Original Study – Master's thesis

A PROSPECTIVE CLINICAL AUDIT OF ENDOTRACHEAL TUBE CUFF PRESSURE MEASUREMENTS IN VENTILATED ICU PATIENTS AT CWM HOSPITAL

Teokotai O-Alone Maea[1], Elizabeth Inaido-Lee[2]

1. Anaesthesia registrar, CWM Divisional Hospital, Correspondence email: maea.t24@gmail.com
2. Department of Anaesthesia, College of Medicine, Nursing and Health Science, Fiji National University
Note: CWMH – Colonial War Memorial Hospital

ABSTRACT

Introduction: It is well known that inappropriately inflated ETT cuff pressure may result in significant patient complications. Clinical guidelines recommend objective measurements of cuff pressure using standard manometric tools with regular monitoring to maintain ETT cuff pressure within the recommended range (20-30cmH2O). Estimation techniques in assessing cuff pressure are unreliable and patients may still be exposed to unfavourable pressure. The aim of this baseline study was to carry out a descriptive audit on the current practice to determine whether ETT cuffs are inflated to correct pressure, and to assess whether cuff pressure were routinely monitored by the nursing staff at the CWM Hospital ICU, over a 3 month period.

Method: An on-site prospective clinical audit that evaluated 47 ventilated ICU patients using convenience sampling. Auditor entered ICU without prior notice to carry out measurements using a single standard aneroid manometer and reviewed patient's charts. Inclusion and exclusion criteria were used to identify patient's eligibility into the study.

Results: More than 50% of ETT cuff pressures were out of range (8% low and 51% high pressure); only 41% were inflated to within the ideal cuff pressure (20-30cmH2O). There was no manometer available to ICU staff during the study period, therefore monitoring and documentation of cuff pressure was not possible. Pressure variabilities and often high cuff pressures were observed among patients who required prolonged intubation (>7 days). A potentially faulty ETT size was identified that require further evaluation.

Conclusion: The current practice on endotracheal tube cuff care at the Intensive Care Unit of CWM Hospital is below the recommended standard for best practice. Patients are exposed to unsafe ETT cuff pressure without objective measurements and regular monitoring. Staff training and availability of manometer are needed to improve current practice to ensure quality and safe patient care. Further audits may benefit patients, and a more comprehensive study to evaluate patient clinical outcome is recommended.

INTRODUCTION

At the Colonial War Memorial (CWM) Hospital, Fiji's largest tertiary and teaching hospital, its current 8-bed Intensive Care Unit (ICU) accommodated an average of up to 30 to 40 admissions a month over the past year. Almost 70% of these patients required intubation for mechanical ventilation. Patients admitted into the ICU are usually from the general wards, emergency department, operating theatre, and often from other hospitals including private and health centres around Fiji. ICU provides intensive care for a variety of clinical cases, including both surgical and medical patients, some of which are septic related, trauma, or post-surgical complications. ICU is a specialized unit that provides the highest level of patient care in any hospital, and the care provided to these patients may determine their outcome. Hence, critically ill patients require endless monitoring and skilled nursing care at all times.

Critically ill patients often require intubation for securing the airway while on mechanical ventilation; a classical cuffed **Endotracheal Tube (ETT)** is effectively used for this purpose. ETT are available as both cuffed and uncuffed; and in ventilated ICU patients it is important that cuffed tubes are used for a particular purpose. Inflation of the endotracheal tube cuff seals the extra luminal airway, facilitating positive pressure ventilation to achieve adequate tidal volumes and reducing micro-aspiration of oral and gastric secretions. [1,2] While the

ETT sits in place in the patient's trachea, it is important when inflating tube cuffs that the pressure created within the cuff is only enough to maintain the seal without compromising the tracheal blood supply as under or over inflation may result in adverse clinical consequences. *A cuff pressure between 20 to 30cmH2O has been recommended as the ideal pressure for the standard adult classical ETT*. [1,2,3,4] There are a few methods in current anaesthetic practice used in assessing cuff pressures including objective methods using a manometer which is the most recommended technique, and other clinical or estimation techniques such as the minimal occlusive volume (MOV), minimal leak test (MLT), and palpation technique, all of which are less reliable. [5] MOV is when a volume of air is added into the cuff that stops any audible leak on end-expiration with positive pressure ventilation; MLT is when air added into the cuff allowing only a "small" leak to be heard at the end of inspiration; Palpation technique or the finger estimation, is when the ETT cuff is inflated with air, and the pilot balloon cuff is palpated as a gross estimation of the intracuff pressure. [5]

Over-inflation of the cuff may result in acute tracheal injury that may hinder a patient's recovery, and inappropriately sustained levels of over-inflated cuffs may result in long term complications such as tracheal stenosis, trachea-oesophageal fistulae formation, tracheal rupture, and recurrent laryngeal nerve palsy. [1,6,7] More commonly, over-inflation can result in stridor and sore throat after extubation. [6] On the other hand, sub-inflation of the cuff put patient at risk of micro-aspiration of colonized subglottic secretions, increasing their risk of developing ventilator-associated pneumonia; [1,6,8] which is a significant cause of morbidity and mortality among ICU patients.

