The knowledge and skill of registered nursing staff at Chris Hani Baragwanath Academic Hospital Emergency Units on endotracheal tube cuff manometry, before and after a training session.

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A Research Report submitted to the Faculty of Health Sciences of the University of Witwatersrand, Johannesburg, South Africa in partial fulfilment of the requirements for the degree of Master of Medicine in Emergency Medicine

Supervisor

Dr Lucy Hindle

Johannesburg, 2022

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SENATE PLAGIARISM POLICY: APPENDIX ONE

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R49 Dr J Henning

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
CLEARANCE CERTIFICATE NO. M210602

NAME: (Principal Investigator)	Dr J Henning
DEPARTMENT:	School of Clinical Medicine Department of Medicine Division of Emergency Medicine Medical School University
PROJECT TITLE:	*The knowledge and skill of registered nursing staff at Chris Hani Baragwanath Academic Hospital Emergency Units on endotracheal tube cuff manometry before and after a training session.*
DATE CONSIDERED:	2021/06/25
DECISION:	Approved unconditionally
CONDITIONS:	
NOTE:	If contact information regarding student study participants is required, please contact the Registrar's office - <Nicoleen.Potgieter@wits.ac.za>
SUPERVISOR:	Dr L Hindle
APPROVED BY:	Dr CB Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	2021/08/23

This Clearance Certificate is valid for 5 years from the date of approval. An extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office secretariat on the 3rd floor, Phillip Tobias Building, Parktown, University of the Witwatersrand, Johannesburg.

I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated from the research protocol as approved, I/we undertake to submit details to the Committee. **I agree to submit a yearly progress report**. When a funder requires annual re-certification, the application date will be one year after the date when the study was initially reviewed. In this case, the study was initially reviewed in **June** and therefore reports and re-certification will be due in the month of **June** each year. Unreported changes to the study may invalidate the clearance given by the HREC (Medical).

Signature of Principal Investigator

05 September 2021

Date

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Submission format of this research report:

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The African Journal of Emergency Medicine guidelines were followed in the write up of this manuscript.

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Submission letter to the editor

Dear Editor – African Journal of Emergency Medicine

Thank you for considering our article entitled: The knowledge and skill of registered nursing staff at Chris Hani Baragwanath Academic Hospital Emergency Units on endotracheal tube cuff manometry, before and after a training session.

Appropriate management of endotracheal tube (ETT) cuff pressures is essential to prevent patient morbidity and mortality. Due to increased length of stay of critically ill patients in emergency departments (EDs), it has become an increasingly important skill among registered nurses in the ED.

Research has been done to determine the knowledge and skill of nursing staff working in theatre or intensive care units around ETT cuff pressures. There has also been research among nurses to show that basic training programs on nursing skills could improve patient care. There is very little research on ED nurses around this topic.

We therefore conducted a study to determine our emergency department's nursing staff knowledge and skills. We also implemented a training program and compared their level of knowledge and skill before and after the program. We also asked participants to give feedback on the training program to see where it could be improved.

Our research showed a definitive lack of knowledge and skill among our nursing participants. We confirmed that a basic training program in the form of a narrated PowerPoint presentation led to significant improvements. Our training program was well received and deemed to be practice changing.

We are certain that this article will appeal to all staff members working within emergency departments especially those in developing countries.

Kind regards

Dr Jandre Henning (Primary author, student)

Dr Lucy Hindle (Supervisor)

Abbreviations

ETT	Endotracheal tube
EDs	Emergency Departments
RNs	Registered nurses
ICU	Intensive Care Unit
MEU	Medical Emergency Unit
TEU	Trauma Emergency Unit

The knowledge and skill of registered nursing staff at Chris Hani Baragwanath Academic Hospital Emergency Units on endotracheal tube cuff manometry, before and after a training session.

Abstract

Introduction

Appropriate management of endotracheal tube (ETT) cuff pressures is essential to prevent patient morbidity and mortality. Due to increased length of stay of critically ill patients in emergency departments (EDs), it has become an increasingly important skill among registered nurses.

Methods

This prospective longitudinal interventional study was performed among registered nurses (RNs) at Chris Hani Baragwanath Academic Hospital's EDs. The study aimed to determine their current knowledge and practical skills on ETT cuff manometry and assess the effectiveness of a training program. The training program involved theoretical and practical components. RNs theoretical knowledge was assessed with a pre- and post-training questionnaire. Theoretical and practical scores were compared pre- and post-training.

Results

Of the 63 RNs employed in the ED, 95% (60 RNs) participated in this study. Only 38.9% used cuff manometry as standard practice and only 12.8% are checking it at appropriate 12 hourly intervals. The pre-training median score on theory was 4.5 (IQR=3.0) and improved to 7.0 (IQR=3.0) post-training. The maximum achievable score was 11 with a pre-training average of 41.8% and post-training of 64.5% (p=0.001).

The practical pre-training median score was 1.0 (IQR=8.0) and improved to 12.0 (IQR=2.0) post-training. The maximum achievable score was 12 with a pre-training average of 29.1% and a post-training average of 93.3% (p=0.001).

Conclusion

This study showed the current lack of knowledge and skills on endotracheal cuff pressure manometry among emergency RNs. It also correlates with other evidence that supports the need for ongoing training programs. Our training program led to significant improvement among participants in both knowledge and practical skills. This training program was well received by participants and deemed to be practice changing. The recommendation after this study will be for South African emergency units to consider using this study and training material as a guide for annual in-service training.

