10.00%	4	110

Neurosurgery ICU								
Charts	**Label**	**N**	**Median**	**Mean**	**STD DEV**	**30**	**Minimum pressure**	**Maximum pressure**
6	Day measurement	3	28	28.67	1.155	16.67%	28	30
	Night measurement	4	30	31.00	2.000	50.00%	30	34
	Researcher measurement	6	20	32.67	33.815	0.00%	10	100
Trauma and Surgery ICU								
Charts	**Label**	**N**	**Median**	**Mean**	**STD DEV**	**30**	**Minimum pressure**	**Maximum pressure**
8	Day measurement	6	31	29.67	6.121	12.50%	20	38
	Night measurement	3	30	33.33	5.774	25.00%	30	40
	Researcher measurement	8	22.5	18.38	12.558	25.00%	0	30
Charts	**Label**	**N**	**Median**	**Mean**	**STD DEV**	**30**	**Minimum pressure**	**Maximum pressure**
39	Day measurement	27	30	29.67	2.760	46.15%	20	38
	Night measurement	17	30	30.71	2.733	30.77%	28	40
	Extraordinary measurement	5	30	31.60	5.177	5.13%	26	40
	Researcher measurement	34	20	24.91	22.665	10.26%	0	110

4.4.6.2 Conclusion: Phase 2

Phase 2 provided a clear summary of the tracheal cuff pressure monitoring practices by nurse practitioners in the academic hospital in Gauteng. Based on the data in relation to time of monitoring, there was no consistency and monitoring was mostly done at the beginning of the shift, whether day or night shift. A pattern emerged when the time cluster is observed – specifically with reference to the mornings between seven and nine o'clock. Where monitoring was done, it was done only once per shift. Pressure adjustments were mostly not documented. There were serious non-compliances during the night shift when compared to the day shift. Extra-ordinary monitoring was a significant problem, but this item can in future studies be investigated thoroughly. The range of the researcher measurements differed considerably from the lowest at 0 cmH_2O to the highest at 110 cmH_2O which was grave concern.

4.5 PHASE 3: COLLABORATIVELY PLAN AND IMPLEMENT INTERVENTIONS

Objective

To collaboratively plan and implement interventions for change: Step 1(share the results) Step 2 (plan) and Step 3 (implement).

Date and Timeframes

Verbal feedback

16 October 2013 and 25 October 2013

Nominal group session

5 November 2013 from 09h00 to 11h00

In-service training

Between 18 November 2013 and 2 January 2014

Posters

From 8 January 2014

Supporting Annexures:

Annexures supporting Phase 3 include: B2, D, G, E, F, I 4, I 5, I 6, I 7and I 8

Phase 2 provided evidence on what the existing practice on tracheal cuff pressure monitoring in the critical care environment of an academic hospital had been.

Phase 3 of the study was conducted in three steps:

- **Step 1:** Diffusion and dissemination of the results
- **Step 2:** Decision on the intervention
- **Step 3:** Intervention

Each step will be discussed in depth in Sections 4.5.1 to 4.5.3

4.5.1 Step 1: Dissemination of results

Verbal feedback was given by the researcher in the critical care units based on the results of phase 2. The operational managers were eager to know the results of the audit. The researcher arranged with the operational managers on a convenient date and time to give the feedback. It was agreed among all stakeholders that the researcher would give verbal feedback to the nurse practitioners of the CCE`s on 16 October 2014 from 07h00 to 11h00 and 25 October 2014 from 07h30 to 11h30. The nurse

practitioners were also informed that they would be invited to a session where they, together with the clinical facilitators, would collaboratively decide on an intervention. A total of 36 (N=36) nurse practitioners received verbal feedback on what the current practice of tracheal cuff pressure monitoring in the critical care environment was (view Table 4.22). The attendance list was completed by the nurse practitioners (N = 36) who received verbal feedback (view Annexure I10.)

Table 4.17: Verbal feedback

Date	Critical care area	Number of attendants
16 October 2013	Emergency Department	6
16 October 2013	High Care	7
16 October 2013	Medical ICU	8
16 October 2013	Neurosurgery ICU	5
16 October 2013	Trauma and Surgery ICU	7
25 October 2013	Cardiothoracic ICU	3
Total		**36**

Discussion: The process of diffusion was used to share the results with the participants of the different critical care areas. As explained by Rogers (2003:10), “diffusion is the process through which an innovation is communicated using certain channels over time among members”.

This explanation is also confirmed by Zidarof et al. (2012:1–2) who state diffusion is a passive process that is controlled or uncontrolled and the aim is to understand the existing practices and identify factors that enable and prevent compliance. Audit and feedback is used as a strategy to improve professional practice and enhance quality improvement; feedback can be given in a written or verbal format or both (Ivers et al. 2012:2). Dixon and Pearce (2011:39) agree with Foy et al. (2005:2) that suitable and sufficient arrangements need to be made in order to share the information with all concerned. The researcher made appointments at different critical care areas to give verbal feedback.

Participants were given verbal feedback on results obtained during Phase 2 in order to plan a way forward. The researcher verbally invited participants to be part of decision making on an intervention during the nominal group meeting. The initial verbal invitation was followed by a formal invitation (view Annexure *1*.5).