Ventilated ICU patients often require prolonged intubation, and looking after their artificial airway is an important aspect in good quality nursing care. [1] This includes documentation and maintaining ETT length at the lips, adequate fitting and changing of the ETT tie if needed, suction down the ETT to remove secretions ensuring tube patency, and maintenance of an adequate ETT cuff pressure. Patients are often intubated elsewhere before they are admitted into ICU, and it is important to carry out routine nursing care of the artificial airway in all patients admitted into the ICU by regular monitoring of ETT cuff pressure to ensure appropriate pressures are maintained to avoid complications.

ETT CUFF PRESSURE

Measurement of ETT cuff pressure among ICU patients are often not routine despite alarming evidence of the incidence of laryngeal and tracheal complications that are strongly associated to poor ETT cuff managements. It is well known that high pressure in the tracheal tube cuff can damage the tracheal mucosa. [2,16,17] In intensive care practice, where intubation is frequently prolonged, it is common practice to check the cuff pressure at frequent intervals. However, if this is performed without actually measuring the pressure in the cuff, high pressures may still result, even when using the MOV or the MLT technique. Pressure can either increase or reduce over time. It is therefore important for the nursing staff to regularly monitor cuff pressures and make adjustment to maintain within an optimal level.

What is the recommended ETT cuff pressure?

An "ideal tracheal cuff pressure", is the lowest amount of pressure needed to seal the airway and prevent any air leak while it does not exceed tracheal capillary blood pressure. Sengupta, Sole, and Ghafouri et al, have recommended the safe and ideal cuff pressure range of 20–30cmH2O for better patient outcome in reducing the risk of adverse complications. [1,2,3,4] Manufacturers of ETTs have also recommended the same pressure range. A target pressure is to maintain an average cuff pressure at 25cmH2O at any time. Other studies have recommended maintaining a cuff pressure lower than the venous perfusion pressure which is about but not higher than 27cmH2O. [3] Tracheal cuff pressures must be kept within an optimal range to ensure effective ventilation and prevent aspiration while maintaining tracheal perfusion. [1]

How should it be checked?

Using a simple tool such as an aneroid manometer is recommended as it is more accurate and superior compared to the other estimation techniques (MOV, MLT, palpation technique) in assessing ETT cuff pressures ($P<0.001$). [1,5,11] If an estimation technique is used then it must be followed by direct measurement using a manometer. Tracheal cuff pressures when objectively measured were higher than normal tracheal perfusion pressures in more than 40% of cases despite satisfactory assessment by palpation. [14] Frequent assessment using a manometer by nursing staff is recommended at least every 8 to 12 hours, [1,6] or at the start of each nursing shift, as cuff pressures does change over time and tubes are adjusted throughout the day. [1,6] Changes in cuff pressure can be affected by change in patient's position, neck and head position, changes in thoracic pressure, and coughing. [1,4] Therefore, regular monitoring of ETT cuff pressure is essential in routine ICU patient care, and measurements should be documented in patient's folder and observation charts.

What happens if out of range pressure?

Cuff pressure levels far less, or in excess than the recommended range may result in clinically significant patient outcome. Sole et al pointed out that pressure less

than 18cmH2O is associated with a four-fold increased risk of aspiration and ventilator-associated pneumonia (VAP). [1,5] Cuff pressure of more than 34cmH2O impedes trachea capillary blood flow, and a higher pressure of more than 50cm-H2O can completely obstruct tracheal perfusion and may result in tracheal ischemia, necrosis, rupture or stenosis. [2,5] Subglottic stenosis, hoarseness of voice, and trachea fistulas can occur with sustained cuff pressure over 30 – 50cmH2O. [1] Trachea mucosal injury can occur as early as 5mins to 1-3hours after intubation with overinflated cuff pressures. [4,11] Prolonged intubation is commonly defined as intubation of more than 7 days. There is an increase in the incidence of complications associated with prolonged intubation and high cuff pressure. [2] The incidence of some of these complications are coughing 66.4%, sore throat 57.5% [16], tracheal stenosis 6-21% [17], laryngeal erythema 94%, ulceration 76% [18], hoarseness of voice 15-80%, and dysphagia 15-94% [2]. Unfortunately, local data or studies on the incidence of post-intubation complications were not available. Furthermore, El-Boghdadly et al, evaluated the risk factors associated with post-operative sore throat among patients who underwent general anaesthesia, and highlighted that prolonged intubation and high cuff pressure were independent risk factors for post intubation tracheal injuries, and the risk are minimized by appropriate monitoring of cuff pressures and maintaining within the ideal pressure. [19]

Based on reviewed evidence and available guidelines, this was the proposed standard for best practice which the study findings were measured against.

- 100% cuff correctly inflated within a recommended pressure range (20-30cmH2O).
- 100% cuff pressures should be measured and documented at the start of each nursing shift, post intubation, and on admission for patients transferred from other units.

PROBLEM STATEMENT

The current CWM Clinical Care Guidelines (Table 1) for ETT management in the ICU, recommend using a manometer to measure the ETT cuff pressure at intubation, and at every nursing shift change, ensuring a cuff pressure of less than or equal to 20mmHg (25-27cmH2O) is maintained. However, what has been routinely practiced at CWM is an estimation technique by inflation of the ETT cuff until no audible leak is heard through the mouth (MOV), or by palpation of the pilot cuff. This is done only once at intubation without direct or objective measurement of the cuff pressure, and no regular assessment of the cuff pressure thereafter. Studies had shown that neither of these methods is reliable nor safe in assessing cuff pressure [1,5,11] therefore leaving the patient vulnerable to potential harm.

This prospective audit was designed to evaluate the current practice on endotracheal tube cuff pressure care in ICU at the CWM Hospital. While in current practice it seems acceptable to evaluate ETT cuff pressures clinically by listening for air leaks or palpation of the pilot cuff, it has not been objectively established whether ETT cuff pressures inflated this way are within the recommended guidelines or not.

Table 1: ICU Guidelines for Clinical Management, CWM 2015

Endotracheal tube care
• Document ETT measurement at lips at intubation, every shift change and PRN • Measure ETT cuff pressure at intubation, every shift change and PRN. ETT cuff pressure should be ≤ 20 mmHg. • Suction ETT every 1-2 hours and PRN. • Change HME daily and PRN if in use for humidification.

AIMS AND OBJECTIVES

The aim of this study was to carry out a prospective audit on endotracheal tube cuff pressure insufflation practices over a 3-month period, June – August 2017, at the CWM Intensive Care Unit (ICU).

The primary objective was to measure the ETT cuff pressures using a standard aneroid manometer after routine cuff inflation. (Percentage of cuffs inflated to correct pressure, and out of range pressures, when checked at random intervals). Cuff pressure less than 20cmH2O was considered as "LOW", and pressure higher than 30cmH2O was considered as "HIGH" cuff pressure.

The secondary objective was to assess staff practice and compliance in monitoring and documentation of endotracheal tube cuff pressures. (Percentage (%) of cuff pressures measured and documented post-intubation and at the start of each nursing shift).

METHODOLOGY

This was an on-site Prospective Clinical Audit, a baseline descriptive study**,** conducted at the CWM Hospital ICU, Suva, over a 3-month period from June to August 2017.

This study utilized an established audit recipe from the Royal College of Anaesthetists (RCoA), UK, (Nightingale, 2nd Ed). The Auditor, as the principal investigator, and none other than the Auditor collected data or measurements for the study.

Data collection included the date & time of the day (time of Nursing shift) the audit was carried out; patient's

information from patient's in-patient folder (NHN number, gender & age, date of admission & date intubation); in-patient's notes and nursing observation charts on documented cuff pressure measurements on admission and other intervals (each nursing shift); and other documentations on ETT tube size and position or length at the lips. Direct cuff pressure measurements were done at the bedside using a single standard aneroid manometer instrument. Direct assessment of ETT tube type (or brand), size and length at lip line were noted and compared against the nursing notes. Other variables were obtained directly from the ventilator display screen; ventilation mode, PEEP, and peak airway pressure. All information were recorded on the audit data collection sheet, which remained with the auditor at all times.

The pressure aneroid manometer used was a *Mallinckrodt* brand, German made; measurement range 0–120cmH2O. This was obtained from the operating theatre of the CWM Hospital. The pressure gauge was approved for use after submission for checking and calibration with the hospital Biomedical Engineer Department. This was the only single tool used for cuff pressure measurements during this study.

SAMPLING

All patients admitted into ICU who were intubated with a classical ETT on mechanical ventilation at the time of the audit were included in the study, and all others were excluded based on the inclusion and exclusion criterion (Table 3). Each patient included in the study was followed up on each subsequent audit until patient was either extubated or deceased. Both the patient and the nursing staff were considered blinded to the study. Although the nursing staffs were aware of cuff measurements in ICU, they were not aware of the purpose and methodology of the study. The Auditor visited the ICU without warning to the nursing and medical staff to carry out data collection at any time of the day, once a day, and on most days of the week.

