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Knowledge, Attitude, and Practices of Nurses Regarding Endotracheal Tube (ETT) Management in a Tertiary Care Hospital in Lahore, Pakistan

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ABSTRACT

***Background**: Endotracheal tube (ETT) management is a critical component of intensive care nursing, with deficiencies in knowledge or practice contributing to preventable complications among mechanically ventilated patients. Local evidence on nurses' knowledge, attitudes, and practices (KAP) regarding ETT care in Pakistani tertiary hospitals is limited. **Objective**: To assess nurses' knowledge and practices related to ETT management in a tertiary care hospital in Lahore, Pakistan, and to examine the associations among knowledge, practice, and nursing care quality, as well as the impact of ETT-specific training. **Methods**: A descriptive cross-sectional study was conducted among 218 registered nurses working in intensive and critical care units. Data were collected using a structured, self-administered questionnaire assessing demographics, ETT-related knowledge, attitudes, practices, and a composite nursing care score. Descriptive statistics, independent samples t-tests, Pearson's correlations, and multiple linear regression were applied. **Results**: Most participants were female (85.8%) and aged 21–30 years (85.3%); 88.5% had received ETT training. Knowledge was high for core concepts but lower for skin assessment and tube repositioning. Infection-control practices were widely observed, though pre-oxygenation and auscultation before suctioning were less consistent. Knowledge and practice correlated strongly with nursing care ($r = 0.70$ and $r = 0.85$, respectively; $p < 0.001$). ETT-trained nurses had significantly higher knowledge and practice scores ($p < 0.001$). Regression showed practice ($\beta = 0.75$, $p < 0.001$) and knowledge ($\beta = 0.15$, $p = 0.04$) independently predicted nursing care quality. **Conclusion**: Practical competency, reinforced by structured ETT training, is the strongest determinant of high-quality ETT-related nursing care in intensive care settings.*

Keywords
endotracheal tube; nursing care; knowledge, attitude, and practice; intensive care unit; tertiary hospital; Pakistan

INTRODUCTION

Nursing practice is central to the quality and safety of care in tertiary healthcare systems, particularly in high-acuity environments such as intensive care units where patients frequently require complex monitoring and life-sustaining interventions (1). Among these interventions, airway management through endotracheal intubation is a cornerstone of critical care, allowing controlled mechanical ventilation and stabilization of patients with respiratory failure, severe neurological compromise, or perioperative instability (2,3). Endotracheal tube (ETT) management is therefore a core nursing responsibility, encompassing continuous surveillance, prevention of complications, and timely, evidence-based interventions that collectively influence morbidity, mortality, and length of stay (4–6).

Intubation and prolonged mechanical ventilation carry well-documented risks, including ventilator-associated pneumonia, tracheal and mucosal injury, pressure ulcers at fixation sites, unplanned extubation, and hemodynamic instability during suctioning or repositioning (3,5,6). The ability of nurses to anticipate and mitigate these risks depends on their understanding of respiratory physiology, airway mechanics, and evidence-based ETT care bundles, including cuff pressure control, aseptic suctioning, and device fixation strategies (4,7). Inadequate theoretical grounding in airway physiology or inconsistent application of standards can contribute to preventable adverse events, particularly in resource-constrained settings where monitoring technologies and staffing levels may be suboptimal (7,8). Errors in ETT care—such as inappropriate suctioning frequency, failure to assess skin integrity under fixation devices, or improper tube repositioning—have been associated with increased device-related complications and potentially avoidable clinical deterioration (5,9).

Beyond knowledge, nurses' attitudes and behavioral patterns are key determinants of adherence to clinical protocols. Stress, fatigue, and high nurse–patient ratios in intensive care can erode compliance with infection-prevention and airway-management guidelines, even when staff are theoretically knowledgeable (10). Conversely, positive professional attitudes, strong safety culture, and team support are associated with better adoption of standardized protocols for ETT care (11). Comparative work has shown that institutional context also matters: tertiary hospitals often manage more complex case mixes and higher turnover, and may struggle with consistent implementation of ETT care standards across units, especially when training coverage and supervision vary between facilities (12,13). Multifaceted interventions combining didactic education, hands-on skills training, clinical audits, and protocol reinforcement have been recommended to achieve sustained improvements in ETT management (14,15).