4.5.2 Step 2: Consensus on interventions

On 5 November 2013 a nominal group session was held in the lecture room of the academic hospital. Consensus was reached through the utilisation of the nominal group technique (NGT). An informed consent form was signed by all members present (view Annexure B.2) The researcher made use of a PowerPoint presentation to provide feedback on what the current practice on tracheal cuff pressure monitoring in the critical care area of the academic hospital was (view Annexure *I* 4).

A total of 11 (N = 11) participants formed the nominal group. Their individual years of experience as professional nurses ranged from 4 to 37 years (the mean was 25 years). Of the 11 participants, nine (n = 9; [81.8%]) had a post-basic qualification in Medical Surgical Nursing Science: Critical Care General (view Table 4.23).

Table 4.18: Nominal group participant characteristics

Participants	Post-basic qualification	Years of experience as registered nurse	Other qualifications
1	Medical Surgical Nursing Science: Critical Care General Diploma	20 years	
2	Medical Surgical Nursing Science: Critical Care General Diploma	4 years	
3	Medical Surgical Nursing Science: Critical Care General Diploma	20 years	
4	Medical Surgical Nursing Science: Critical Care General Diploma	25 years	
5	Medical Surgical Nursing Science: Critical Care General Diploma	26 years	
6	Medical Surgical Nursing Science: Critical Care General Diploma	19 years	Nursing Education; Nursing Administration; Medical Surgical Nursing: Emergency Degree
7	Medical Surgical Nursing Science: Critical Care General Diploma	31 years	Nursing Administration Diploma
8	Medical Surgical Nursing Science: Critical Care General Diploma	30 years	Nursing Administration Diploma
9	Medical Surgical Nursing Science: Critical Care General Diploma	29 years	Nursing Education Diploma
10	Although does not have a qualification in Medical Surgical Nursing Science: Critical Care, has other clinical qualifications	35 years	Medical Surgical Nursing Science: Emergency, Nursing Administration Degree
11	Has additional clinical qualification	23 years	Nursing Administration Diploma

The nominal group session was led by the facilitator from the University of Pretoria. Consensus was reached to address the interventions below in the order of importance as listed:

- Revise the standard.

- Provide in-service training.
- Verbal reminders need to be done by shift leaders.
- Document the found and adjusted pressures.
- Reminders by means of posters.

Discussion: Dissemination of the results can be used passively where written reports or feedback is handed out or actively where there is a discussion of the findings (Dearing 2009:504; de Vos et al. 2011:487).

4.5.3 Step 3: Interventions

The intervention consist of five components, each of the components will be discussed in-depth in Sections 4.5.3.1 – 4.5.3.5.

4.5.3.1 Revision of the standard

"A standard is a written description or a statement of the level of performance with special reference to structure, process and outcome" Muller et al. 2006:474 "Standardised clinical guidelines are step-by-step interventions for providers to follow in an effort to promote high quality of care while controlling resource utilisation and costs" (Marquis & Huston 2012:551).

The standard operational procedure of tracheal cuff pressure monitoring was revised and the frequency of monitoring was stated (view Annexure G). The hospital's VAP checklist which requires tracheal cuff pressure to be monitored twice per shift was also revised to, firstly, specify the times of monitoring as 09h00 and 14h00 for the day shift and 19h00 and 24h00 for the night shift and, secondly, to stipulate the procedures to be followed during monitoring (view Annexure F). Yoder-Wise (2011:399) emphasise standards should reflect evidence-based practice and should be updated as new research emerges.

⇨Supporting reflections by the nominal group:

- *"That's very good. It is important to assign standardise* [standards] *because it can also help when they come from a different unit or a hospital. So we can say that we have to standardise the frequency and justify the frequency…"*
- *"Ok, so now we need to come up with one pager that will be user-friendly that will be part of the everyday work. So if we make a heading called 'Information' this will include posters, in-service*

training. When must this be done? Because previously it was not clear how often it should be done…"

- *"Maybe twice a shift…* [referring to the number of times per shift pressure cuff monitoring should be done]*"*
- *"Ok, we can say eight o'clock. The pressure must also be checked immediately when admitted to the unit and after intubation…"*
- *"We can say the first one will be at 07h00/19h00 at the beginning of the shift and the second one will be at 14h00/24h00 or what do you think?"*
- *"Ok so we keep the times for the first observation and 6 hours from that for the second observation, which will be at 02h00/14h00. Is that acceptable?"*
- *"The VAP checklist requires monitoring to be done twice per shift, so times can be specified…"*
- *"Every shift will do it twice and whenever the patient goes for a scan or comes from theatre in between, they will be checked again. Once a patient comes from outside the unit, the checking will be done immediately…"*

Discussion: A standard is revised following new evidence from research and to improve the quality of care (Yoder-Wise 2011:399). Though Memela and Gopalan (2014:34) question the viability of only 8-hourly monitoring because the significant variations in endotracheal cuff pressure are a major concern in critical care environments worldwide. In this study it was foreseen that the revised standard will assist with consistency in monitoring and also prevent unclear and confusing situations of care.

4.5.3.2 In-service training

Training can be defined as an organised method of ensuring that people have knowledge and skills for a specific purpose and they have acquired the necessary knowledge to perform duties (Marquis & Huston 2012:366). The researcher gave in-service training in different critical care areas which covered the content that was agreed upon by the nominal group (view Annexure I 3).

⇨Supporting reflections by the nominal group:

- *"I was thinking two things; service training in the unit and we can look at the skill of the person…"*
- *"So we can look at the in-service* [training] *and to become aware of the complications, therefore in-service training and skills* [will be good]…"
- *"So, in-service training you can think of suggestions to further* [improve knowledge]*…"*
- *"So, we can add the importance of measuring and complications. What else*?*"*
- *"We can also say that Anatomy and Physiology will be added to in-service…"*
- *"We now have a timeframe for in-service so everybody will now know when they should check…"*

- *"We can say the importance, cost and complications of cuff pressure monitoring. We can also add skill because there are different skills, we can`t just assume everyone knows. We need to ensure that staff members know how and are able to adjust the pressure…"*
- *"How are we going to do that? Are we going to check that every person is skilled?"*
- *"We can make it part of in-service. It will be a theoretical and a practical component that will be demonstrated. The facilitator or unit manager will make sure that everybody is competent. There was a suggestion that on an individual basis, the unit manager can come and do the in-service training…"*
- *"Availability of equipment is quite challenging but those of you who have good relationships with the reps can organise something there. The suggestion also came for theatre…"*

The in-service training was given from 19 November 2013 to 2 January 2014 in the critical care areas represented by the attendants who took part in the in-service training sessions (view Table 4.19).

Table 4.19: Summary of attendants for in-service training

Date	Shift	Unit	Number of attendees
18 November 2013	Day	Coronary ICU	4
18 November 2013	Day	Neurosurgery ICU	8
18 November 2013	Day	Cardiothoracic ICU	7
18 November 2013	Day	Medical ICU	7
19 November 2013	Day	High Care	7
19 November 2013	Day	Trauma and Surgery ICU	6
19 November 2013	Day	Emergency Department	10
21 November 2013	Day	High Care	7
22 November 2013	Day	Trauma and Surgery ICU	7
8 December 2013	Night	Trauma and Surgery ICU	5
2 January 2014	Day	Trauma and Surgery ICU	4
Total			**72**

Discussion: In-service learning can have a considerable positive impact on outcomes and can significantly improve cognitive, behavioural and social outcomes (Strait et al. 2009:106–107). It is confirmed by Billig (2007:19) and Hurd (2006:2) that in-service training is a tool that can be used to enhance learning outcomes such as knowledge, skills and attitudes. The lecture method can be used to deliver in-service training because this method allows for ongoing explaining and giving information about an issue with the recipient listening either willingly or unwillingly (Hughes & Quinn 2013:189). According to Bouadma et al. (2010:789-92), an educational programme, which was designed to be

used in the critical care environment in an effort to prevent VAP, had a positive effect on the reduction of VAP.

4.5.3.3 Reminder by shift leaders

As agreed during the nominal group session, shift leaders were to remind the nurse practitioners during risk rounds and handover rounds about the monitoring.

⇨Supporting reflections by nominal group:

- *"Ok, we can also enhance the quality control "*
- *"Next we can look at the specific person that will be responsible for the checking and the recording…"*
- *"In the ICU it will be easy because there is always a shift leader. In every unit it will be indicated…"*
- *"The indicated person will only check that it was done. When doing rounds, you will just see whether it was done or not…"*
- *"The risk rounds are the next one. This forms part of quality improvement. It also forms part of procedure. It will be easier once the in-service training is done and everyone knows what is expected…"*

Discussion: Verbal reminders by shift leaders form part of quality control measures. Marquis and Huston (2012:543) state quality control refers to activities that are used to evaluate, monitor or regulate services rendered. It is further mentioned by Yoder-Wise (2011:393) that the goal of quality management is to improve the system and not to assign blame. These authors further stress the importance of communication between managers and employees to improve the quality of care.

4.5.3.4 Posters

Pictorial information can aid readability and improve understanding thereby enabling the formation of a mental model of the situation (Kools et al. 2005:104). Pictures or posters can be used to enforce learning. On 8 January 2014, which was in the week after the in-service training had been completed, the researcher distributed posters in all participating critical care areas which clearly asked the following question: "*Is your patient's tracheal cuff pressure 25–30 cmH_2O?"* (view Annexure *I* 8). The posters were printed in colour, laminated and the words were clear and big enough to easily read. The managers and staff were to decide on where to place the posters. All the posters were placed at the doors and even next to basins where they were visible and could be clearly seen.

⇨Supporting reflections by the nominal group:

- *"Ok, we can also add pictures…"*
- *"Let's go back to in-service training because there is important information that we need to include. There were suggestions that we can include pictures…"*
- *"Let's think in terms of the poster. This was a good suggestion but who will take responsibility for the poster? We can even print it in colour and put it in a plastic sleeve, it doesn't need to be an expensive poster. It is a good idea to see it, just to raise awareness. To re-emphasise what was taught during in-service training…"*

Discussion: Pictures are used to enforce learning which can lead to a definite change in nurse practitioners' behaviour towards tracheal cuff pressure monitoring. The advantages of using pictures are numerous: they are flexible; using pictures can save space; long-term availability is assured; pictures stimulate and improve interactions, and they are more effective in conveying ideas (Altintas et al. 2014:196). The advantage of poster usage is supported by Deonandan et al. (2013:184) who found students learn best when linkages between teaching and research are expressed in a more practical manner.

4.5.3.5 Documentation

Tracheal cuff pressure deflates over a period of time after adjustment to therapeutic levels of between 25 and 30 cmH_2O (Sole et al. 2011:110). In order to prove visibility of cuff deflation and also ensure cuff pressure compliance, proper documentation had to be done.