Table 2: Inclusion & Exclusion Selection of Patients

Inclusion Criteria:	Exclusion Criteria:
All patients admitted into the adult ICU intubated with classical cuffed ETT on mechanical ventilation	• Patients on tracheostomy or with nasal intubation other than oral route intubation • Patient intubated with an un-cuffed tube and with other than the classical ETT • Patients with ETT cuff completely deflated to assess leak (leak test) • Patients in prone position • Patients receiving active cardiopulmonary resuscitation (CPR)

DATA COLLECTION AND MANAGEMENT

Permission was obtained from the hospital Medical Superintendent to carry out the study at the CWM Hospital ICU. During which the unit Sister-in-Charge and the Head of Department were informed and discussed on the proposed study. The Auditor also acknowledged that it must not disrupt or interfere with the clinical ward rounds, clinical procedures carried out on patients, or routine patients care by the nursing staff. Hand hygiene and tool decontamination were ensured between each patient as per ICU protocol using allocated antiseptic hand gel, or soap & water. Disposable gloves or appropriate personal protective equipment (PPE) were worn when indicated. Patients were identified as per selection criterion. A standard pressure aneroid manometer, 10cc syringe, and a 3-way stopcock were tools required for cuff measurements. Patient particulars were recorded on printed data collection sheet, and documented cuff pressure readings were checked against nursing notes. Ventilation parameters were noted directly from ventilation monitor.

The 3-way stopcock was connected to the manometer and cuff pressure measurement was taken by attaching the other end of the 3-way stopcock firmly to the ETT pilot cuff; measurement was recorded onto data collection sheet. The syringe was connected to the 3rd connection port of the 3-way stopcock to remove or add air to the cuff as required to a target pressure between 20-30cmH2O. The cuff pressure was measured and compared to the minimum pressure required to prevent a leak without exceeding 30cmH2O. Where cuff pressure found to be either overinflated or underinflated beyond the recommended pressure range, staff was informed and cuff pressure was adjusted accordingly to safeguard the patient.

If unable to maintain a minimal leak with cuff pressure more than 30cm-H2O, a senior nursing staff or the ward registrar was informed immediately. In addition, before and after taking cuff pressure measurements and where any adjustments were made to the ETT cuff, the Auditor observed patient's ventilation status and vital sign parameters for any new, sudden changes or deterioration that might have occurred with the intent to alert a senior nursing staff or ward registrar should this occur. This was carried out for each patient during the study.

Data was recorded using simple data collection sheet and entered manually onto Microsoft Excel spread sheets. This was to ensure minimal errors and to verify that data entry was accurate. The data was analyzed by the Auditor. A descriptive analysis was done using Microsoft excel to calculate the mean, median, mode, standard deviation, minimum and maximum values, and to create graphs to describe patterns and distribution.

The study proposal was reviewed and approved by the College Health Research & Ethics Committee (CHREC) of the Fiji National University (FNU), and the Fiji National Health Research & Ethics Review Committee (FNHRERC) through the Fiji Ministry of Health. Upon giving approval, the authorized bodies considered this study a "low risk" as cuff pressure assessments are part of "routine patient care" in ICU practice. The committees also highlighted that, during the audit, if objective cuff pressures were found to be excessively high or inadequately low, then this were to be addressed by adjusting the pressure to an acceptable range as per best practice guidelines, to ensure that the "best continuous care is given to patient". Senior staff or the ward registrar was to be informed immediately if any changes needed to be made to the patient care (ETT cuff). There was no patient consent necessary for this audit study as considered and approved by the authorizing committees. Permission to conduct this audit on-site was obtained from the hospital Medical Superintendent in writing.

At no time during the conduct of the study or the analysis of data were patients' identities revealed. Patients' National Hospital Numbers (NHN) were obtained instead, which ensured patient confidentiality and anonymity. This information was collected by the Auditor, and remained with the Auditor. The purpose of the NHN was only to identify the frequency which the same patient was audited, the different ETT brand and sizes used by the same patient (some patients needed reintubation), and to monitor the duration of intubation during their ICU admission.

RESULTS

A total of 52 patients were identified, 5 patients were excluded according to the inclusion/exclusion criteria. The final sample size of 47 patients from whom 172 measurements were collected and analyzed (Table 4). Of the 5 patients that were excluded, 4 patients were intubated with an armoured (reinforced) ETT, and the other a post-surgical patient with severe submandibular swelling who required the ETT cuff to be completely deflated to assess for "leak test" in preparation for weaning and extubation.