Introduction

The endotracheal tube (ETT) cuff is used to create a seal between the tracheal mucosa and the ETT. Appropriate cuff pressure can prevent a ventilator pressure leak during positive pressure ventilation and prevent aspiration[1–3]. Overinflation of the cuff can lead to complications like post-extubation hoarseness, sore throat, recurrent laryngeal nerve damage, tracheal ulceration, tracheal stenosis, tracheo-oesophageal fistula, and tracheal rupture[4,5]. Appropriate management of ETT cuff pressure is essential to prevent complications[1–5]. Many South African emergency departments (EDs) are faced with overcrowding and access block[6]. This may lead to an increased length of stay in the ED for intubated patients[6]. Thus, appropriate management of ETT cuff manometry is essential to EDs care.

A South African nursing guideline recommends 12 hourly cuff pressure checks and a cuff pressure range of 25-30cmH2O[3]. The American Heart Association Paediatric Advanced Life support guidelines of 2015 recommend using manufacturer specifications for cuff pressure[7]. A review of the literature and manufacturer specifications shows a generally acceptable range of 20-30cmH2O[1–5,7–11]. The current best practice to monitor cuff pressures would be a transducer with continuously displayed pressures on a patient monitor[12]. In South Africa, this is not readily available or feasible, therefore a single measurement during a 12-hour nursing shift using a cuff manometer is the current practice recommended by South African guidelines[3].

Many different techniques to estimate the cuff pressure have been trialled including minimum occlusive volume, minimum leak, predetermined volume, and pilot balloon palpation. These techniques have all been found to be unreliable and unsafe[13–15]. A lack of awareness and knowledge around ETT cuff manometry has been shown in several studies performed in critical care settings both locally and internationally[16–19]. A local study performed with intensive care unit (ICU) nursing staff showed only 62% knew about current critical care cuff pressure guidelines and only 53% reported routinely measuring cuff pressures[16].

Implementation of basic training programs on the measurement of cuff pressure has shown improved awareness, knowledge and skills leading to improved patient outcomes[20–22]. A recent study regarding endotracheal tube cuff manometry performed among critical care nurses working at an adult ICU in a teaching hospital in Malaysia showed significant knowledge retention at 9 months post educational intervention[22]. Another quality improvement project on endotracheal cuff manometry in theatre at the San Antonio Military Medical centre showed significant improvement post-intervention[21]. There is currently insufficient research on current ED nursing knowledge, skills, and practice on endotracheal cuff manometry.

The primary aim of this study was to identify the current knowledge and skill of the emergency nursing staff at a tertiary hospital on cuff manometry, identify their current practice, and implement a training program.

Methods

This prospective longitudinal interventional study was performed at Chris Hani Baragwanath Academic Hospital's EDs. The EDs consist of a medical adult emergency unit (MEU) and a trauma emergency unit (TEU). The study population consisted of professional RNs working in the EDs. There were 63 RNs employed at the time of the data collection (October and November 2021). The University of Witwatersrand's Human Research Ethics Committee granted ethical clearance (Clearance number: M210602).

Sessions were run during October and November 2021. Each session aimed to determine the pre-training knowledge and skill of the RNs, provide them with training, and then re-assess them post-training.

Data was collected in the form of questionnaires and an excel spreadsheet for the scores of the practical component. A demographics questionnaire was used to collect basic data and level of training and experience. The pre- and post-training questionnaires were the same and consisted of 8 multiple choice questions with a total of 11 marks. Questions 1-4 had multiple correct answers and were individually negatively marked for incorrect options. Questions 5-8 were the single best answer. Both questionnaires were completed in the same session.

The practical component consisted of a test on 3 pre-intubated manikins, labelled A, B, and C. At each mannikin the RNs were assessed on technique, whether they achieved a correct measurement, and if they were able to inflate and deflate the cuff using the cuff manometer. Four marks were given at each mannikin, giving a total of 12 marks. The cuff at Mannikin A was inflated to a normal value (20 – 30 cmH20). Mannikin B was overinflated (40 – 60cm H2O) and C was underinflated (10 – 15cm H2O). Practical assessments were done on an individual basis in a screened area to allow for privacy for the participant and to avoid confounding.

Each participant received the same training, consisting of a 10-minute narrated PowerPoint presentation translating core knowledge and demonstrating the correct way to perform the skill. At the end of each session, participants were asked to complete a training evaluation form.

Data was captured on Microsoft Excel spreadsheets and analysed using IBM SPSS statistics version 28. Descriptive statistics are presented as frequencies and percentages for categorical variables. The Kolmogorov-Smirnov test indicated that the data on the pre- and post-training scores deviated from a normal distribution. Therefore, the descriptive statistics on continuous variables are reported as median scores with an interquartile range. The Wilcoxon sign rank test was used to examine if there were significant changes in the RNs post-training versus pre-training scores on both the theory and practical training elements. The Kruskal Wallis test was used to examine if the post-training score improvements varied significantly between RNs at the MEU and trauma departments as well as the RNs working experience and previous training. Statistical significance testing was set at the 95% confidence level.

Results

Of the 63 RNs employed in the ED, 60 (95%) consented to participate in the study. Of these, 57% worked in MEU and 43% in Trauma.

Most nurses had between 1-10 years of working experience. Of the nurses surveyed 14% had received formal training on cuff manometry. Only 38.9% used cuff manometry as their technique and only 12.8% are checking it at appropriate 12 hourly intervals (**Table 1**).

Table 1: Participant demographics

	N%
Years of practice	
<1	9 (15.5)
1-10	27 (46.6)
10-20	21 (36.2)
>20	1 (1.7)
Years managing intubated patients	
<1	14 (23.7)
1-10	32 (54.2)
10-20	13 (22.1)
>20	0 (0)
Formal training on ETT cuff manometry	
Yes	14 (23.3)
No	46 (76.7)
Type of training	
Post-graduate studies	8 (57.2)
In-service training	1 (7.1)
Work experience	5 (35.7)
Current technique used to check ETT cuff pressure	
Cuff manometry	14 (38.9)
Pilot balloon palpation	12 (33.4)
Minimal occlusive volume	3 (8.3)
Unspecified	7 (19.4)
Frequency of ETT cuff tube pressure checks in unit	
Hourly	12 (30.7)
4 hourly	3 (7.7)
6 hourly	2 (5.1)
12 hourly	5 (12.8)
Daily	4 (10.3)
Once post-intubation	4 (10.3)
Unspecified	9 (23.1)

The pre-training median score on theory was 4.5 (IQR=3.0) and improved to 7.0 (IQR=3.0) post-training (**Figure 1**). The maximum achievable score was 11 with a pre-training average of 41.8% and post-training of 64.5% (**Figure 2**). This was a statistically significant improvement ($p<0.05$).

The practical pre-training median score was 1.0 (IQR=8.0) and improved to 12.0 (IQR=2.0) post-training (**Figure 1**). The maximum achievable score was 12 with a pre-training average of 29.1% and post-training of 93.3% (**Figure 2**). This was also a statistically significant improvement ($p<0.05$).

Figure 1: Pre- and Post- training results: Theory and Practical median scores

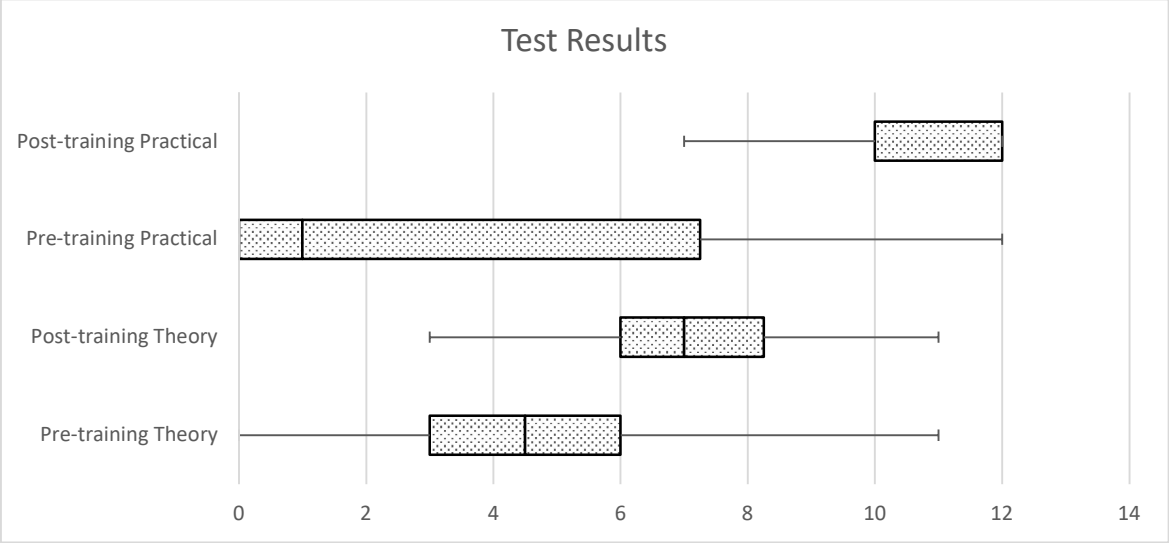
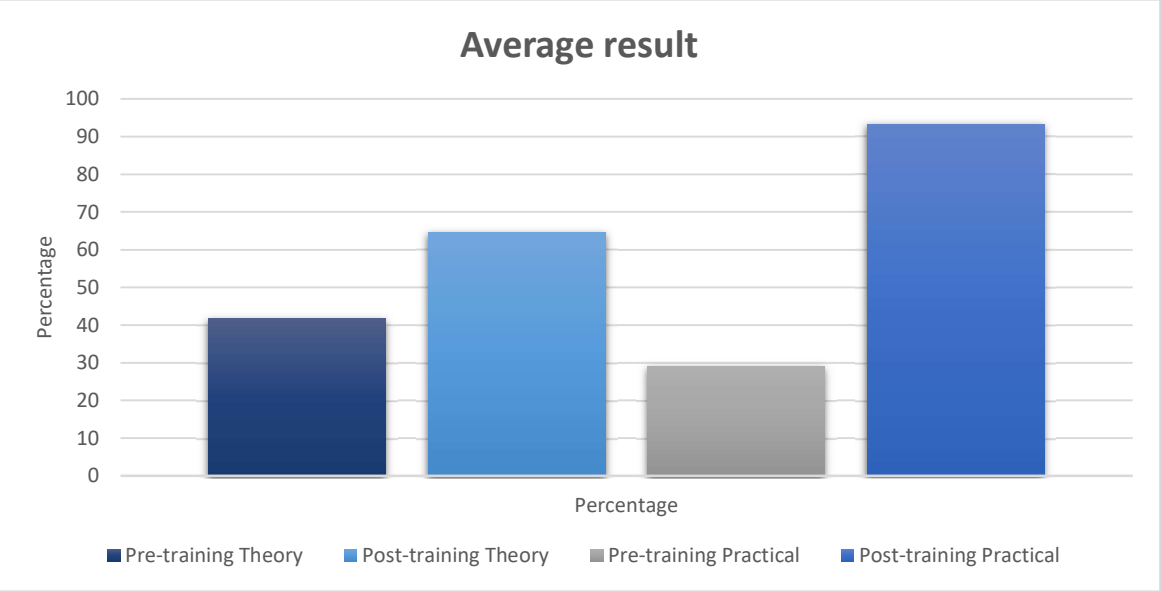


Figure 2: Pre- and Post-training results: Theory and Practical averages



There were no statistically significant differences in the level of post-training theory improvement by department, years as a registered nurse, years of experience managing intubated patients, previous training on ETT cuff pressure measurement, or experience with intubated patients.

There were statistically significant differences in the level of post-training practical improvement by years of experience managing intubated patients(p=0.03), previous training on ETT cuff pressure measurement (p=0.00), and previous experience checking ETT cuff pressures (p=0.00). Nurses with 1-10 years of experience, previous formal training, and those who have checked ETT cuff pressure before showed the biggest improvement (**Table 2**).

Table 2: Demographics vs Post-training practical improvement

Variable	N	Post-training practical score improvement		P-Value
		Median	IQR	
Years working as a registered nurse				
<1 year	9	10.0	4.0	0.44
1-10 years	27	10.0	8.0	
10-20 years	21	7.0	6.0	
Years managing intubated patients				
<1 year	14	10.0	4.0	**0.03***
1-10 years	32	9.0	8.0	
10-20 years	13	6.0	4.0	
Previous training on cuff manometry				
Yes	14	4.0	5.0	**0.00***
No	46	10.0	5.0	
Ever checked cuff manometry before				
Yes	36	6.5	7.0	**0.00***
No	24	11.0	4.0	

The training program was well received by the participants. Most participants felt that the training was relevant and will impact on their daily practice and that this training should be provided regularly in the form of in-service training. Of note 32% of participants felt that this training should also be provided in languages other than English (**Table 3**).

Table 3: Training evaluation

Training elements evaluated	Percentage (n=60)		
	Strongly agree	Agree	Disagree
• Topics discussed were relevant to my daily practice	95%	5%	0%
• I found the time for training to be sufficient	70%	28%	2%
• This will have an impact on my daily practice	90%	8%	2%
• This would be a good continuous training program for in-service training of nurses	97%	3%	0%
• Content was fair and appropriate for my level	87%	13%	0%
• Questions in the questionnaires were fair and appropriate for my level	75%	25%	0%
• Content and training should be provided in languages other than English	15%	17%	68%

Discussion

This study is one of the first to look at knowledge and skills on endotracheal cuff pressure monitoring among ED nursing staff in the world. We concluded that there is significant knowledge and skill deficit in endotracheal cuff manometry among ED RNs at the hospital surveyed. There is also no existing training program with only 14% of participating RNs having received any formal training before this research. We found that significant improvements in theory and skills could be made after a short training program.

Only 38.9% of the nurses in the study are currently using cuff manometry, and only 12.8% are using it at the correct 12 hourly intervals (**Table 1**). This implies that current practice may put our critically ill ventilated patients in the ED at risk. Due to the increased length of stay of intubated patients within EDs, endotracheal cuff pressure manometry has become an essential skill among registered nurses in the ED[23].

Data from ICU and theatre research worldwide have previously shown a lack of awareness, knowledge, skills, and training among nurses on cuff pressure manometry [16,20,22,24–26]. A study performed among 591 ICU nurses in Belgium showed that 53% were checking cuff pressures 8 hourly and that they were unaware of the indications[26]. A local study performed in ICU at a tertiary hospital showed that only 53% of nurses report checking cuff pressures routinely[16]. Their findings were consistent with ours among a cohort of ED nursing staff.

When pre-training testing was done in our study, we found a 41.8% average for knowledge and a 29.1% average for practical skills. By implementing a basic training program consisting of a narrated PowerPoint presentation, significant improvements were noted in both knowledge and skills (**Figure 1**, **Figure 2**). A 22,7% ($p<0.05$) improvement in their knowledge and 64.2% ($p<0.05$) improvement in skills were noted (**Figure 2**). Anecdotally, awareness and implementation of cuff pressure monitoring were noted within the units as the training program was being rolled out. Our findings of improved awareness, knowledge, and skill after a training program were consistent with previous research[20–22].

In our study, RNs without prior experience measuring cuff pressures or previous formal training showed the most improvement. This is likely because they performed worse in the pre-training evaluations and had the biggest potential margin for improvement. A local study performed among nursing staff in 13 ICUs in Johannesburg showed that nurses receiving formal training on clinical nursing skills will perform much better compared to those with work experience alone[24]. Continuous formal training programs among nurses have been shown to assist in improving awareness, knowledge, and skills to further improve patient care[25,27]. This emphasizes the need for continuous formal training programs when nursing skills are critical for patient outcomes.

The study also found that the training program was well received by the participants and appropriate to their daily practices (**Table 3**). It is very important for training programs themselves to be assessed to ensure fitness for purpose and acceptability to the relevant group.

Limitations

This research was only performed at one hospital among a small cohort of emergency nurses. However, it involved both medical and trauma emergency units and participation in the study was very high. Although nurses were asked about their current practice this study was not able to independently verify this information as this was not one of the study aims. There could be an element of familiarity with the questions since the same questionnaires were used before and after training. No long-term assessment was performed on the retention of knowledge and skills. Several studies have shown skill retention tends to decline steadily over 12 months with maximal decline after 1 year[28–30]. Ideally, the training would be repeated at intervals to ensure skill retention.

Conclusion

To our knowledge, this is the first study assessing the knowledge and skills of RNs working in EDs on endotracheal tube cuff manometry in the world. This study showed a definitive lack of knowledge, skill, and formal training when it comes to ETT cuff manometry, which is an essential ED nursing task. By implementing a narrated PowerPoint training presentation, significant improvements were noted in awareness, knowledge, and skills. The training program was also found to be acceptable and relevant by the nurses. The recommendation after this study will be for South African emergency units to consider using this study and training material as a guide for annual in-service training. This would need to be implemented along with a unit protocol for the management of cuff pressures in the ED and improved access to tools needed to measure endotracheal tube cuff manometry.

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Protocol

The knowledge and skill of registered nursing staff at Chris Hani Baragwanath Academic Hospital Emergency Units on endotracheal tube cuff manometry, before and after a training session.

Research protocol in partial fulfilment of

the degree for Master of Medicine

(Emergency Medicine).

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Supervisor

Dr Lucy Hindle

INTRODUCTION

Inappropriate management of endotracheal tube cuff pressures are associated with significant morbidities. Many emergency departments, specially public hospitals in South Africa, are constantly faced with overcrowding leading to an increased length of stay in the emergency department for intubated patients awaiting Intensive Care Unit (ICU) beds(1). Other factors may also play a role in length of stay. These include investigations, time for treatment and consultations. A large provincial study done in Canada found that the average length of stay in the emergency department before ICU admission was 7 hours(2). There is no clear South African data about length of stay for intubated patients in the emergency department. The importance of correct management of endotracheal tube cuff pressures starts already in the emergency department.

Two types of endotracheal tube cuffs are currently available. Low-Volume High-Pressure (LVHP) cuffs – creates high pressure over a small area to prevent aspiration and assist in positive pressure ventilation(3). The benefit is that there are no folds in the cuff which would assist to prevent aspiration. High-Volume Low-pressure (HVLP) cuffs dissipate the pressure over a larger area to try and minimise mucosal damage, however they run a higher risk of aspiration. Most modern endotracheal tubes are HVLP cuffs to try and minimise morbidity associated with high cuff pressures(3).

The cuff is used to create a seal around the endotracheal tube and tracheal mucosa. The seal is considered adequate when there is no leakage past the cuff during positive pressure ventilation(4). Sultan et al found that the pressure inside the cuff is a good representation of the pressure exerted over the tracheal mucosa(5).

International consensus guidelines lack recommendations regarding exact cuff pressure ranges and monitoring. A South African nursing guideline recommended that endotracheal tube cuff pressures should be checked on every shift (12h) and be kept within 25-30 cmH_2O range(6). The American Heart Association Pediatric Advanced Life Support 2015 guidelines suggest the use of manufacturer specifications for cuff pressure and that cuffed endotracheal tubes can be used for all ages(7). There are no clear South African guidelines on managing cuff pressures.

An endotracheal tube cuff is considered underinflated when the pressure inside the cuff is inadequate to create a seal. An inadequate seal can lead to ventilator leaks and aspiration. Many studies evaluated the minimum pressure to create a seal. One found that a minimum pressure of 19.1 cmH20 is required during positive pressure ventilation(6). Some newer endotracheal tube cuffs are made with thin-walled polyurethane resulting in a lower seal pressure of 9,5 cmH_2O(4). Rello et al found a 4- fold risk for ventilator associated pneumonia when the cuff pressure was lower than 20 cmH_2O(8).

An endotracheal tube cuff is considered overinflated when it impairs tracheal mucosal capillary blood flow. Seegobin et al found that in normotensive patients a continuous antero-lateral wall pressure of more than 30 cmH_2O causes decreased tracheal mucosal capillary blood flow and with a pressure of more than 50 cmH_2O blood flow is completely obstructed. (9). One study found that 15 minutes of compromised blood flow resulted in superficial tracheal mucosal damage and after 15 minutes of obstructed blood flow columnar epithelial cells were destroyed, exposing the basement membrane(10).

High cuff pressures can cause minor complications like sore throat and hoarseness post intubation or more severe complications like recurrent laryngeal nerve damage, tracheal ulceration/granuloma, tracheal stenosis, non-malignant trachea-oesophageal fistula and tracheal rupture(11,12). The correct management of cuff pressure in the critically ill patient is therefore of utmost importance.

Many factors influence cuff pressure over time including patient position, size of endotracheal tube and anaesthetic agents. Nseir et al studied continuous monitoring of cuff pressures in 101 patients. The cuff was inflated to 25 cmH2O, continuous pressure monitoring applied yielding 808 hours of data. They found that one third of patients had sustained over- or underinflation for more than 30 minutes. It was also noted that there is a constant decrease of cuff pressure over time. The longer the duration of intubation, the greater the loss of cuff pressure(13,14).

A lot of research has been done to evaluate the optimal way to manage endotracheal tube cuff pressures. Many different techniques are in use and is mostly dependent on local departmental guidelines or personal preference. Current best practise would be a pressure transducer that display the actual pressure continuously on a monitor(15). That is currently not readily available or feasible throughout South African public hospitals. A single measurement using a cuff manometer twice during a 24h shift is in the current nursing guidelines and accepted as standard of care in most departments(6).

The following techniques to estimate cuff pressures without manometry have been investigated through the years but found to be ineffective(16–18):

1) Minimal occlusive volume technique: A volume of air is injected into the endotracheal tube cuff until an audible end-inspiratory leak during positive pressure ventilation is not heard anymore.

2) Minimum leak technique: A small amount of air is injected until only a small amount of audible leak is heard at end-inspiration.

Both techniques have shown to be inaccurate and increase the risk of aspiration and ventilator associated pneumonia(17).

3) Predetermined volume technique: A preselected amount of air is injected. This disregards the size or make of the tube, the intrathoracic pressure or the tracheal diameter(16,17).

4) Pilot balloon palpation: The endotracheal cuff is inflated with air and the pilot balloon is then palpated to estimate the correct pressure. Because this is the easiest method to use, it is widely practised. Research about the validity of this has been done but proven to be totally ineffective and dangerous practice(16–18). A study in Iran has shown that there can be improvement with an in vitro educational program from 24.2% to 39.7%(17). However, that is still too low to be used as a safe alternative.Stewart et al compared all the estimation techniques with manometry and found them to be inadequate(16).

A local study done at Groote Schuur Hospital in Cape Town found that intubation in the trauma unit versus elective theatre intubation is associated with a two- to threefold increase in cuff pressure. Only 30% of patients in the trauma unit had cuff pressures below 30 cmH_2O(19). Emergency patients requiring intubation are often in shock or hypotensive resulting in poor perfusion. Hence the importance of meticulous management of endotracheal tube cuffs starts already in the emergency department.

As seen in the literature, new and easier ways to manage cuff pressures are constantly being investigated to try and make it easier and more accessible. However, no estimation technique has been validated yet. A cuff manometer is therefore required, and staff education is needed on the correct use and importance of it. This remains a constant challenge in developed countries and even more so in developing countries with resource limitations.

Most emergency units in South African public hospitals are faced with overcrowding and shortage of beds. Some units might have shortage of staff causing current staff to have less time per patient. Other units might have resource and budget constraints hindering them to have all the required equipment. Staff might lack training or experience. Many factors make this challenge a major one in our setting.

STUDY AIM

To determine the knowledge of registered nursing staff at Chris Hani Baragwanath Academic Hospital (CHBAH) Emergency (Medical Emergency and Trauma) Units on endotracheal tube cuff manometry, before and after a training session.

STUDY OBJECTIVES

1. The knowledge and skill of registered nursing staff at Chris Hani Baragwanath Academic Hospital Emergency Units on endotracheal tube cuff manometry, before and after a training session.
2. Describe their current experience level and daily practice.
3. Compare their knowledge and practical skills before and after the training program.
4. Evaluate the quality of the training program.

METHODOLOGY

Study design

Prospective longitudinal interventional study.

Study population

All registered nursing staff currently working in the Medical Emergency and Trauma Units at Chris Hani Baragwanath Hospital.

Inclusion criteria

All nursing staff with a registered nursing degree working at Medical Emergency and Trauma Units at Chris Hani Baragwanath Hospital.

Exclusion criteria

None.

Sample Size

Currently there are 63 professional nurses working at the two departments at CHBAH. 36 in Trauma and 27 in MEU.

By having a 5% margin of error and a 95% confidence level we have determined that a sample size of at least 54 nurses is needed.

Data Collection

- Data collection will start once the protocol has been approved and ethical clearance obtained.
- Data collection (questionnaires) will be done at every session.
- Multiple sessions will be held over a 3-month period with a maximum of 10 participants per session.
- Participation will be voluntary.
- All data will be kept anonymous.
- The training and evaluation will be standardized and will be the same no matter who the trainer is. The training will be a narrated PowerPoint presentation with a practical video presentation at the end.
- Program for each session:
    - A pre-training program questionnaire will be used consisting of two parts:
        - First part: Gathering data on basic demographics, experience level and current practice.
        - Second part: Determining current knowledge and practical skill on endotracheal tube cuff manometry.

- The training program will be provided to the registered nurses by myself (Dr J Henning), the supervisor (Dr L Hindle) and an emergency medicine medical officer. We will also include the MEU nursing manager (Sr Maine) as part of training faculty. She will not train or evaluate participants during the research project. She will be involved with continuous in-service training after the research project if we can prove efficacy of the training program.
- A post-training questionnaire will be used consisting of two parts:
  - First part: Determining current knowledge and practical skill on endotracheal tube cuff manometry.
  - Second part: Evaluation of the training program by the participants.
  - Participants will perform the same skill again post training.

- Approximately 60 minutes will be used per session.
  - 20 minutes allocated for the explanation and purpose of the study, pre-training questionnaires and practical assessment of cuff pressure measurement.
  - 20 minutes allocated for the training program.
  - 20 minutes allocated for closure, post-training questionnaire and practical assessment and training program evaluation.
- Up to 10 participants will be involved per session.
  - Arrangements are made with each unit manager to allocate registered nursing staff from their respected units to participate in the study and training program.
  - Sessions will be held over a three-month period to try and involve as many registered nurses as possible.
  - Sessions will be held at most convenient times to try and minimize the impact to their units.

    - Basic contact PPE will be required during the Covid pandemic. This will require all participants and researchers to wear masks. Alcohol based sanitizers wil be used during the practical component to keep equipment and hands clean. Social distancing will be enforced and moved to an outside location if necessary.

- Participants will be introduced to the research aims as well as instructions on participation. Informed consent will be done and collected. Each participant will be given a unique number. That will be used to keep data anonymous.
- They will then perform the endotracheal tube cuff manometry skill behind a screen. An instructor will evaluate each participant.
- Three intubation manikins will be used. All will be pre-intubated and cuff pressures will be set. Each endotracheal tube will be inflated to different levels – overinflated, appropriate and underinflated. The manikins will be labelled A, B and C.
- They will be evaluated on whether their technique was correct and if they got the correct measurement. They will also be asked to inflate or deflate the cuff and be assessed on that. An excel spreadsheet will be used to capture this data.
- Between participants equipment will be sanitized and cuff pressures will be rechecked by the researcher to ensure accurate pressures.
- Participants will then fill in the pre-training questionnaires.
- Training will be provided.
    - A standardized video presentation will be used. It will be in the format of a narrated PowerPoint presentation with a video demonstration at the end. A training handout will also be given to each participant.
- The participants must then complete the post-training questionnaire and demonstrate the practical skill again. A post-training excel spreadsheet will be used to capture the data.

- After completion of the questionnaires will it be placed in sealed boxes. Separate boxes will be used for each questionnaire – pre-training, demographics, post-training, and training evaluation. Those boxes will be kept sealed until the last session is completed. The participants unique number will appear on all questionnaires.
- Questionnaires: The 1st 4 questions can have multiple correct answers. A correct mark will be allocated for each correct option. An incorrect option will result in a negative mark – meaning one less mark for that specific question only. They will not be able to score less than 0 for any question. The 2nd set of 4 questions will be single best answer with no negative marking. A maximum score of 11 can be achieved.
- Practical: They will be score a 1 or 0 on each of the 4 components. 1 for being correct and a 0 for being incorrect. Technique will be assessed by checking if the participants can connect the cuff manometer and the pilot balloon correctly. Measurement will be assessed by checking if they can determine the pre-set pressure correctly (overinflated/appropriate/underinflated). They will be assessed on inflating and deflating the cuff correctly using the cuff manometer. That will be done at each of the 3 manikins giving a maximum score of 12.

DATA ANALYSIS

- All data will be captured on electronic data sheets using Microsoft Excel.
- Data analysis will be carried out in SAS or Statistica.
- The demographic questionnaire data will be used to determine our study populations level of experience, current practise and previous training received.
- Theory/Knowledge: Data from the pre-training questionnaire will be used to determine the participants current level of knowledge. That will then be compared to the post-training questionnaire data using the paired t-test. The data will be expressed as a numerical score of correct answers on each questionnaire.
- Practical: Data from the pre-training skill performance will be used to determine the participants current level of skill. That will be expressed as a numerical score out of 12. That will then be compared to the post-training skill performance. The 2 sets of data will be compared using the paired t-test.
- Data will be used to compare participants knowledge with their skill level.
- Descriptive analysis of the training evaluation will be done.

ETHICS AND PERMISION

- We are currently in the process of obtaining ethical clearance from the Human Research Ethics Committee (HREC) at the University of Witwatersrand.
- Permission will be obtained from CHBAH CEO as well as the head of departments and nursing unit managers in Medical Emergency Unit and Trauma.
- Each participant will get a basic information sheet and consent to participate.

TIMING

- Literature review: July – December 2019
- Preparing protocol: January – October 2020
- Protocol assessment and ethics application: November 2020 – March 2021
- Data collection: April – July 2021
- Data analysis: August – September 2021
- Writing up thesis: October – November 2021

FUNDING

Costs related to stationery, copying, traveling and phone calls will be carried by the primary researcher.

LIMITATIONS

Knowledge of a study being performed about cuff pressure manometry might motivate nursing staff to go and read up around the topic.

Nursing staff might communicate questionnaire questions to each other.

OUTCOMES

It is hoped that this study would identify a possible lack of knowledge within our departments and then to show the efficacy of a basic training program which can be used after the study on an ongoing basis. Improved knowledge and skill of nursing staff could lead to improved patient outcomes.

It is also hoped that this study would emphasize the importance of cuff tube manometry.

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Appendix 1: Participant information sheet

Information sheet

My name is Dr Jandré Henning. I will be conducting a research MMED study at Chris Hani Baragwanath Academic Hospital. It will involve registered nursing staff working in MEU and Trauma.

The title of the study is: The knowledge and skill of registered nursing staff at Chris Hani Baragwanath Academic Hospital Emergency Units on endotracheal tube cuff manometry, before and after a training session.

Why am I performing the study?

Research has shown that it is important to monitor endotracheal cuff pressures. The aim of the study will be to identify nursing staff's current knowledge and skill and see if we can improve that by developing a training program. The training program could be used after the completion of the study as in-service training.

How will participation work?

Only registered nursing staff from MEU and Trauma at CHBAH will be involved. We will conduct multiple sessions over a three-month period to try and involve all nursing teams. Your unit managers will give us permission to utilize an hour of your time.

During that hour you will have to complete 2 questionnaires, a practical skill, training, and a training evaluation form. First questionnaire will be demographic information and knowledge of endotracheal tube cuff pressure manometry. Then we will provide you with a 20-minute training program. You will be provided with a training handout.

After the training you will do another questionnaire and evaluation form on how you found the training course.

Participation is voluntary.

You will be under no obligation to participate in the study. No one can penalize you for not participating. You can withdraw your participation in the study at any time. Those participating will not be given any incentives. Consent will have to be signed upon agreeing with participation.

Confidentiality

Your information and questionnaires will always be anonymous. Your questionnaires will have unique numbers on them to be able to compare the pre- and post-training answers. There will be no identifiable data on any of these questionnaires. The questionnaires will be dropped off in two separate sealed boxes after completion. The data on the questionnaires will be used by the researcher, supervisor, and statistician. The data will only be used for the purpose of the study. Your answers in the questionnaires will therefore not penalize you in any way or form.

Risks

There will be no risk in participating.

Benefits

There will be no incentives. However, you will be receiving an in-service training program on endotracheal tube cuff manometry that will improve your knowledge and skills.

Thank you for your time and assisting in this research project.

Enquiries

Myself(researcher)	Supervisor
Dr Jandré Henning	Dr Lucy Hindle
082 716 4577	082 871 0638
janhen89@gmail.com	hindle.lucy@gmail.com

Appendix 2: Demographics questionnaire

Demographics questionnaire **Unique number:**

1. Unit/Department that you are currently working in?

   a. MEU b. Trauma

2. How many years have you been practising as a registered nurse?

   a. 1 year b. 1-10 years

   c. 10-20 years d. >20 years

3. How many years of experience do you have with managing intubated patients?
   a. <1 year b. 1-10 years

   c. 10-20 years d. >20 years

4. Have you received any formal training on measuring endotracheal tube cuff pressure?
   a. Yes b. No

5. If yes, during which training?

   a. Pre-graduate nursing

   b. Post-graduate training (specify)? _____

   c. In-service training

   d. Work experience

6. Have you ever checked endotracheal tube cuff pressure?

   a. Yes – using what technique? _____

   b. No

7. Are you required to check et tube cuff manometry in your unit?

   a. Yes - how often? _____ b. No

Appendix 3: Pre- and post-training questionnaire

Questionnaire **Unique number:**

For each of the following questions please select the ones that best represents your correct answers – more than one answer may be correct.

1. What is the role of the endotracheal tube cuff?

    a. Prevent displacement of endotracheal tube.

    b. Prevent aspiration.

    c. Prevent air leaks during positive pressure ventilation.

    d. Provides comfort to the patient.

    e. None of the above

2. Which of the following complications are associated with over-inflation of an ETT cuff (too much air in cuff)?

    a. Tracheal stenosis b. Hypertension

    c. Vocal cord paralysis d. Nausea and vomiting

    e. Headaches f. None of the above

3. Which of the following complications are associated with under-inflation of an ETT cuff (too little air in the cuff)?

    a. Hoarse voice b. Ventilator pressure leak

    c. Ventilator associated pneumonia d. Barotrauma

    e. Patient can self-extubate f. None of the above

4. Which techniques to determine ETT cuff pressure are reliable?

    a. Palpation of pilot balloon

    b. Minimal occlusive volume (no audible air leak)

    c. Predetermined volume (as per manufacturer)

    d. Using a cuff manometer

For the next 4 questions indicate which ONE of the options is correct?

5. How often should endotracheal tube cuff manometry be done?

    a. Once post intubation b. Hourly

    c. 12hly d. Daily

6. What is the optimal (correct) pressure for an ETT cuff?

    a. <10mmHg b. 10-20mmHg

    c. 20-30mmHg d. >30mmHg

7. Does ETT cuff pressure change with time?

    a. Yes b. No

8. Does ETT cuff pressure change with a change in the patient's airway pressure or ventilation?

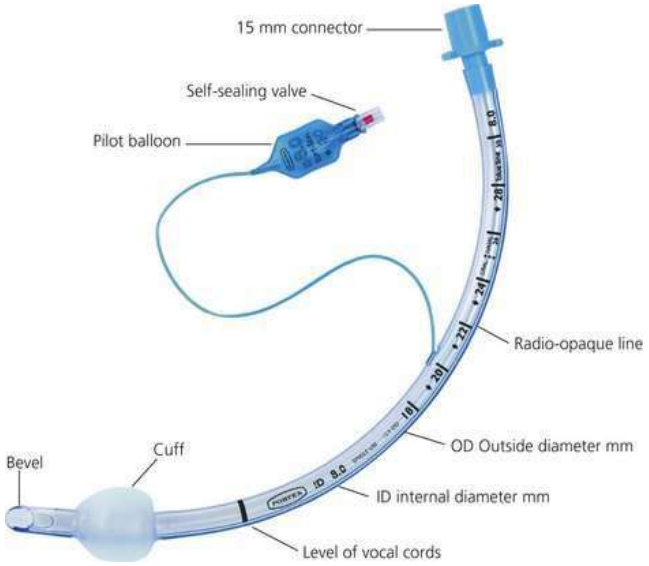
    a. Yes b. No

Appendix 4: Training Handout

Endotracheal tube cuff manometry training handout Objectives

- To understand what endotracheal cuff pressures are and the importance thereof.
- To understand the relevant equipment available and how to use them.
- To know what best practice is.
- To know how to apply that in a South African setting.
- To acquire the practical skills to perform endotracheal cuff manometry.

Endotracheal Tube



Pilot balloon

- One-way valve to inflate or deflate ET-tube cuff.
- It can be used to determine whether the cuff is inflated or not.
- It cannot be used to estimate the cuff pressure.

Cuff Manometer

- It is the gold standard to determine ET-tube cuff pressure.
- The acceptable pressure range is 20-30cmH20.

- Intubated patients should have their ET-tube cuff pressure checked at least every 12 hours.
- ET-tube cuff pressure is dynamic. Many factors influence the cuff pressure on a continuous basis. Hence the importance of regular checks.

Complications

Overinflation

- Sore throat/hoarseness post intubation
- Laryngeal nerve damage
- Tracheal stenosis
- Trachea-oesophageal fistula
- Tracheal rupture

Underinflation

- Aspiration
- Ventilator associated pneumonia
- Ventilator pressure leaks

Practical demonstration

- How to connect cuff manometer and et tube
- How to read the current pressure and adjust it by inflation/deflation

Appendix 5: Training evaluation form

Training evaluation form

We appreciate your participation and value your feedback.

Please answer the following questions by ticking the appropriate box.

Criteria	**Strongly Agree**	**Agree**	**Disagree**
Topics discussed were relevant to my daily practice			
I found the time for training to be sufficient			
This will have an impact on my daily practice			
This would be a good continuous training program for in service training of nurses			
Content was fair and appropriate for my level			
Questions in the questionnaires were fair and appropriate for my level			
Content and training should be provided in languages other than English			

Appendix 6: Pre- / Post-training practical capture sheet Manikin A/B/C

Unique number	Technique	Correct Measurement	Inflate	Deflate
1.				
2.				
3.				
4.				
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58.				
59.				
60.				

Appendix 7: Consent forms

Informed consent – CHBAH CEO

I, _____(name and surname), give voluntary consent for the above-mentioned study to be done at CHBAH. I understand the information sheet and that no staff or patients will be harmed or penalized in performing this research. I understand that the research will only be done with appropriate ethical clearance.

CHBAH CEO (name and surname): _____

Signature: _____

Date: _____

Witness (name and surname): _____

Signature: _____

Date: _____

Informed consent – Head of department

I, _____(name and surname), head of department at _____, give consent for voluntary participation of registered nurses working in _____. I understand the information sheet and that no participant or non-participant will be penalized. I understand that this will be done during working hours and I will ensure that service delivery to patients will not be compromised during this time.

HOD (name and surname): _____

Signature: _____

Date: _____

Witness (name and surname): _____

Signature: _____

Date: _____

Informed consent – Participant

I, _____ (name and surname), give voluntary consent in participating in the above-mentioned study. I have read the information sheet and understand that all data will be kept anonymous. I understand that I have the right to withdraw from the study at any point with no penalties.

Participant (name and surname): _____

Signature: _____

Date: _____

Witness (name and surname): _____

Signature: _____

Date: _____