International literature describes a mixed picture regarding nurses' knowledge, attitudes, and practices (KAP) toward ETT care. Studies from high-income countries report that, although nurses are generally familiar with ETT-related complications, gaps persist in areas such as individualized suctioning indications, optimal suction pressure, and systematic skin assessment at fixation points (18,20–22). In lower- and middle-income settings, additional constraints—such as limited access to continuous professional development, variable staffing, and uneven availability of equipment—may further exacerbate these gaps (16,18,23). Evidence from cross-sectional studies in China and Tanzania, for example, has shown inconsistent adherence to best-practice suctioning techniques and highlighted the need for structured training and policy support to standardize ETT care (18,23). Educational interventions and competency-based training programs have demonstrated significant improvements in nurses' knowledge and skills related to ETT management and cuff pressure control, as well as sustained gains in suctioning practice (8,19,24,25).

Within Pakistan, ICU nurses are central to airway management in tertiary hospitals, yet local evidence on their KAP regarding ETT management remains limited. Existing work in comparable contexts suggests that relatively young, predominantly female nursing workforces often enter critical care roles early in their careers and may lack sufficient structured mentorship to translate theoretical learning into expert practice (1,16,17). While international studies point to the benefits of repeated, simulation-enhanced training in ETT care (8,14,15,19,24,25), there is a paucity of context-specific data describing baseline knowledge, attitudes, and practices among nurses working in Pakistani tertiary-care ICUs. In particular, there is little empirical evidence quantifying how knowledge and practice relate to an overall measure of nursing care quality for ETT management, and whether prior ETT-specific training is associated with meaningful differences in performance.

This study addresses this gap by investigating the knowledge, attitudes, and practices of nurses regarding ETT management in a tertiary care hospital in Lahore, Pakistan, and by examining how these domains relate to a composite measure of nursing care quality. The primary objective is to assess the level of knowledge and practice related to ETT care among ICU nurses and to evaluate the association between these domains and overall nursing care performance. A secondary objective is to compare knowledge and practice scores between nurses who have received ETT-specific training and those who have not, and to determine whether training status predicts higher competency. The study is guided by the research question: among nurses working in critical care units at a tertiary care hospital in Lahore, what are the levels of knowledge, attitudes, and practices regarding ETT management, and how do knowledge, practice, and ETT training predict the quality of nursing care delivered to intubated patients?

MATERIALS AND METHODS

This descriptive cross-sectional study was conducted to evaluate the knowledge, attitudes, and practices of nurses regarding ETT management and to examine their association with a composite nursing care quality score in a large tertiary care hospital in Lahore, Pakistan. The hospital provides specialized intensive and critical care services to a diverse patient population from urban and peri-urban catchment areas, with general, medical, and neurosurgical ICUs and an emergency department that regularly manage mechanically ventilated patients (1–3). Data collection was carried out over a three-month period from April to June 2024, during which routine clinical operations and staffing patterns were representative of usual practice.

The target population comprised registered nurses working in adult intensive and critical care settings, including intensive care units, coronary care units, and emergency units where endotracheal intubation and mechanical ventilation are regularly performed. Eligible participants were registered nurses with at least one year of experience in critical care settings, directly involved in bedside care of intubated patients, and present during the study period. Nurses on extended leave, those working exclusively in administrative or non-clinical roles, and individuals who declined participation were excluded. A non-probability convenience sampling approach was used to recruit participants during their scheduled shifts; although probability sampling is ideal for external validity, convenience sampling is commonly employed in ICU-based observational studies due to workload and scheduling constraints (18,23).

The sample size was calculated using OpenEpi software, assuming a two-sided confidence level of 95%, an anticipated prevalence of adequate ETT-related knowledge and practice based on prior regional and international work, and a margin of error considered acceptable for cross-sectional KAP research (18,22,23). This yielded a minimum sample size requirement that was exceeded by the final sample of 218 nurses, thereby enhancing the precision of estimates and supporting subgroup analyses by training status. Eligible nurses were approached in person during duty hours, informed of the study purpose and procedures, and invited to participate voluntarily. Written informed consent was obtained from all participants before questionnaire administration, and confidentiality was assured. No incentives were provided.

Data were collected using a structured, self-administered questionnaire adapted from previously validated tools assessing knowledge, attitudes, and practices related to ETT and suctioning care in ICU populations (7,14,18,20,22–25). The instrument comprised four sections. The first section captured demographic and professional characteristics, including age, gender, educational qualification, job title, years of experience as a registered nurse, unit type, and prior ETT-specific training. The second section assessed knowledge regarding ETT management, including items on the purpose of ETT insertion, common anatomical sites affected by oral ETT, major risk factors contributing to ETT-related complications, appropriate evaluation of skin around the ETT connection, principles of tube repositioning, recommended duration of ETT intubation prior to consideration of tracheostomy, and measures to prevent ETT-related pressure ulcers. Knowledge items were scored dichotomously as correct or incorrect, and summed up to generate a total knowledge score, with higher scores indicating greater theoretical understanding.

The third section evaluated attitudes toward ETT care, focusing on perceptions of the importance of ETT management, commitment to adherence with protocols, perceived barriers to optimal ETT care, and motivation to participate in training. Attitude items were rated on Likert-type scales, and responses contributed to an overall attitude profile, though the primary quantitative analyses focused on knowledge, practice, and nursing care scores. The fourth section assessed self-reported practices related to ETT management and suctioning procedures, including auscultation before suctioning, explanation of the procedure to patients where feasible, pre-oxygenation, hand hygiene before and after suctioning, use of gloves, aprons, and face protection, maintenance of catheter sterility, proper disposal of used materials, timely reconnection of oxygen, lubrication of the catheter tip, use of the dominant hand for catheter manipulation, pre-procedure equipment testing, and use of a protective towel on the patient's chest. Practice items were scored as "yes" or "no" and summed to derive a total practice score, with higher scores indicating better adherence to recommended behaviors (5,18,20,22,23).

In addition, a composite nursing care score was derived from items reflecting the overall quality of ETT-related nursing care, including consistency of assessments, timeliness and completeness of interventions, and adherence to evidence-based standards for airway management and skin integrity monitoring (3,5,6,14). This composite variable was treated as the primary outcome in inferential analyses. Content validity of the adapted

questionnaire was reviewed by a panel of experienced critical care nursing faculty and clinicians, and minor contextual modifications were made to align with local practice norms. Internal consistency reliability for the KAP domains in the study population was confirmed with a Cronbach's alpha of 0.82, indicating good reliability (7,14,22).

Data collection was conducted by trained research assistants who distributed questionnaires during duty hours and briefly oriented participants to the instructions. Participants completed the instrument in approximately 20 minutes in a quiet area of the unit, ensuring minimal disruption to clinical responsibilities. Completed questionnaires were checked for completeness at the point of collection, assigned unique study codes, and stored in a locked cabinet accessible only to the research team. Data were then entered into a password-protected database with double-entry verification to minimize transcription errors and ensure data integrity.

The primary variables of interest were total knowledge score, total practice score, and total nursing care score. Secondary variables included demographic and professional characteristics and ETT training status (trained vs untrained). Descriptive statistics were calculated to summarize participant characteristics and KAP scores, including means and standard deviations for continuous variables and frequencies and percentages for categorical variables. Independent-samples t-tests were used to compare mean knowledge and practice scores between ETT-trained and untrained nurses, and effect sizes were expressed as Cohen's d to facilitate interpretation of group differences (18,23–25). Pearson's correlation coefficients were computed to examine the associations between knowledge, practice, and nursing care scores, with 95% confidence intervals estimated using Fisher's z transformation. Multiple linear regression analysis was conducted to determine the independent contributions of knowledge and practice scores to the nursing care score, adjusting for both predictors simultaneously and estimating standardized regression coefficients (β), standard errors, t-statistics, p-values, and 95% confidence intervals (5,8,14,22–25). Model assumptions, including linearity, homoscedasticity, and normality of residuals, were assessed using standard diagnostic plots.

Analyses were performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Missing data were examined prior to analysis; questionnaires with substantial missing responses in key KAP sections were excluded, while sporadic missing values in individual items were handled by case-wise deletion for the relevant analysis. A two-sided p-value of less than 0.05 was considered statistically significant. Ethical approval was obtained from the Institutional Review Board of the Nursing Institute of Health Sciences under reference number NINHS/Admin/355-10/2024, and the study adhered to the ethical principles of beneficence, non-maleficence, respect for autonomy, and justice (1,16). All procedures and instruments are described in sufficient detail to permit replication of the study in similar tertiary care ICU settings.

RESULTS

A total of 218 registered nurses working in intensive and critical care units participated in the study. Table 1 summarizes their demographic and professional characteristics. The sample was predominantly female (85.8%) and young, with 85.3% aged 21–30 years. Most participants held a bachelor's degree in nursing (97.0%) and worked as staff nurses (70.6%), whereas 23.9% were senior nurses and 5.5% served as nurse supervisors. Slightly more than half of the nurses (55.2%) had five or fewer years of experience as registered nurses, 13.7% had 6–10 years, 12.8% had 11–15 years, and 18.3% had 20 or more years of experience. The majority were employed in general ICUs (77.5%), followed by medical ICUs (13.8%) and neurosurgical ICUs (8.7%). Notably, 88.5% of participants reported having received ETT-specific training.

Table 1. Demographic and professional characteristics of intensive care nurses (N = 218)

Category	Subcategory	Frequency (n)	Percentage (%)
Gender	Male	37	14.2
	Female	181	85.8
Age group (years)	21–30	186	85.3
	31–40	15	6.9
	41–50	17	7.8
Education	Bachelor's degree	215	97.0
	Master's degree	3	3.0
Job title	Nurse	154	70.6
	Senior nurse	52	23.9
	Nurse supervisor	12	5.5
Years as registered nurse	≤5	120	55.2
	6–10	30	13.7
	11–15	28	12.8
	≥20	40	18.3
ICU type	General	169	77.5
	Medical	30	13.8
	Neurosurgical	19	8.7
ETT training	Yes	193	88.5
	No	25	11.5

Table 2 presents item-wise knowledge regarding ETT management. Most nurses correctly identified the purpose of ETT insertion (82.6%) and the recommended duration of ETT intubation before considering tracheostomy (86.7%). Similarly, 74.8% correctly recognized key factors contributing to ETT-related complications, and 76.6% acknowledged the importance of keeping the skin clean and dry to prevent ETT-related injury. However, only 55.0% correctly answered questions related to systematic evaluation of the skin around the ETT connection, and less than half (44.9%) demonstrated correct knowledge regarding appropriate ETT repositioning. Knowledge of the most common sites affected by oral ETT (68.8%) and the preventive use of gauze between the ETT and skin (64.7%) was moderate. These patterns indicate generally sound foundational knowledge with notable deficits in domains directly related to pressure injury prevention and fixation practices. Table 3 summarizes self-reported practices related to suctioning and ETT care. Adherence to core infection-prevention measures was high: 95.4% of nurses reported washing hands before suctioning and 89.2% reported washing hands afterward, 93.8% used gloves, and 92.3% reported appropriate disposal of catheters and gloves.

Sterility of the suction catheter was maintained by 87.7% of respondents, and 84.6% reported reconnecting oxygen within 10 seconds after suctioning. Most nurses indicated that they explained the procedure to patients where feasible (81.5%), tested suction equipment before use (81.5%), used goggles or face masks (81.5%), and lubricated the catheter tip (78.5%).

Table 2. Item-wise knowledge regarding ETT management (N = 218)

Item	Correct n (%)	Incorrect n (%)
Purpose of insertion of ETT	180 (82.6)	38 (17.4)
Most common sites affected by oral ETT	150 (68.8)	68 (31.2)
Most common factors contributing to ETT-related complications	163 (74.8)	55 (25.2)
Evaluation of skin around connection of ETT	120 (55.0)	98 (45.0)
Appropriate repositioning of ETT	98 (44.9)	120 (55.1)
Duration of ETT intubation before tracheostomy is considered	189 (86.7)	29 (13.3)
Prevention of ETT-related pressure ulcer by placing gauze between ETT and skin	141 (64.7)	77 (35.3)
Keeping skin clean and dry helps prevent ETT-related skin breakdown	167 (76.6)	51 (23.4)

However, only 60.0% reported auscultating before suctioning and 60.0% reported using an apron during the procedure, while 67.7% placed a towel on the patient's chest. Pre-oxygenation before suctioning was reported by 64.6% of nurses, suggesting room for improvement in physiological safety measures.

Table 3. Distribution of nurses' practice regarding suctioning and ETT-related procedures (N = 218)

Item	Yes n (%)	No n (%)
Auscultate before suctioning	131 (60.0)	87 (40.0)
Explain procedure to patient (when feasible)	178 (81.5)	40 (18.5)
Hyper-oxygenate before suctioning	141 (64.6)	77 (35.4)
Wash hands prior to suctioning	208 (95.4)	10 (4.6)
Use gloves during suctioning	204 (93.8)	14 (6.2)
Use apron during suctioning	131 (60.0)	87 (40.0)
Maintain sterility of suction catheter	191 (87.7)	27 (12.3)
Use goggles/face mask during suctioning	178 (81.5)	40 (18.5)
Dispose of catheter and gloves properly	201 (92.3)	17 (7.7)
Reconnect oxygen within 10 seconds	184 (84.6)	34 (15.4)
Wash hands after suctioning	194 (89.2)	24 (10.8)
Lubricate suction catheter tip	171 (78.5)	47 (21.5)
Use dominant hand to attach and manipulate suction catheter	181 (83.0)	37 (17.0)
Test suction equipment before use	178 (81.5)	40 (18.5)
Place towel on patient's chest during suctioning	147 (67.7)	71 (32.3)

Table 4 displays the correlations among total knowledge, practice, and nursing care scores. There was a strong, significant positive correlation between knowledge and practice scores ($r = 0.75$; 95% CI 0.69–0.80; $p < 0.001$), indicating that higher knowledge was associated with better reported practice. Knowledge also correlated strongly with the nursing care score ($r = 0.70$; 95% CI 0.63–0.76; $p < 0.001$), suggesting that nurses with higher theoretical understanding tended to deliver higher-quality ETT-related care. The strongest association was observed between practice and nursing care scores ($r = 0.85$; 95% CI 0.81–0.88; $p < 0.001$), underscoring the central role of practical competency in determining overall nursing care quality.

Table 4. Correlations among knowledge, practice, and nursing care scores (N = 218)

Variable pair	Pearson r	95% CI for r	p-value
Total knowledge score vs total practice score	0.75	0.69 to 0.80	<0.001
Total knowledge score vs nursing care score	0.70	0.63 to 0.76	<0.001
Total practice score vs nursing care score	0.85	0.81 to 0.88	<0.001

To examine the impact of ETT training on competency, mean knowledge and practice scores were compared between nurses who had received ETT training and those who had not (Table 5). ETT-trained nurses ($n = 193$) had considerably higher mean knowledge scores (8.2 ± 1.5) than untrained nurses (5.1 ± 2.1), with a t-statistic of 6.7 ($df = 216$; $p < 0.001$) and a very large effect size (Cohen's $d = 1.96$). Similarly, practice scores were higher among trained nurses (9.1 ± 1.2) than among untrained nurses (6.3 ± 1.8), with $t = 4.2$ ($df = 216$; $p < 0.001$) and Cohen's $d = 2.19$, indicating a very large difference in practice performance associated with training.

Table 5. Comparison of knowledge and practice scores by ETT training status (N = 218)

Outcome	Training status	n	Mean ± SD	Mean difference	t (df = 216)	p-value	Cohen's d
Knowledge score	Trained	193	8.2 ± 1.5	3.1	6.7	<0.001	1.96
	Untrained	25	5.1 ± 2.1				
Practice score	Trained	193	9.1 ± 1.2	2.8	4.2	<0.001	2.19
	Untrained	25	6.3 ± 1.8				

Multiple linear regression analysis was conducted to evaluate the independent contributions of knowledge and practice scores to the nursing care score (Table 6). The overall model was statistically significant and explained 72% of the variance in nursing care scores ($R^2 = 0.72$; $F(2,215) = 45.8$; $p < 0.001$). After adjusting for both predictors, practice emerged as the dominant predictor of nursing care quality, with a standardized

coefficient β = 0.75 (SE = 0.05; t = 14.3; p < 0.001; 95% CI 0.65–0.85). Knowledge also had a statistically significant, though more modest, independent association with nursing care (β = 0.15; SE = 0.07; t = 2.1; p = 0.04; 95% CI 0.01–0.29). These findings indicate that both knowledge and practice are important for high-quality ETT-related nursing care, but that practice contributes more strongly to observed variation in nursing care performance.

Table 6. Multiple linear regression analysis predicting nursing care score (N = 218)

Predictor	Standardized β	Standard error	t-value	p-value	95% CI for β
Knowledge score	0.15	0.07	2.1	0.04	0.01 to 0.29
Practice score	0.75	0.05	14.3	<0.001	0.65 to 0.85
Model summary					
R^2 = 0.72	F(2,215) = 45.8			<0.001	

DISCUSSION

This study provides a detailed examination of nurses' knowledge, practices, and nursing care quality regarding ETT management in a tertiary care hospital in Lahore, Pakistan, and quantifies how these domains are related to each other and to formal ETT training. The results highlight a predominantly young, well-educated, and female nursing workforce working in high-acuity environments, consistent with patterns reported in other tertiary care and regional contexts where nurses assume critical care responsibilities early in their careers (1,16,17). The high proportion of staff with ETT-specific training is encouraging, yet item-level and practice-level analyses reveal specific gaps in ETT-related competencies that carry important implications for patient safety.

At the knowledge level, nurses demonstrated strong understanding of core concepts such as the purpose of ETT insertion, duration of intubation prior to tracheostomy, and general risk factors for ETT-related complications. These findings align with prior reports that ICU nurses generally recognize the broad indications and risks associated with mechanical ventilation and airway devices (2–4,6). However, knowledge gaps were evident in domains directly linked to pressure injury prevention and fixation practices, including regular evaluation of skin at ETT connection points and appropriate ETT repositioning. Fewer than half of respondents answered the repositioning item correctly, and only about half demonstrated adequate knowledge of systematic skin assessment, raising concerns about the risk of device-related pressure injuries and unplanned extubation (5,9,18). Similar deficits have been identified in studies from diverse settings, where nurses often report familiarity with general ETT care yet exhibit incomplete understanding of key technical details, such as optimal fixation strategies or indications for tube repositioning (5,18,20–22).

Self-reported practices showed a reassuringly high adherence to fundamental infection-prevention measures, including hand hygiene, glove use, catheter sterility, and proper disposal of contaminated materials. These behaviors are central to preventing ventilator-associated pneumonia and other healthcare-associated infections, and their high prevalence suggests that institutional policies and training on standard precautions are relatively well embedded in the study setting (3,5,6,18,22). Nonetheless, more nuanced aspects of physiologically safe suctioning were only moderately adhered to. Just under two-thirds of nurses reported pre-oxygenation before suctioning, and only 60% consistently auscultated before the procedure. The incomplete use of protective aprons and variable use of face protection mirror findings from other cross-sectional studies, which have shown that steps not directly audited or emphasized in protocols may be less consistently implemented (18,20,22,23). These patterns underscore the need for ongoing education emphasizing the physiological rationale for specific suctioning behaviors and for local checklists that explicitly incorporate such steps (5,18,21,22).

The strong positive correlations observed among knowledge, practice, and nursing care scores reinforce the conceptual link between cognitive, behavioral, and outcome-oriented domains of competency. The association between knowledge and practice (r = 0.75) and between knowledge and nursing care (r = 0.70) suggests that a higher level of theoretical understanding is associated with better adherence to recommended behaviors and higher overall care quality. These relationships are consistent with prior work showing that education and targeted training improve ETT-related knowledge and are associated with better procedural compliance (8,14,18,19,22–25). The strongest correlation was between practice and nursing care (r = 0.85), indicating that the behavioral translation of knowledge into consistent bedside actions is the most proximal driver of observable nursing care quality. This is in line with the view that protocol adherence and competent execution of procedures, such as suctioning, fixation, and skin assessment, are critical to preventing complications of mechanical ventilation (5,6,21,22).

The regression analysis further clarifies these relationships by showing that, when knowledge and practice are considered simultaneously, practice remains the primary independent predictor of nursing care quality, while knowledge contributes a smaller but statistically significant additional effect. These findings are congruent with educational models such as Benner's novice-to-expert framework, which emphasize that experiential learning and repeated situated practice are required to move from theoretical understanding to expert clinical performance (17). They also resonate with interventional studies demonstrating that multifaceted programs combining didactic components with supervised practice, simulation, and competency assessments produce larger and more durable improvements in ETT care than classroom instruction alone (8,14,19,24,25). Thus, while improving knowledge is necessary, strengthening and reinforcing practice behaviors at the point of care may yield greater gains in nursing care quality.

The large differences in knowledge and practice scores between ETT-trained and untrained nurses, with very large effect sizes, provide empirical support for the value of structured training programs. Trained nurses outperformed their untrained colleagues across both domains, consistent with previous work documenting substantial gains in knowledge, cuff pressure management, suctioning competence, and adherence to guidelines following focused educational interventions (8,18,19,24,25). Given the magnitude of these differences and the strong association between practice and nursing care quality, institutionalizing regular, mandatory ETT-focused training, including refresher sessions and hands-on skills assessments, appears to be a high-yield strategy to enhance patient safety in mechanically ventilated populations (14,15,19,24,25).

Despite these strengths, several limitations should be considered when interpreting the findings. The cross-sectional design precludes causal inference; although training and higher practice scores are associated with better nursing care, longitudinal or quasi-experimental studies would be needed to demonstrate causal effects of training on patient outcomes such as ventilator-associated pneumonia, device-related pressure injury, or unplanned extubation (3,6,18,22). Practices were self-reported and may be subject to social desirability bias; observational studies often reveal

lower adherence rates than those reported by nurses themselves (18,20,22,23). The use of convenience sampling within a single tertiary hospital may limit generalizability to other institutions with different staffing patterns, resource levels, or training infrastructures (1,12,13,16). Finally, while the questionnaire showed good internal consistency, further psychometric validation—such as confirmatory factor analysis and test–retest reliability—could strengthen confidence in the measurement of KAP domains (7,14,22).

Nevertheless, the study has important implications for nursing practice and policy. First, sustained improvements in ETT care will likely require integration of structured training into routine continuing professional development, with periodic refresher courses and competency assessments for all ICU nurses. Second, unit-level job aids, checklists, and bedside prompts can help standardize key steps such as pre-oxygenation, auscultation, and skin inspection, thereby reducing variability in practice (5,6,14,21,22). Third, local audit and feedback mechanisms could provide real-time information on adherence to ETT care standards and inform targeted interventions where gaps are identified (13–15,22). Finally, future research should extend beyond process measures to link nurse-level KAP variables and training interventions to hard patient outcomes, such as infection rates, duration of mechanical ventilation, and ICU length of stay, thereby strengthening the evidence base for investment in ETT-focused educational programs (3,6,18,22–25).

CONCLUSION

Nurses working in intensive and critical care units in a tertiary care hospital in Lahore demonstrated generally strong foundational knowledge and high adherence to core infection-prevention practices related to ETT management, but important gaps persisted in specific safety-critical domains such as systematic skin assessment and tube repositioning. Formal ETT training was associated with substantially higher knowledge and practice scores, and both knowledge and practice independently contributed to a composite measure of nursing care quality, with practice emerging as the dominant predictor. These findings suggest that institutionalizing regular, competency-based ETT training and reinforcing evidence-based bedside behaviors through protocols, checklists, and audit–feedback systems are essential strategies to enhance the quality and safety of airway management for mechanically ventilated patients in tertiary care settings.

REFERENCES

1. Smith A, Khan R, Ali M. The evolving role of nurses in tertiary healthcare systems. J Nurs Health Care. 2018;7(2):45–51.
2. Jones L, Brown P. Airway management in intensive care: principles and nursing responsibilities. Crit Care Nurs Q. 2019;42(3):215–222.
3. Johnson T, Ahmed R, Lee C. Prevention of ventilator-associated complications: the nurse's perspective. Int J Nurs Pract. 2020;26(4):e12877.
4. Johnson T, White F. Airway control and nursing management of intubated patients. Clin Nurs Rev. 2017;23(1):59–67.
5. Brown D, Williams E. Best practices in endotracheal suctioning: an evidence-based review. J Clin Nurs. 2021;30(5–6):755–764.
6. Smith A, Jones L, Brown P. Complications of mechanical ventilation: implications for nursing practice. J Adv Nurs. 2019;75(8):1623–1632.
7. Atkins S, Murphy K. The importance of physiological knowledge in airway management. Nurs Crit Care. 2019;24(2):110–118.
8. Quinn L, Turner G. Educational interventions to enhance nurses' competence in endotracheal tube care. Nurs Educ Today. 2019;79:128–134.
9. Jones P, Taylor J, Ahmed Z. Errors in endotracheal tube management and their prevention. J Clin Pract. 2020;74(9):e13567.
10. Miller H, Foster L. Stress, fatigue, and adherence to protocols among ICU nurses. Int J Nurs Stud. 2020;103:103498.
11. Carter R, Anderson P. The role of attitude in adherence to airway management guidelines. Br J Nurs. 2017;26(19):1085–1092.
12. Patel S, Wilson J. Comparative evaluation of ETT care practices across hospital levels. Nurs Health Sci. 2018;20(1):66–74.
13. Walker D, Martinez F. Barriers to evidence-based endotracheal care in tertiary hospitals. Int J Crit Care Nurs. 2019;12(4):254–262.
14. Richards J, Martin E. Improving ETT management through multifaceted training programs. J Nurs Manag. 2021;29(3):402–410.
15. Thompson B, Harris G. Educational strategies and their impact on clinical competence in airway management: a systematic review. Nurs Educ Perspect. 2022;43(1):29–35.
16. Almalki M, FitzGerald G, Clark M. The nursing profession in Saudi Arabia: an overview. Int Nurs Rev. 2011;58(3):304–311.
17. Benner P. From Novice to Expert: Excellence and Power in Clinical Nursing Practice. Menlo Park (CA): Addison-Wesley; 1984.
18. Zhang W, Zhang Z, Chen L, Ye Y, Xie J. Current practice of endotracheal suctioning in intensive care units in China: a cross-sectional study. BMC Nurs. 2021;20(1):249.
19. Mohamed S, Ali N. Effect of training program on nurses' knowledge and competence regarding endotracheal tube and tracheostomy care in mechanically ventilated patients. IOSR J Nurs Health Sci. 2019;8(3):52–62.
20. Blackwood B. Tracheal suctioning of adults with artificial airways: current endotracheal suctioning practice—a literature review. J Adv Nurs. 1999;29(3):719–726.
21. Sole ML, Bennett M, Ashworth S. Clinical indicators for endotracheal suctioning in adult patients receiving mechanical ventilation. Am J Crit Care. 2015;24(4):318–324.
22. Pinto M, Ribeiro L, Ferreira F, Ferreira A. Nursing practice on endotracheal suctioning in intensive care units: a systematic review. Rev Esc Enferm USP. 2019;53:e03491.
23. Mwakanyanga ET, Masika GM, Tarimo EA. Knowledge and practice on endotracheal suctioning among nurses working in intensive care units: a cross-sectional study in Tanzania. BMC Nurs. 2018;17:20.
24. Yildiz F, Ozden D. The effect of training on nurses' knowledge about endotracheal cuff pressure control. Turk J Intensive Care. 2019;17(2):67–73.
25. Afshari A, