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# Institutional Factors Affecting Practices of Endotracheal Tube Cuff Pressure Management at a Level 6 Hospital in Nairobi, Kenya

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**Abstract**

**Background:** Maintaining endotracheal tube (ETT) cuff pressure within the therapeutic range of 20–30 cm $H_2O$ is essential for airway patency, effective positive-pressure ventilation, and prevention of tracheal ischemia or aspiration. Despite clear international guidelines, critical care nurses frequently encounter barriers rooted in institutional factors.

**Broad Objective**: This study sought to establish institutional factors affecting practices of endotracheal tube cuff pressure management at a level 6 Hospital, Nairobi, Kenya

**Methodology:** A cross-sectional quantitative study was conducted in June 2023. A sample of 85 nurses was calculated using Fisher's formula and selected by convenience sampling. Data were collected using a self-administered structured questionnaire and an observational checklist. Analysis was performed with SPSS version 26.0 using descriptive, bivariate ($\chi^2$/Fisher's exact), and binary logistic regression statistics.

**Results**: The response rate was 100% (n = 85). Most nurses (90.6%) reported a nurse–patient ratio of 1:2. Only 7.1% stated that the hospital provides a manometer, while 50.6% reported that it does not and 42.4% were unsure. Guidelines/protocols were reported as present by only 21.2%; 54.1% were unsure. Manual palpation of the pilot balloon was available to 87.1% and preferred by 71.8% of nurses. Observational findings confirmed the complete absence of manometers, guidelines, and documented cuff pressures. Education level ($p < 0.001$), existence of protocols ($p = 0.003$), and confidence in ETT care ($p < 0.001$) were significantly associated with satisfactory practice. Overall, 52% of nurses demonstrated satisfactory practice. Confidence in ETT care (OR 3.51, 95% CI 1.04–11.85) remained an independent predictor in logistic regression.

**Discussion:** The findings point to significant structural deficiencies. A critical resource deficiency was noted.

**Conclusion:** The hospital lacked formalized policies and essential monitoring equipment (manometer), coupled with the high reported workloads. Therefore, this Level 6 hospital must not only provide continuous learning opportunities for ETT care but must also formalize evidence-based guidelines and provide the necessary resources to standardize this critical practice and guide safe culture transmission.

**Keywords:** *Endotracheal Tube Cuff Pressure, Institutional Factors, Manometer, Guidelines and Protocols, Critical Care, Kenyatta National Hospital, Nurse-Patient Ratio, Pilot Balloon Palpation.*

## 1. Introduction

Proper Endotracheal Tube cuff pressure management is a cornerstone of safe and effective mechanical ventilation. The ETT cuff pressure is the force exerted by the inflated cuff against the tracheal wall. This pressure should be controlled, serving the dual purpose of ensuring both airway integrity and adequate positive pressure delivery (Nazari et al., 2020; Fallatah et al., 2021). The regulation of the pressure imposed on the tracheal mucosa, alongside the volume of air used to inflate the cuff, is considered one of the most significant variables in maintaining a cuffed ETT (Fallatah et al., 2021).

Globally, the professional consensus, emphasized for patient safety (Park et al., 2020; Murugiah et al., 2021), suggests that the cuff pressure of ETT should be kept within the narrow therapeutic range of 20-30cmH2O, which is recommended for patient safety (Srinivasan et al., 2020; Siderkeviit et al., 2020). This pressure requires routine monitoring (usually every 8 hours) to maintain it (Kumar et al., 2021). Any pressure less than 20cmH2O or more than 30cmH2O (Hemmati et al., 2020) poses significant and separate risks. If the cuff inflates too tightly, capillaries underneath the cuff become obstructed and blood does not flow through them, causing tissue necrosis and possible tracheal stenosis (narrowing). On the other hand, if the cuff is under-inflated, the cuff seal will be compromised, which will lead to air leakage and increase the risk of stomach aspiration and ventilator-associated pneumonia (VAP) (Mpasa, 2017). Continuous ETT cuff pressure monitoring has been widely accepted as a method to actively reduce the rate of VAP (Sevdi et al., 2021).