⇨Supporting reflections by the nominal group:

- *"I think if we write the interpretations we have to reflect it so that when we come back the next day, it will be reflected on the certain amount of pressure…"*
- *"Ok, so the specific recording of the cuff pressure and actual reading is important…"*
- *"The other thing that came out strongly is the recording. One of the suggestions was even on the checklist; they* [nurse practitioners] *should not just make a tick. They should record the actual reading. I think what will help is if we decide on the times, we should indicate it on the flow chart so that everybody knows when is the time to record…"*
- *"The recording will be done on the checklist and on the flow chart. Now we need to decide how we will indicate it. Will we make a red dot or how do you usually do it?"*
- *"Let's say what they* [nurse practitioners] *found or adjusted, they will record it. So the times will be indicated with a red pen. Anything else pertaining to the recording?"*

- *"The next thing we need to discuss is the adjustment policy. Each person will record what they found and they will record what they adjusted the pressure to…"*

Discussion: In order to prove visibility of cuff deflation and pressure compliance, it was decided that the found pressure and adjusted pressure had to be documented. As indicated by the results of Phase 2, the documentation of the found and adjusted pressure was not visible. In fact, only one pressure was documented and this was mostly recorded as 30 cmH_2O. The documentation of the actual found pressure can help with the identification of tracheal cuff leakages and pressures that are too low or high (Perrie 2010:D4:5). In support, Bernon et al. (2013:641) state cuff pressure need to be documented as it will serve as evidence when an intervention is necessary. Over- and underinflated tracheal cuffs would be prevented if proper documentation is done which, in turn, will ensure a good outcome for patient safety. Consensus was reached in the nominal group that all documentation needed to be clear and also had to be added to the hospital's VAP checklist (view Annexure F).

4.5.4 Conclusion: Phase 3

The process of diffusion was used when the researcher gave verbal feedback in the participating critical care areas. This was followed by the process of dissemination of the results during the nominal group session. Consensus on the intervention as well as the steps to be taken to ensure its implementation was reached during the nominal group session.

The intervention agreed upon is set out below.

- Revision of the hospital standard of tracheal cuff pressure monitoring which was done by the clinical department.
- The hospital VAP checklist in relation to specific times of monitoring which were 07h00, 14h00, 19h00 and 02h00.
- In-service training by the researcher and seventy two nurse practitioners received training
- Documentation of the found and adjusted pressures.
- Posters on which was clearly written: *"Is your patient's tracheal cuff pressure 25–30 cmH_2O?"* were distributed and fixed to doors and placed next to basins as reminders.

4.6 PHASE 4: POST-INTERVENTION

During phase 3, the results were disseminated and interventions implemented by the researcher. The objective of phase 4 was to re-investigate for change in practice by conducting the post-intervention audit.

Objective

To re-investigate for change in practice (post-intervention audit)

Date and Timeframe

9 April 2014 from 07h30 to 10h00

17 April 2014 from 07h00 to 10h00

Supporting Annexure

The Annexures supporting Phase 4: H

Four of the hospital clinical facilitators who had assisted in Phase 2 conducted a post-intervention audit 20 weeks after the intervention had been implemented. One facilitator was not available for the duration of Phase 4. A post-intervention was performed to evaluate change. The post-intervention comprised data collection after the intervention (Polit & Beck 2008:261). The same clinical audit tool that was used in Phase 2 was again used for data collection in Phase 4 and two sets of data were collected. The researcher also used the same aneroid manometer she had used during Phase 2 for monitoring.

The first set of data was collected on 9 April 2014 between 07h30 and 10h00. The researcher reminded the hospital clinical facilitators telephonically a day before. A briefing session was held to remind the facilitators on how to use the clinical audit checklist. Queries that arose were clarified. The facilitators were allocated by the researcher to different critical care areas and pens and clinical audit tools were given to them where. Seventeen (N = 17) patients' ICU flow charts were audited. The researcher did monitoring of fourteen (n = 14) patients who were still intubated at the time of the audit. The second set of data was collected on 17 April 2014 from 07h30 to 10h00. A total of thirteen (N = 13) patients' ICU flow charts were audited. The researcher monitored twelve (n = 12) patients who were still intubated at the time of the audit. One patient was extubated.

In Phase 4 a total of thirty (N = 30) patients' flow charts were audited. From the Cardiothoracic ICU there were 4 (n = 4; [13.3%]). No flow charts from the Coronary ICU were audited, thus (n = 0; [0%]). In the Medical ICU ten (n = 10; [33.3%]) were audited and in the Neurosurgery ICU four (n = 4; [13.3%]). The Trauma and Surgery ICU rendered ten (n = 10; [33.3%]) audits; the High Care nil (n = 0; [0%]) and the Emergency Department two (n = 2; [6.6%]).

Of the 30 (N = 30) flow charts audited, on five (n = 5; [16.6%]) of the flow charts cuff pressure monitoring were done more than once per shift. The time of monitoring again showed a cluster pattern

where most of the monitoring was done at the beginning of the day and night shifts; however, the night shift monitoring did show some improvement (view Table 4.20).

Table 4.20: Flow chart day and night time and pressure (post-intervention)

Flow chart	Day time	Pressure	Night time	Pressure	Extra-ordinary	Pressure
1	10:00	30 cmH_2O	ND	ND	NA	NA
2	08:00 16:00	30 cmH_2O 30 cmH_2O	05:00	30cmH_2O	NA	NA
3	08:00	40 cmH_2O	ND	ND	NA	NA
4	08:00	20 cmH_2O	ND	ND	NA	NA
5	10:00	30 cmH_2O	ND	ND	NA	NA
6	ND* admitted 18:00	ND	04:00	30cmH_2O	ND admission	ND
7	10:00	30 cmH_2O	ND	ND	NA	NA
8	ND	ND	ND	ND	NA	NA
9	08:00	30 cmH_2O	04:00	30cmH_2O	NA	NA
10	ND	ND	19:00 06:00	30cmH_2O 30 cmH_2O	NA	NA
11	NA admitted 01:00	NA	01:00 06:00	30 cmH_2O 30 cmH_2O	01h00 admitted	30 cmH_2O
12	08:00	30 cmH_2O	**NA**** extubated	NA	NA	NA
13	12:00	28 cmH_2O	20:00	28 cmH_2O	NA	NA
14	09:00	30 cmH_2O	21:00 04:00	30 cmH_2O 30 cmH_2O	NA	NA
15	07:00	30 cmH_2O	19:00	18 cmH_2O	NA	NA
16	ND	ND	ND	ND	NA	NA
17	07:00	30 cmH_2O	20:00	30 cmH_2O	NA	NA
18	11:00	20 cmH_2O	01:00	30 cmH_2O	NA	NA
19	ND	ND	06:00	30 cmH_2O	NA	NA
20	10:00	30 cmH_2O	05:00	30 cmH_2O	NA	NA
21	10:00	30 cmH_2O	NA extubated	NA	NA	NA
22	ND admitted 13:00	ND	19:00	30 cmH_2O	ND admission	ND
23	ND	ND	21:00	30 cmH_2O	NA	NA
24	07:00	30 cmH_2O	20:00	30 cmH_2O	NA	NA
25	07:00	30 cmH_2O	19:00	30 cmH_2O	NA	NA
26	09:00	20 cmH_2O	21:00	30 cmH_2O	NA	NA
27	08:00	28 cmH_2O	ND	ND	NA	NA
28	ND	ND	20:00	25 cmH_2O	NA	NA
29	ND	ND	19:00 03:00	30 cmH_2O 30 cmH_2O	NA	NA
30	12:00	30 cmH_2O	21:00	30 cmH_2O	NA	NA

Abbreviations

***ND = Monitoring not done**

****NA = Not applicable**

The following table 4.21 provide information regarding tracheal cuff pressure measurements during day, night and researcher measurement per CCE post-intervention.

Post-intervention measurements per unit will be indicated in Table 4.26.

Table 4.21: Post-intervention tracheal cuff pressure monitoring

Cardiothoracic ICU								
Charts	**Label**	**N**	**Median**	**Mean**	**STD DEV**	**30**	**Minimum pressure**	**Maximum pressure**
4	Day – measurement	3	28	28.67	1.155	25.00%	28	30
	Night – measurement	3	28	27.67	2.517	25.00%	25	30
	Researcher	4	24	29.50	29.456	0.00%	0	70
Emergency Department								
Charts	**Label**	**N**	**Median**	**Mean**	**STD DEV**	**30**	**Minimum pressure**	**Maximum pressure**
2	Day – measurement	1	30			50.00%		
	Night – measurement	1	18			0.00%		
	Researcher	2	22	22.00	8.485	0.00%	16	28
Medical ICU								
Charts	**Label**	**N**	**Median**	**Mean**	**STD DEV**	**30**	**Minimum pressure**	**Maximum pressure**
10	Day – measurement	9	30	28.89	6.009	60.00%	20	40
	Night – measurement	6	30	30.00	0.000	60.00%	30	30
	Researcher	9	22	23.33	11.225	30.00%	0	40
Neurosurgery ICU								
Charts	**Label**	**N**	**Median**	**Mean**	**STD DEV**	**30**	**Minimum pressure**	**Maximum pressure**
4	Day – measurement	3	30	30.00	0.000	75.00%	30	30
	Night – measurement	3	30	30.00	0.000	75.00%	30	30
	Researcher	3	20	18.67	10.066	0.00%	8	28
Trauma and Surgery ICU								
Charts	**Label**	**N**	**Median**	**Mean**	**STD DEV**	**30**	**Minimum pressure**	**Maximum pressure**
10	Day – measurement	6	30	28.33	4.082	50.00%	20	30
	Night – measurement	7	30	30.00	0.000	70.00%	30	30
	Researcher	10	20	20.20	5.770	10.00%	10	30

Table 4.22: Post-intervention day shift cuff pressure compliance

1. Compliant: Pressure 25–30 cmH_2O	19
2. Non-compliant: Pressure <25 and >30 cmH_2O	4
3. Serious non-compliant: No monitoring	7
4. Not applicable: Extubated	1
5. Total	31

Table 4.23: Post-intervention night shift cuff pressure compliance

1. Compliant: Pressure 25–30 cmH_2O	21
2. Non-compliant: Pressure <25 and >30 cmH_2O	1
3. Serious non-compliant: No monitoring	7
4. Not-applicable: Extubated	3
5.Total	32

Table 4.24: Post-intervention: extraordinary

1 Compliant	1
2 Non-compliant	0
3 Serious non-compliant	2
Total	3

The following results represent the documentation of the found and the adjusted pressure to prove visibility of cuff deflation and cuff pressure compliance post-intervention.

Table 4.25: Day shift documentation post-intervention

1 Yes	11
2 No	11
3 Not measured	6
Total	28

Table 4.26: Night shift documentation post-intervention

1 Yes	6
2 No	14
3 Not measured	8
Total	28

4.6.1 Section F: Researcher monitoring

The researcher monitoring post-test was done on only 26 (N=26) patients because four (n = 4; [13.3%]) were extubated and thus they did not meet the criteria. With the researcher measurements, there was eighteen (n = 18; [69.2%]) non-compliant pressures with a range from 0 cmH_2O (the lowest) and 70 cmH_2O (the highest). Sixteen (n = 16; [61.5%]) pressures were below 25 cmH_2O. Of the pressures two (n = 2: [7.69%]) were above 30 cmH_2O (view Table 4.27).

Table 4.27: Researcher monitoring time and pressure post-intervention

Patient no.	Researcher time	Pressure
1	09:00	22 cmH_2O
2	09:10	30 cmH_2O
3	09:05	40 cmH_2O
4	09:15	30 cmH_2O
5	08:15	20 cmH_2O
6	08:17	30 cmH_2O
7	08:19	20 cmH_2O
8	08:25	14 cmH_2O
9	08:27	28 cmH_2O
10	08:30	28 cmH_2O
11	08:35	20 cmH_2O
12	Extubated	Extubated
13	08:50	0 cmH_2O
14	08:45	28 cmH_2O
15	08:00	16 cmH_2O
16	08:05	28 cmH_2O
17	08:20	20 cmH_2O
18	08:30	20 cmH_2O
19	08:25	18 cmH_2O
20	08:35	0 cmH_2O
21	Extubated	Extubated
22	07:41	20 cmH_2O
23	07:45	10 cmH_2O
24	07:50	20 cmH_2O
25	07:15	20 cmH_2O
26	08:08	70 cmH_2O
27	Extubated	Extubated
28	Extubated	Extubated
29	08:05	8 cmH_2O
30	09:06	30 cmH_2O

4.6.2 Conclusion: Phase 4

Phase 4 provided the practice post-intervention which showed an improvement in the night monitoring and the documentation of the found and adjusted pressure. An improvement in the monitoring can improve the quality of care to patients and save costs. There were still pressures that were found to be

non compliant as they were < 25cmH_20 and >30cmH_20. The following Section provides the pre- and post-comparisons of the results.

The following tables provide information in numbers and percentages of the pre- and post-intervention comparisons of compliant tracheal cuff pressures, and the researcher measurements view Tables 4.28 to 4.33).

Table 4.28: Tracheal cuff pressures (day shift measurements)

Pressure in cmH_2O	Frequency	Percentage (%)	Cumulative frequency	Cumulative percentage (%)
Not done	20	28.99%	20	28.99%
20	4	5.8%	24	34.78%
26	1	1.45%	25	36.23%
28	5	7.25%	30	43.48%
29	1	1.45%	32	44.93%
30	34	49.28%	65	94.2%
32	2	2.9%	67	97.1%
38	1	1.45%	68	98.55%
40	1	1.45%	69	100%

Table 4.29: Pre-post intervention comparisons (day shift – compliant)

Day compliant	Post	Pre	Total
1. Compliant	18 0.0002 64.29	23 0.0002 63.89	41
2. Non-compliant	4 0.0714 14.29	4 0.0556 11.11	8
3. Serious non-compliant	6 0.0482 21.43	9 0.0375 25	15
Total	**28**	**36**	**64**

Table 4.30: Pre-post intervention comparisons (night shift – compliant)

Night compliant	Post	Pre	Total
1. Compliant	19 1.7857 67.86	14 1.3158 36.84	33
2. Non-compliant	1 0.2863 3.57	3 0.2109 7.89	4
3. Serious non-compliant	8 1.505 28.57	21 1.1089 55.26	29
Total	**28**	**38**	**66**

Table 4.31: Documentation pre- and post-intervention (day shift)

Pre-intervention (day)	Post-intervention (day)
Yes = 3	11
No = 24	11
No monitoring = 9	6

Table 4.32: Documentation pre- and post-intervention (night shift)

Pre-intervention night	Post-intervention night
Yes = 1	6
No = 17	14
No monitoring = 21	8

Table 4.33: Researcher measurements pre- and post-intervention

Pre-intervention	Post-intervention
Minimum = 0	Minimum = 0
Maximum = 110	Maximum = 70
Total measurements = 34	**Total measurements = 28**

NB: Of the 69 (N = 69) patients, seven (n = 7; [10.1%]) were found extubated; hence, their tracheal cuff pressures could not be measured. The pre-intervention measurements were 34 (n = 34; [49.2%]) and the post-intervention measurements were 28 (n = 28; [40.5%]).

The night monitoring of compliant pressures (view Table 4.30) shows improvement, and also an improvement in the serious non-compliant. The documentation of the found and adjusted pressures (Tables 4.31 and 4.32) shows improvement comparing the pre-intervention to the post-intervention results. The researcher measurements in the pre- and post-intervention (view Table 4.33) indicate minimum pressure of 0 cmH_2O in both instances and maximum pressures of 110 cmH_2O in the pre-intervention and 70 cmH_2O in the post-intervention. This concludes that pressures were still maintained below 25cmH_20 and above 30cmH_20.

Discussion: Looking at the data collected and the results, the day monitoring of pre-and post-intervention comparisons show some improvement with regard to serious non-compliance (view Table 4.29 for day measurements) although there was a drop in the compliant pressures in the post-

intervention day monitoring. El-Khatib et al. (2010:276) evaluated the knowledge critical care practitioners had on guidelines for the prevention of VAP. They concluded that knowledge of recommended guidelines does not necessarily reflect appropriate practice.

Bouadma et al. (2010:789-92) investigated the impact a multifaceted programme had on compliance with preventative measures to prevent VAP in a 1 000 bedded tertiary hospital. Among the measurements was tracheal cuff pressure monitoring; tracheal cuff was to be maintained >20 and <30 cmH_2O. Five performance assessments were conducted at baseline before the educational session and 1 month, 6 months, 12 months and 24 months thereafter. Compliance with an adequate tracheal cuff pressure was >40% during the first three assessments before increasing to 82% and finally 89% during the last two observation periods after introducing the monitoring alarm.

Another pre-post-intervention study was conducted by Jiang et al. (2013:1886) in which they evaluated a teaching tool to increase the accuracy of pilot balloon palpation in measuring tracheal cuff pressure. In the study there was a control and a study group. There was no difference in cuff pressures of the study group and control group during pre-intervention as both groups were overinflating the tracheal cuffs. There was an improvement in the cuff inflation by the study group immediately after the intervention as pressures were inflated to 26 cmH_2O which was lower than the control group with pressures above 35 cmH_2O. At two weeks post-intervention both groups inflated cuffs to an average of 28 cmH_2O and 37 cmH_2O. At three months post-intervention cuff pressures were found inflated to an average of 28 cmH_2O and 36 cmH_2O for both groups. The study proved the effect of an intervention on tracheal cuff pressure monitoring.

Discussion: The above studies prove that there is an improvement following an intervention which also correlates with the present study where there is evidence of improvement.

4.7 SUMMARY

Chapter 4 provided the research results and analysis. The conclusions and recommendations based on these study results are presented in Chapter 5.

CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

Chapter 4 provided the results and analysis of the study. In this chapter the conclusions and recommendations based on the study results are presented. The research objectives were used to guide the conclusions and the recommendations of this study.

5.2 RESEARCH AIM AND OBJECTIVES

The aim of the study was to investigate the effect of an intervention on tracheal cuff pressure monitoring in the critical care environment of an academic hospital in Gauteng.

In order to address the aim, the following objectives relating to tracheal cuff pressure monitoring in the critical care environment were delineated (view Annexure A):

- **Objective 1:** Prepare for the audit **(Phase 1)**
- **Objective 2**: Investigate the current practices **(Phase 2)**
- **Objective 3**:Collaborate, plan and implement interventions for change **(Phase 3)**
- **Objective 4:** Re-investigate change in practice **(Phase 4)**

5.3 CONCLUSIONS AND RECOMMENDATIONS

The clinical audit cycle was used to guide the steps followed in this study project. The problem identified by the researcher was inadequate practices relating to tracheal cuff pressure monitoring in the critical care environment of the academic hospital in Gauteng.

5.3.1 Objective 1: Prepare for the audit (Phase 1)

An information session was scheduled and conducted by the researcher. Five (5) clinical facilitators were involved in the implementation of best practices in the critical care areas of the academic hospital. Based on the information that was shared by the researcher, there was a positive response from the hospital clinical facilitators of the hospital to be involved in the study. The clinical facilitators were very enthusiastic and prepared to assist in the data collection process.

5.3.1.1 Recommendations for Objective 1

The recommendations for Objective 1 are:

- The involvement of the clinical facilitators from the preparation stage of the study to enhance ownership of the project. This plays a significant role in cuff pressure monitoring.
- The facilitators to form part of the audit team as they are involved in the in-service training of nurse practitioners in the hospital.
- Random audits which can be performed every three months with feedback given to the staff can promote conformance to standard.

5.3.2 Objective 2: Investigate the current practices: pre-intervention (Phase 2)

An audit on the previous 24 hours of intubated patients' file charts was conducted and the researcher monitored tracheal cuffs of patients who were intubated with cuffed tubes. The data were used as the evidence in practice of tracheal cuff pressure monitoring in the critical care areas of the academic hospital. Based on the data, monitoring was done mostly at the beginning of the shift, especially on day duty which was evidenced by the time cluster that was observed. The frequency of monitoring was still not consistent despite the available revised standard, Best Practice Guideline, and the VAP checklist. The documentation of the found and adjusted pressure remained a problem. Serious non-conformances were observed at night. Researcher measurements ranged from 0 cmH_2O to 110 cmH_2O during the pre-intervention phase. The extraordinary monitoring was found to be a problem during pre-intervention.

5.3.2.1 Recommendations for Objective 2

The recommendations for Objective 2 are:

- The time of tracheal cuff pressure monitoring to be consistent with the revised standard and the hospital VAP checklist. The timeframes are to be 09h00, 14h00, 19h00 and 02h00, and when there is suspicion of cuff leakage.
- Continuous in-service training to be planned. The nurse practitioners should be involved in presenting the in-service training as it promotes ownership and professional growth.
- The in-service training to emphasise the ideal tracheal cuff pressure and the complications of poor monitoring. Posters or pictures can be used to raise awareness and to be placed at strategic places in the CCUs where they are visible.
- Documentation of the found and adjusted pressure to be emphasised during handover rounds and the importance shared.
- The extra-ordinary monitoring can improve since during admissions and reintubations more nurse practitioners are involved, and as a team effort this could be easily carried out.
- Managers, shift leaders and the clinical facilitators can do random monitoring and give feedback which will improve compliance; give compliments or praise any improvement observed as this will motivate staff.

5.3.3 Objective 3: Collaboratively plan and implement interventions (Phase 3)

Based on current practices, to collaboratively plan and implement interventions for change in practice of tracheal cuff pressure monitoring. Verbal feedback was given by the researcher in the different critical care areas, and the results were shared to the nominal group participants. A consensus was reached on the intervention which included the revision of the standard, in-service training, verbal reminders and posters with feedback.

5.3.3.1 Recommendations for Objective 3

The recommendations for Objective 3 are:

- Collaborate with clinical facilitators, operational managers and shift leaders on quality risk rounds and give feedback to the nurse practitioners and compliment where necessary.
- Tracheal cuff pressure monitoring to be included in the risk rounds checklist.
- Discuss the findings on tracheal cuff pressure monitoring practices like frequency, ideal cuff pressure and the complications during unit meetings and let it be part of the daily handover.

- Involve the nurse practitioners in determining the solution to improve compliance, as there will be ownership.

5.3.4 Objective 4: Re-investigate practices post-intervention (Phase 4)

Following the implemented interventions re-investigate change in practices of tracheal cuff pressure monitoring in the CCE`s of the academic hospital. Based on the results of the data collected recording of the found and adjusted pressure was still a problem, but showed some improvement. Consistency in the frequency of monitoring was also still a problem. The results showed a slight improvement where the monitoring in one critical care area was done twice and on night shift. Extraordinary monitoring was still poorly done, but there was a slight improvement in the documentation of the found and adjusted pressure. Time of monitoring still showed monitoring was mostly done at the beginning of the shift. Serious non-conformances were still observed, though night monitoring post-intervention had improved. The researcher`s measurements revealed non-compliant pressures of 0 cmH_2O – 70 cmH_2O. Previous studies show an improvement in practice post-intervention, although sustainability is lost with time.

5.3.4.1 Recommendations for Objective 4

The recommendations for Objective 4 are:

- Continuous feedback on the improvement even if it is minor can motivate and build confidence of the nurse practitioners.
- Provide statistics and celebrate any improvement no matter how little it can be, as this will encourage and build confidence of the nurse practitioners.

5.4 FUTURE RESEARCH

It is recommended that future research studies consider the following possible research themes.

- Patients admitted with cuffed tracheal tubes from theatre – what is the pressure? The data to be collected for a period of three and the results to be shared with the anaesthetists who intubate patients in theatre.
- Variables like age, gender, tube size, and the brand name and ventilator days to be looked at independently.
- Evaluation of the knowledge of nurse practitioners on tracheal cuff pressure monitoring.

- Sustainability to be monitored.

5.5 LIMITATIONS

The research was limited to the critical care areas of the academic hospital. The involvement of critical care areas also in the private sector could give a broader aspect on the practice. The research did not address the knowledge of nurse practitioners in relation to tracheal cuff pressure practices. Monitoring tracheal cuff pressure is still a serious problem; hence, the recommendation for sustainability to be monitored in future studies.

5.6 RESEARCHER'S REFLECTION

In my role as a critical care nurse practitioner who has worked in the critical care environment for more than 20 years, I was often challenged by my colleagues' poor cuff pressure monitoring practices. Despite the in-service education I gave to the staff in my area, as a shift leader I was experienced and trained to be observant of their positive and negative behaviours. Although there were positive colleagues who would call me and share the measurements they found on patients from theatre, these measurements were always high, never below 60 cmH_2O. I was nicknamed 'the cuff pressure sister'. I also received immense support from the clinical facilitators, without whom I often felt I would not survive.

The challenges encountered during data collection were the brand name as some markings were not clear, and also the tube sizes. Due to poor data regarding the patients from theatre, I strongly feel that future research studies should look at these patients on a continuous basis for at least a month and then only give feedback. The time-consuming exercises I believe that contributed to the lengthy time of my study was the information session that I had to undertake with the clinical facilitators, the nominal group session with the nurse practitioners, and the intervention phase. The clinical audit tool was actually fun for me and so was the coding system I learnt from the statistician. In relation to the timing of the post-intervention, this was delayed as I relied on the availability of the clinical facilitators but they also had their own planned work schedule and could not always be available to assist me. What I also learnt from the statistician regarding reducing sources of variability made me realise that you can collect data that will not answer your questions. By conducting this study I came to realise that factors like age,

ventilation days, gender, the size of the tube and brand name had no influence on the nurse practitioners' monitoring of tracheal cuff pressure.

5.7 CONCLUSION

This chapter dealt with the synthesis of the results of the study. Despite the intervention strategies that were implemented, little improvement in practice was observed in the critical care areas. Nurse practitioners need to be continuously reminded through in-service training in order to sustain the best practices. Perhaps the financial implications and the cost incurred following complications of poor tracheal cuff pressure monitoring need to be shared with the nurse practitioners in order to raise awareness among them of the significance of monitoring tracheal cuff pressure and how, if not done according to prescribed standards, it can strain the financial resources of the patient, the family and the country.

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