Figure 1: Age Distribution

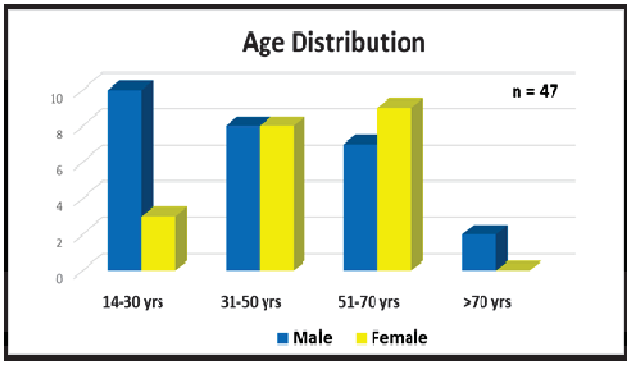


Table 3: Study Sample			
Patients Identified 52		Total Measurements 179	
Patients Excluded 5		Measurements Excluded 7	
Patients in Study 47		Measurements Analyzed 172	
Male 27	Female 20	Male 79	Female 93

There were 47 patients in total included in the final analysis; 57% were male, and 43% were female (Figure 1 & Table 6). They ranged from 14 to 81 years of age, with a mean age of 43 years (SD ± 16.86). Looking at the duration of intubation, 15% were intubated for less than 24 hours, while 62% were intubated within a week, and 11% required intubation longer than 7 days, which was considered as "prolonged intubation" (Figure 3). The longest duration a patient was intubated was 26 days, with an average of 4.6 intubated days. A total of 61 classical ETTs were used, 74% of which were of smaller sizes 7.0 and 7.5cm (ID), and 26% comprised of the larger sizes 8.0 and 8.5cm (ID) (Figure 2).

Figure 2: Endotracheal Tube Sizes

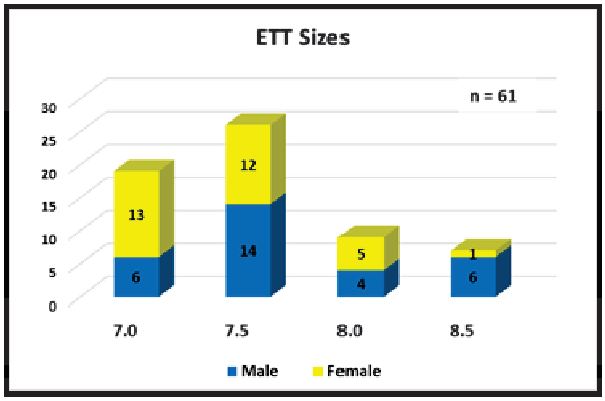


Table 5: Study Sample Characteristics		
Age (Years)	Youngest: 14 Eldest: 81 Mode: 43 Mean: 45 ± 16.86	
Gender: Male: Female:	n = 47 27 (57%) 20 (43%)	
Classical ETT Size: (ID) 7.0 7.5 8.0 8.5	n = 61 19 (31%) 26 (43%) 9 (15%) 7 (11%)	
Time of Nursing Shift: Morning (6:30am – 3:00pm) Afternoon (1:30pm – 10:00pm) Night (10:00pm – 6:30am)	n = 172 67 (39%) 105 (61%) 0 (0%)	
Days Intubated: <24 hours 1- 7 days >7 days	n = 47 6 (15%) 30 (62%) 11 (23%)	Min: <24 hours Max: 26 days Mean: 4.6 days
Ventilation Mode: SPONT Adaptive ASV SIMV Mandatory	n = 172 29 (17%) 2 (1%) 38 (22%) 91 (53%) 12 (7%)	
PEEP: <5cmH20 5cmH20 >5cmH20	n = 172 12 (7%) 99 (58%) 61 (35%)	
Peak Airway Pressure (Ppeak) <35cmH20 >35cmH20	n = 172 165 (96%) 7 (4%)	
Documentation of measured ETT cuff pressure	0 (0%)	
Other documentation of ETT *(ETT size, Length at lips)*	n = 172 154 (89.5%)	

Figure 3: Intubated days

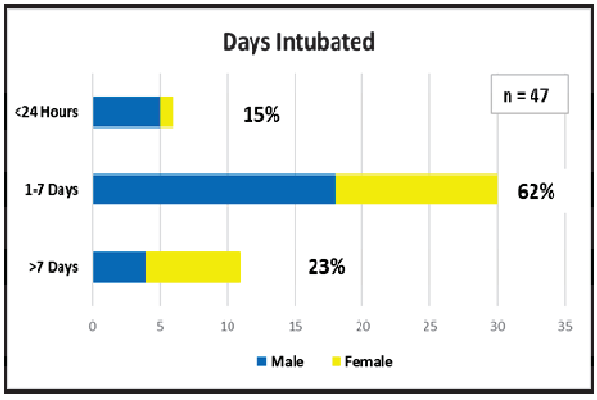


Table 4: Endotracheal Tube Cuff Pressure Measurements		
ETT Cuff Pressure Range	n = 172	Low: 10 Max: 120 Median: 32 Mode: 20 Mean: 45.7 ± 32.2 Range: 10 - 120
Low (<20cmH20)	14 (8%)	
Ideal (20-30cmH20)	70 (41%)	
High (>30cmH20)	88 (51%)	

Of the 47 patients, 172 measurements were collected and analyzed; 8% were inflated within the "Low" pressure range, 41% were within the acceptable "Ideal" pressure range, and 51% were within the "High" pressure range. Cuff pressures ranged from 10cmH2O to 120cmH2O, with a mean ETT cuff pressure of 45.7cmH2O (SD ± 32.2) (Table 5).