However, worldwide practice often deviates from this clear guidance. A cross-sectional study in the United States, for example, showed the alarming results of non-standardized care, that an average cuff pressure of 81.8cmH2O was measured in prehospital intubations (Chen et al, 2021). Moreover, even in critical care units, there is irregular use of standardized cuff monitoring techniques (Rodrigues et al., 2020), as only 38/61 CCUs in Brazil adopted cuff monitoring techniques. The reports highlight the importance of adopting standardized methods across the global to ensure patient safety (Chen et al., 2021).

In low-resource settings in Sub-Saharan Africa, the task of obtaining and maintaining optimum ETT cuff pressure may be especially difficult. Research conducted around the continent has shown that cuff pressures are too high and too low in far more than acceptable rates. For instance, in South Africa, an audit showed that 65% of the cuff pressures measured were above the upper limit, and in Ghana, dangerously high cuff pressures (DGMAH Study, 2025; Groote Schuur Hospital Study, 2013) were often recorded in trauma patients. The use of these inaccurate estimation techniques (pilot balloon palpation, for example) is due to the fact that the dedicated cuff manometer used for this purpose is often too costly to purchase and maintain (Bulamba et al., 2017). Also, institutional weaknesses compound this issue: Jun et al. (2016) found that suggested practices, guidelines or tools for controlling cuff pressure in ETT were not found in a study in Malawi, resulting in non-standardized treatment regimens. Likewise, in Sri Lanka, the majority of nurses were not aware of the current guidelines, with a particular lack of knowledge concerning the prevention of tracheal complications (Colombage & Goonewardena, 2020). However, training programmes have proven to be very effective, such as in Malaysia, where nurses' competence in delivering care for patients requiring ETT cuff pressure monitoring was significantly improved by targeted education (Murugiah et al., 2021).

East Africa's resource and systemic issues highlighted throughout highlight the need for localized investigation. The Kenyatta National Hospital (KNH), a major national and regional

referral hospital in Kenya, is a high-acuity environment in which mechanically ventilated patients are cared for.

## 2. Materials and Method

### 2.1 Setting

The study was carried out in the main Critical Care Unit (CCU) of Kenyatta National Hospital (KNH) located in Nairobi, about 3.5 km from the city center, Kenya. KNH is a national, referral and teaching hospital that offer a variety of critical care services. The CCU was chosen as the site of the study because it is the main place where adult patients with mechanical ventilation and high levels of acute care are treated. The unit has an information-rich context for compliance with best practices due to its operational requirements and the abundance of ETT management procedures.

### 2.2 Study Design

The study used a cross-sectional study design with a quantitative approach. The study sought to find out institutional factors affecting practices of endotracheal tube cuff pressure management at a level 6 hospital, Nairobi, Kenya at a single point in time.

### 2.3 Study Population

The target population included all professional nurses working in the main KNH CCU who were using the Human Resources (HR) registry of 2021 with an estimated population (N) of 109 nurses. Only those who consented to participate were included in the study as nurses.

### 2.4 Sample Size Determination

The minimum required sample size (n) was determined by the formula for a single population proportion (Fisher's formula) for a finite population:

$$n_0 = \frac{z^2 pq}{d^2}$$

where:

- $Z = 1.96$ (for a 95% confidence level)
- $p = 0.5$ (estimated population proportion for maximum sample size)
- $q = (1-p) = 0.5$
- $d = 0.05$ (level of precision/standard error)

The minimum calculated sample size was determined to be n = 85 nurses.

### 2.5 Sampling Technique

A convenience sampling method was used to select the sample for two weeks to select the desired sample size. This was the most appropriate way of doing this, as the CCU nurses are on different shifts, and to have them come in to recruit during their shift would be the most practical.

### 2.6 Data collection instruments and processes

Nurses' knowledge, self-reported practices and institutional resource constraints regarding the management of ETT pressure were obtained using a structured questionnaire which was self-administered.

The validity was judged by the experts comprising faculty members in Kenyatta University School of Health Sciences, and hence content, construct and face validated. Reliability: The test-retest procedure was used to assess the reliability. Good and acceptable internal consistency of the instrument was obtained with a Cronbach's alpha coefficient of 0.76 (Gay, 1992).