Measurements were collected during the morning (39%) and afternoon shifts (61%), none were collected during the night shift (Table 6). Most patients were ventilated using the SIMV (Synchronized Intermittent-Mandatory Ventilation) mode (53%), and 58% required minimal PEEP of 5cmH2O, 37% required higher PEEP more than 5cmH2O, while 7% required PEEP less than 5cmH2O (Table 6).

There were no routine measurements and documentation of ETT cuff pressure in the nursing notes or patient's charts, but almost 90% documentation of ETT sizes and length of the ETT at the lips were noted in the nursing notes.

DISCUSSION

The results from this study have shown that our current practice on ETT cuff care is below the recommended standard for best practice. The current technique in assessing ETT cuff pressures were able to accurately estimate only 41% of ETT cuffs to be within the ideal pressure range, while more than 50% were out of range (Table 5). Patients who required prolonged intubation were also exposed to dangerously high cuff pressure. (Figure 5).Table 5 and Figure 4, illustrates the audit cuff pressure measurements over the study period. The 2 red lines represent the "ideal" recommended cuff pressure range, while most of the measurements were outside of this range. The incidence of cuff over-inflation was more common than under-inflation. The measured cuff pressures ranged from 10cmH2O to as high as 120cmH2O, with a mean cuff pressure of 47.5cmH2O. Of those within the "high" cuff pressure range, 56% had cuff pressure measurements that were dangerously high that even exceeded 50cmH2O. This required correction to the ideal range. The current estimation techniques (MOV, cuff palpation) commonly practiced in ICU for assessing cuff pressure is not recommended as reported by Sole, Harm, and Stewart et al. [1,5,11]. Comparing findings from this study to other similar studies (Table 7), the incidence of out of range cuff pressures were similar. This may highlight that poor ETT practice is a common problem among other institutions.

Table 6: Comparison of Cuff Pressure from other studies		
Author	% Out-of-range	Mean Pressure
Sengupta. P, et al 2004	50%	35.3 cm H_2O
Stewart. L, et al 2003	70%	44.5 cm H_2O
Sole. M, et al 2011	73%	
Basir, et al 2012	83%	69.2 cm H_2O
Maddumage. M.E, et al 2017	74%	

Monitoring and documentation of ETT cuff pressures in accordance to local guideline was not carried out, as measuring tools were not available to ICU staff during the study period. ICU staff continued assessing ETT cuff pressure using clinical estimation techniques. It was noted from senior staff and Sister In-charged that manometers were once available in the past years but was not routinely used for its purpose. Until about a year ago when ICU was under reconstruction; equipments, monitors, even drugs went missing during movements and relocation of the unit within the hospital. Since then these equipments are still not accounted for. However, despite not having the tool available, staff was able to monitor & document ETT sizes and length at the lips which is also an important aspect in management of ETT. This goes to show that staff do pay attention in looking after ETT, and if they were provided with the appropriate tool and training, they may have performed accordingly.

It is not an uncommon practice in ICU to use smaller ID ETT sizes (7.0cm & 7.5cm) for female patients and larger ID sizes (8.0cm & 8.5cm) for male patients, however some patients were intubated from outside of ICU, and this could have accounted for the different ETT used among female and male patients seen in this study. Some female patients were intubated with sizes 8.0 and 8.5cm, while male patients were intubated with sizes 7.0 and 7.5cm (Figure 2). This could be a potential confounding factor that could have influenced cuff pressure.

Figure 5 illustrates variabilities in cuff pressures over time among ICU patients that required prolonged intubation. A study reported by Sole et al [1], that cuff pressure decreased within 4-5 hours after intubation, and that regular monitoring and documentation are necessary to ensure optimal pressure is maintained to safeguard patients. Sole also highlighted that it can be difficult to maintain cuff pressures within a narrow range of 20-30cmH2O unless continuous or direct measurements were used.

Only limited brands (e.g. Mallinckrodt, Flexicare, etc.) of classical ETT are currently available in the ICU. In fact, for the past 3 years, Fiji Government Pharmacy have been supplying ICU with only one brand of ETT, the Flexicare tubes, sizes 7.0cm – 8.5cm (ID). These are of low volume high pressure (LVHP) cuffed tubes. High volume low pressure (HVLP) cuffed tubes are rarely available in ICU unless they are brought in from other units or received as donations. During this study, at most instances, ETT brand and sizes could easily be identified while patients were intubated, by identifying unique

Figure 4: Endotracheal Tube Cuff Measurements

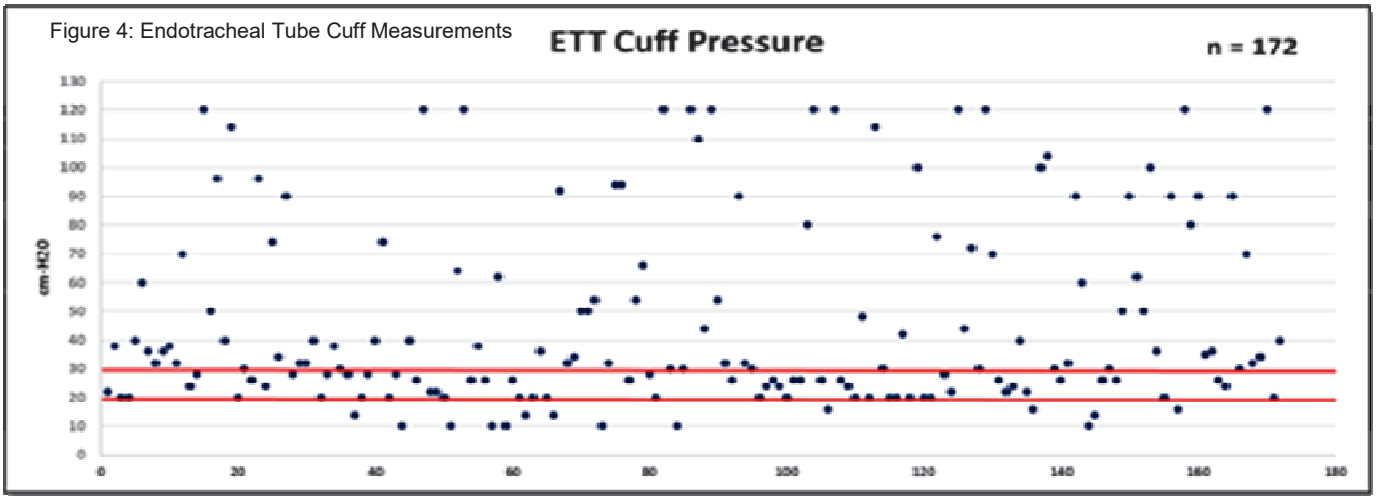
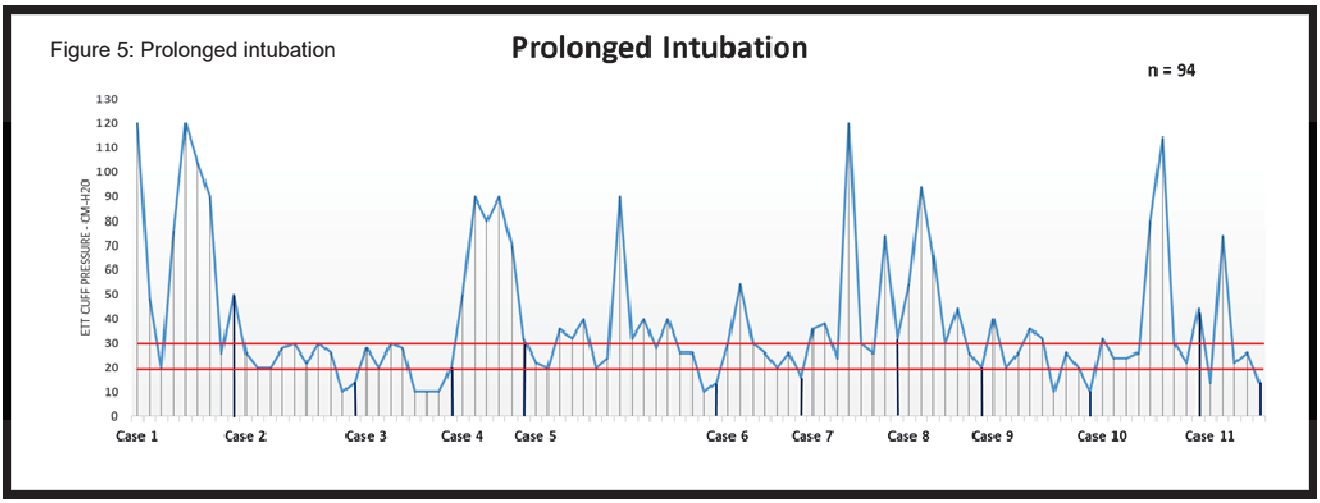


Figure 5: Prolonged intubation



markers and labels on the pilot cuffs and on the proximal part of the ETT. However, it was considered rather complicated to identify specific ETT type or brand for most patients especially those admitted from other wards or hospitals, that would have used different tube from those commonly used in ICU. This was also true for the same reason when identifying cuffs whether it was HVLP or LVHP cuffed tubes. Therefore, all ETT were identified as "classical", and HVLP / LVHP cuffed tubes could not be assessed separately.

Interestingly, one particular size of classical ETT currently used in ICU was identified to be potentially problematic in some patients. 63% (n=24) of the ETT size 8.5cm were found with extremely high cuff pressures more than 50cmH2O and even up to 120cmH2O, with large air leak when adjusted to 90cmH2O or lower. This incidental finding was observed after 4 patients were intubated and ventilated using the same size of ETT at the same time during an audit check. An asthmatic patient among this group of patients was not receiving adequate ventilation, desaturated and became bradycardic. Patient required reintubation with a different size of ETT, and cuff pressure was adjusted accordingly. Another patient who was requiring PEEP of more than 10cmH2O was not ventilated well due to a large air leak. The ICU team and Consultant were informed of this finding and were addressed by the team. The 8.5cm ETT that were identified causing ventilation problems did not make much difference to the overall "out of range" data after being removed for comparison reason. However, this was a significant finding during this audit.

LIMITATIONS OF STUDY

- The duration of the audit was short as compared to other similar studies, perhaps the validity of the study would have been achieved by increasing the duration of the audit period.
- The audit measurements were carried out only once a day. By increasing the frequency of the audit in a day could have captured more patients and measurements, and could have increased the sample size. Some patients have died or extubated before the audit was carried out, and therefore were not included in the audit. The overall sample size obtained during the audit period may be small precluding assessment of the impact of various factors such as PEEP, airway pressures, ventilation modes, ETT sizes, and etc.
- The only single manometer tool available that was used for the audit could only measure up to limit of 120cmH2O. There were instances that cuff pressure seemed more than 120cmH2O but this could not be measured with the available tool.
- Standard monometer pressure gauges were not available in the ICU during the study period. Therefore, staff practice and compliance on ETT cuff monitoring could not be assessed and make conclusive analysis. This requires immediate attention.
- Identifying the brand of ETT and to see whether high volume, low pressure, or low volume, high pressure cuffed tubes were used was not possible for all patients included in the study. Therefore, assessment of the different cuffs could not be evaluated. A reason then for a "pre-test" of the audit was reasonable.
- Clinically significant patient outcomes such as post extubation complications especially after being exposed to suboptimal cuff pressures were not evaluated in this study. Although this was beyond the scope of this baseline study, it would have enhanced the validity and significance of the study if further evaluated.
- Factors such as changes in head position, thoracic pressure, tracheal diameter versus ETT sizes, use of sedation and paralysis, and many other confounding factors which could interfere with cuff pressures were not evaluated in this study.
- The patient's primary or relevant clinical diagnosis and indication for intubation were not considered, collected, or evaluated in this study. This might have some significant implications on ETT cuff pressure measurements and patient outcome.

CONCLUSION

The current practice of endotracheal tube cuff care at the CWM Hospital ICU is not to standard, and the absence of a manometer for the CWM ICU has meant that the current practice of endotracheal tube cuff care is below the recommended standards of best practice. Patients are exposed to unsafe cuff pressures without objective measurements and regular monitoring of ETT cuff. This requires immediate intervention to improve the current practice and to ensure quality patient care in ICU. Further audits may benefit patients, and a more comprehensive study to evaluate clinical outcome is recommended.

Recommendations:

1. **Purchase of manometer and staff training for CWM ICU**. Training for staff not only on the use of manometer tools and its significance, but also on the importance of ETT care and its clinical purpose in the overall care of the patient. Administrators to ensure that essential tools such as a manometer are made available in ICU to promote and ensure quality patient care. The use of manometer instruments may have its own limitations, and staff training is essential.
2. **Regular ETT cuff audits at CWM Hospital.** Further audit to reassess improvement in our

practice and to ensure reliability of good practice in ICU is maintained by increasing the duration of the study period. Patients who may benefit from repeat audits.

3. **Further study of patient outcomes after intubation and ICU admission.** A more comprehensive follow-up study is recommended to evaluate patient's outcome and complications that may arise from current practice. A more comprehensive study that will include other confounding factors that may potentially influence cuff pressures and clinical outcome could be further evaluated.
4. **Potentially dangerous ETT need to be removed**. ETT size 8.5cm that were identified during the study to be potentially faulty will need further evaluation and assessment to ensure patient safety. This could also mean cost-cutting if other substitutes could be used and these faulty tubes can be discontinued.
5. **Current guideline need to be updated and standardized**. The current outdated ICU clinical guideline need to be reviewed and updated according to current standard of best practice. To ensure that the required practice is feasible and the necessary tools are available for staff use. Practice guidelines could be standardized for ICU and the operating theatre, where patients are commonly intubated and ventilated to ensure safe and quality patient care.

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