The data collection tool was pre-tested among 16 nurses in Neurosurgery Critical Care Unit (NCCU), of KNH. The NCCU was chosen for this study because of the following reasons: NCCU has the same nurse characteristics as the main CCU and patients who were admitted to NCCU have the same patient acuity as admitted patients to the main CCU, which allowed for the relevance of the trial without contaminating the study.

This study was conducted in the month of June for two weeks, 2023. The researcher was available in the unit to give the questionnaire and checklist, to answer any questions that might arise while filling it out, and to retrieve all the instruments as soon as they were finished, increasing the response rate and quality of the data.

### 2.7 Data Management and Analysis

Immediate post-collection checks of questionnaires were made to ensure they were complete and consistent. Completed instruments were coded, counted and entered into a computer using Statistical Package for Social Sciences (SPSS version 26.0) software. Frequencies, percentages, means and standard deviations were used for descriptive data results and bivariate and multivariate analysis was used to explore the association and predict institutional factors that relate to adherence to best practices. Very careful attention was given to data security, which was kept as low a risk as possible by having the password-protected electronic data on the computer only accessible to the researcher and by keeping all hard copy questionnaires in a locked cabinet.

### 2.8 Ethical Considerations

Before the commencement of the study, the research committee (KU-ERC) (KNH-UoN) (ERC), KNH administration and National Commission for Science, Technology & Innovation (NACOSTI) were contacted for their approval. All study participants gave written informed consent. No name or identifier was used in the study materials and questionnaires were numbered serially, not revealing the names of participants. The participants did not receive any costs for participation; there was no penalty for withdrawing from the study, and no requirement for the participants to declare the reason for their withdrawal from the study.

### 2.9 Study Limitations

These limitations were: The high workload in the CCU, which restricted nurses' participation time; convenience sampling, which could lead to selection bias; and self-reported data, which could be biased.

## 3. Results

### 3.1 Response Rate

Of the 85 questionnaires distributed to nurses working in the Critical Care Unit, all were completed and returned, yielding a response rate of 100%.

### 3.2 Demographic Characteristics of Respondents

**Table 1: Demographic Characteristics of the Respondents**

| Demographic Characteristic | | Frequency | Percent |
|---|---|---|---|
| Gender | Male | 13 | 15.3 |
| | Female | 72 | 84.7 |
| Education level | Diploma | 14 | 16.5 |
| | HND | 49 | 57.6 |
| | BScN | 22 | 25.9 |
| Years of ETT care experience | > 7 years | 35 | 41.2 |
| | < 7 Years | 50 | 58.8 |

The respondents had a mean age of 38 ± 8.33 years, ranging from 21 to 52 years. The mean duration of ETT care experience was 7.38 ± 6.06 years. Most respondents were female (84.7%, n = 72), held a Higher National Diploma in Nursing (57.6%, n = 49), and had less than seven years of ETT care experience (58.8%, n = 50).

### 3.3 Institutional Factors Affecting ETT Cuff Pressure Management

Table 2 presents the institutional factors influencing endotracheal tube (ETT) cuff pressure management among nurses working in the critical care unit. Most respondents (90.6%, *n* = 77) reported a nurse-to-patient ratio of 1:2 during most shifts, while 9.4% (*n* = 8) reported a ratio of 1:1. More than half of the respondents (50.6%, *n* = 43) indicated that the hospital did

not provide a manometer for ETT cuff pressure management, whereas only 7.0% ($n$ = 6) reported that a manometer was available. Additionally, over half of the respondents (54.1%, $n$ = 46) were unsure whether the hospital had established guidelines and protocols for ETT cuff pressure management. Workload was perceived by 36.5 % (n = 31) of respondents as interfering with proper cuff-pressure management, whereas 51.8 % (n = 44) did not consider workload a barrier. Training of staff was almost universally regarded as important (91.8 %, n = 78). Finally, 60.0 % (n = 51) felt that the prevailing nurse–patient ratio still permitted adequate ETT cuff-pressure management.

**Table 2: Institutional Factors Affecting Practice**

| Characteristic | Response | Frequency ($n$ = 85) | Percent (%) |
|---|---|---|---|
| Nurse-patient ratio (most shifts) | 1:2 | 77 | 90.6 |
| Hospital provides a manometer | Yes | 6 | 7.1 |
| | No | 43 | 50.6 |
| | Not sure | 36 | 42.4 |
| Hospital has laid down guidelines | Yes | 18 | 21.2 |
| | No | 21 | 24.7 |
| | Not sure | 46 | 54.1 |
| Workload affects management | Yes | 31 | 36.5 |
| | No | 44 | 51.8 |
| Training plays an important role | Yes | 78 | 91.8 |

### 3.4 Methods Available and Preferred for Measuring Cuff Pressure

Manual palpation of the pilot balloon was the method available to the overwhelming majority of nurses (87.1 %, n = 74). Far smaller proportions reported access to the minimum-leak technique (4.7 %), predetermined-volume technique (7.1 %) or minimum-occlusive-volume technique (1.2 %). When asked which method they preferred for routine care, 71.8 % (n = 61) selected manual palpation, 12.9 % preferred a digital manometer and 15.3 % stated that they do not measure cuff pressure at all (Table 3). The most frequently cited reason for preferring the chosen method was ease of use (30.6 %).

**Table 3: Methods Available and Preferred for Measuring ETT Cuff Pressure (n = 85)**

| Characteristic | Category | Frequency | Percent |
|---|---|---|---|
| Methods available | Minimum leak technique | 4 | 4.7 |
| | Minimum occlusive volume | 1 | 1.2 |
| | Manual palpation of pilot balloon | 74 | 87.1 |
| | Predetermined volume technique | 6 | 7.1 |
| Preferred method | Digital manometer | 11 | 12.9 |
| | Manual palpation of pilot balloon | 61 | 71.8 |
| | Do not measure | 13 | 15.3 |

### 3.5 Observational Checklist Findings

Direct observation of the unit environment and patient records confirmed several critical structural gaps. No cuff manometer was present in the Critical Care Unit, and no ETT cuff-pressure measurements had been recorded on any patient's chart during the study period. Likewise, no written guidelines or protocols for cuff-pressure management were displayed or available on the unit. The nurse–patient ratio documented in the duty allocation register remained consistently 1:2 across morning, afternoon and night shifts, while the unit continuous-medical-education (CME) register contained no entry on ETT cuff-pressure management for the preceding five months. These objective findings corroborate the self-reported scarcity of equipment and formal guidance.

### 3.6 Practice of ETT Cuff Pressure Management

Self-reported confidence in the four core domains of cuff-pressure management was as follows (Table 4):

- Measuring cuff pressure accurately: 23.5 % very confident, 49.4 % confident.
- Adjusting cuff pressure appropriately: 20.0 % very confident, 51.8 % confident.
- Recognising signs and symptoms of over- or under-inflation: 15.3 % very confident, 48.2 % confident.
- Measuring pressure every 8 hours as recommended: 34.1 % very confident, 23.5 % confident.

When the four Likert-scale items were summed and the median score used as the cut-off (≥ 11), 52 % (n = 44) of respondents were classified as having satisfactory practice of ETT cuff-pressure management, while 48 % (n = 41) fell below the satisfactory threshold.

**Table 4: Self-Reported Confidence / Practice of ETT Cuff Pressure Management (n = 85)**

| Domain | Very confident | Confident | Somewhat confident | Not confident |
|---|---|---|---|---|
| Measuring ETT cuff pressure accurately | 20 (23.5 %) | 42 (49.4 %) | 16 (18.8 %) | 7 (8.2 %) |
| Adjusting ETT cuff pressure appropriately | 17 (20.0 %) | 44 (51.8 %) | 24 (28.2 %) | – |
| Recognising signs of over-/under-inflation | 13 (15.3 %) | 41 (48.2 %) | 27 (31.8 %) | 4 (4.7 %) |
| Frequently measuring pressure 8-hourly | 29 (34.1 %) | 20 (23.5 %) | 20 (23.5 %) | 16 (18.8 %) |

### 3.7 Bivariate Associations between Predictor Variables and Satisfactory Practice

Bivariate analysis using $\chi^2$ or Fisher's exact tests examined associations between selected variables and satisfactory ETT cuff pressure practice (Table 5).

Education level showed a highly significant association with satisfactory practice (Fisher's exact $p < 0.001$); nurses holding a Higher National Diploma constituted 65.9% of those with satisfactory practice. Existence of protocols ($p = 0.003$) and confidence in ETT care ($p < 0.001$) were also significantly associated with satisfactory practice. Gender, nurse–patient ratio, workload perception, years of ETT experience, knowledge level, and attitude did not reach statistical significance.

**Table 5: Bivariate Analysis of Practice of ETT Cuff Pressure and Selected Predictor Variables**

| Characteristic | Satisfactory (n = 44) | Not satisfactory (n = 41) | Test statistic | p-value |
|---|---|---|---|---|
| Female | 39 (88.6%) | 33 (80.5%) | $\chi^2 = 1.088$ | 0.297 |
| HND education | 29 (65.9%) | 20 (48.8%) | Fisher's exact | <0.001* |
| Nurse–patient ratio 1:2 | 42 (95.5%) | 35 (85.4%) | Fisher's exact | 0.111 |
| Protocols exist | 15 (34.1%) | 3 (7.3%) | Fisher's exact | 0.003* |
| Confident in ETT care | 44 (100%) | 5 (12.2%) | Fisher's exact | <0.001* |

| Characteristic | Satisfactory (n = 44) | Not satisfactory (n = 41) | Test statistic | p-value |
|---|---|---|---|---|
| Workload does **not** affect care | 18 (40.9%) | 26 (63.4%) | Fisher's exact | 0.113 |
| Knowledgeable | 27 (61.4%) | 24 (58.5%) | $\chi^2 = 0.071$ | 0.790 |
| Experience < 7 years | 25 (56.8%) | 25 (61.0%) | $\chi^2 = 0.151$ | 0.697 |

***Statistically significant at $p \leq 0.05$.***

### 3.8 Binary Logistic Regression Analysis

A binary logistic regression model was fitted to identify independent predictors of satisfactory ETT practice. The overall model was statistically significant ($\chi^2 = 15.424$, df = 7, p = 0.031) and explained 22.4% of the variance (Nagelkerke $R^2 = 0.224$). The Hosmer–Lemeshow test indicated adequate model fit (p = 0.062) (Table 6).

Two variables remained independently associated with satisfactory practice after adjustment:

- Confidence in ETT care (OR = 3.51, 95% CI 1.04–11.85, p = 0.04)
- Perception that workload does **not** affect care (OR = 0.23, 95% CI 0.06–0.86, p = 0.03)

Female gender (OR = 3.11) and possession of an HND (OR = 2.80) increased the odds of satisfactory practice but did not reach conventional statistical significance (Table 7).

**Table 6: Binary Logistic Regression Model Information**

| | Intercept | Model | Df | Sig. |
|---|---|---|---|---|
| -2 Log Likelihood | 98.988 | 15.424 | | |
| Model Chi-square test | | 15.424 | 7 | 0.031 |
| Cox and Snell | | 0.166 | | |
| Nagelkerke R square | | 0.224 | | |
| Hosmer Lemeshow Chi-square test. | | 13.440 | 7 | 0.062 |

**Table 7: Logistic Regression Predicting the Odd of ETT Practice**

| Characteristic | B | S.E. | Wald | df | Sig. | Exp(B) | 95% CI Lower | 95% CI Upper |
|---|---|---|---|---|---|---|---|---|
| ETT care attitude: Negative | -0.14 | 0.65 | 0.04 | 1.00 | 0.84 | 0.87 | 0.24 | 3.13 |
| Confidence in ETT care: Yes | 1.26 | 0.62 | 4.10 | 1.00 | 0.04 | 3.51 | 1.04 | 11.85 |
| Workload affects ETT care: No | -1.45 | 0.66 | 4.81 | 1.00 | 0.03 | 0.23 | 0.06 | 0.86 |
| Nurse: Patient Ratio | 0.60 | 0.60 | 0.99 | 1.00 | 0.32 | 1.83 | 0.56 | 5.97 |
| Years of ETT care provision: < 7 years | 1.06 | 0.70 | 2.26 | 1.00 | 0.13 | 2.87 | 0.73 | 11.38 |
| Gender: Female | 1.14 | 0.90 | 1.59 | 1.00 | 0.21 | 3.11 | 0.53 | 18.21 |
| Education: HND | 1.03 | 0.54 | 3.64 | 1.00 | 0.06 | 2.80 | 0.97 | 8.05 |
| Constant | -6.49 | 3.41 | 3.62 | 1.00 | 0.06 | 0.00 | | |

## 4. Discussion

The results show deep institutional shortcomings which affect the practice of endotracheal tube (ETT) cuff pressure management in the main Critical Care Unit of Kenyatta National Hospital. The structural gaps are similar to Donabedian's model, which suggests that there is

a positive relationship between the structure and processes of care and patient outcomes (Donabedian, 2005).

Women's predominance in nursing (84.7 %) is typical of the nursing profession in the country and internationally (Ministry of Health, 2015; Nursing and Midwifery Council, 2022; Bureau of Labor Statistics, 2022). The age of respondents (38 years and above) is similar to the mean age of 35.4 years reported earlier for the country as a whole (Ministry of Health, 2015). Gender and age give context to the practice but are less revealing than were the institutional factors in this research.

***Institutional Factors and Resource Deficiencies***

Near complete lack of objective monitoring equipment was a critical resource deficiency. Half of the nurses (50.6 %, n = 43) stated that the hospital does not have a manometer, 7.1 % (n = 6) confirmed it and 42.4 % were unsure. Witnessed that no manometer was found on the unit. This is in contrast to that of better resourced places, where Maddumage et al. (2017) found that 82 % of the intensive care units in Sri Lanka had manometers. In contrast, the situation at KNH reflects that of resource-constrained settings in Sub-Saharan Africa, where unsafe cuff pressures have been reported to be high, and the lack of devices has been attributed to this (Khan et al., 2023; Memela & Gopalan, 2014). The manometer is still considered the standard method for keeping the recommended 20-30 cm $H_2O$ range (Fernandez et al., 1990; Lorente et al., 2007; O'Donnell, 1995). It impacts on many different aspects: the lack of flow monitoring, the risk of ischaemia of the tracheal mucosa, and ventilator-associated pneumonia (VAP) (Hameed et al., 2008); and the lack of opportunities for simulation-based learning, preceptorship and quality improvement programmes (Tarasi et al., 2011).

***Absence of Standardised Guidelines and Protocols***

Likewise, there was no formal guidance. Fifty-four percent (n = 46) did not know if the hospital had written guidelines or protocols for managing cuff pressures on ETTs; 24.7 % (n = 21) stated that there were no such guidelines or protocols. Protocols are vital in the process of localising evidence-based practice, and in standardising care (Estabrooks, 1999; Flynn & Sinclair, 2005). The lack of them is a systemic failure that affects patient safety (LeBlanc et al., 2012). Likewise, regional studies have reported such deficiencies, with a recent study in Malawi revealing that three-quarters of intensive care units did not have readily available evidence-based guidelines, which led to markedly different practices (Jun et al., 2020).

***High Value Placed on Staff Training***

Despite the structural deficiencies, training was given a critical importance by nurses with 91.8% agreement that training is important in cuff pressure management. This readiness is a positive one and educational interventions have been proven to bring about significant increase in both knowledge and practice (Vázquez-Calatayud et al., 2021; Mohamed et al., 2016; Murugiah et al., 2021).

***Practice and workload factors***

Since there were no manometers or protocols, practice turned to an inaccurate subjective method. 87.1 % of nurses could palpate the pilot balloon manually, and 71.8 % chose to do this. This technique has been shown to be highly unreliable in numerous manikin and clinical studies, with as low as 10 % of people correctly identifying the safe pressure range and as high as 90 % of them misperceiving the range (Ghorashi et al., 2016; D'Mello et al., 2016; Oto et al., 2016). Using a qualitative device instead of palpation means that the patient is at a significant risk of tracheal injury due to over-inflation (pressures often over 60 $cmH_2O$), and at a risk of micro-aspiration and VAP due to under-inflation (Mpasa, 2017).

Safe practice was further restricted by the virtually ubiquitous nurse/patient ratio of 1:2. While this ratio was more favourable than many resource-poor units, 40 % of the nurses believed that this ratio did not allow them to manage cuff pressures properly. Nurses are

reported to be at risk of missed care and adverse patient care outcomes in the context of critical care workload as it is identified as an occupational risk factor (Oliveira et al., 2016; Ross et al., 2019). Due to the dynamic nature of cuff pressure, which can change as a result of sucking, positioning, and changes in airway pressure, frequent and accurate cuff monitoring is required and is easily skipped when time is of the essence (Nazari et al., 2020). The normalisation of the faster but less safe palpation method is part of the institutional pressure and fits in with existing correlations of higher workload and higher VA-P (ventilator-associated pneumonia) rates (Blot et al., 2011).

***Knowledge, Education and Practice***

60% of nurses had an adequate understanding of the key aspects of ETT care – that pressure management is important for the safety of the patient, that the target range is 20–30 mmHg and that the main complication of ETT care is damage to the tracheal mucosa. Advanced critical-care training resulted in more knowledge among female nurses and those who received a Higher National Diploma, which is in line with previous findings that higher critical-care training levels provide greater knowledge and skill (Aboalizm & Elhy, 2019; Azizian et al., 2020). The majority of respondents had a high level of confidence in their practical skills in measuring, adjusting and recognising abnormal cuff pressures, and confidence was an independent predictor of satisfactory practice in the logistic regression model.

However, there was a gap between knowledge and practice. 52 % had a satisfactory practice score. This is a gap that needs to be explained within the framework of the lack of structured continuous professional development. If nurses do not receive education on a regular basis, the critical knowledge parts are easily forgotten when they leave formal education (Vázquez-Calatayud et al., 2021). The fact that nurses with less than seven years' experience were more knowledgeable also reinforces this hypothesis that, rather than the accumulation of clinical experience, current knowledge is maintained by formal education.

## 5. Conclusions

This study demonstrates that ETT cuff pressure management in the main Critical Care Unit of this Level 6 hospital is compromised by three interlocking institutional failures: the absence of objective monitoring devices (manometers), the lack of formalised and accessible guidelines, and high nurse–patient ratios that constrain meticulous care. These structural deficits force reliance on inaccurate pilot-balloon palpation and result in only 52% of nurses achieving a satisfactory practice score.

The findings confirm that the primary barriers to safe practice are institutional rather than individual. Without deliberate action to provide essential equipment, standardise protocols, and protect time for accurate monitoring, critically ill patients will continue to face preventable risks of tracheal injury and ventilator-associated pneumonia, while an unsafe practice culture is transmitted to successive cohorts of healthcare professionals.

## 6. Recommendations

Based on the institutional failures, unsafe practices, and high workload identified in this study, the following actions are essential to enhance patient safety and standardize Endotracheal Tube (ETT) cuff pressure management:

*1. Standardize Equipment Provision*

The hospital must prioritize the immediate procurement and mandatory deployment of ETT cuff manometers to every critical care bedside. This is essential to standardize the structural component of care. As a viable stopgap, the low-cost Loss of Resistance (LOR) syringe method should be formally evaluated and implemented, as it has shown significantly better accuracy than manual palpation (Khan *et al.*, 2018).

*2. Develop and Disseminate Protocols*

Accessible, evidence-based guidelines on ETT cuff pressure management must be immediately developed, formally approved, and prominently displayed at all critical care bedside points. This will standardize the process of care and provide a clear benchmark for clinical audits.

*3. Prioritize Continuous Education*

The hospital should establish a robust, mandatory program of onsite Continuous Medical Education (CMEs) specifically focused on ETT cuff pressure management. Training must cover recent evidence, the clinical consequences of inaccurate pressures, and the correct, practical use of monitoring devices to reinforce a patient safety culture.

*4. Optimize Nurse-Patient Ratio*

Nurse managers should vigorously advocate for and implement modalities aimed at achieving the standard 1:1 nurse-patient ratio for all mechanically ventilated patients. Mitigating heavy workloads will reduce the risk of missed care and ensure nurses have the time to perform meticulous procedures accurately.

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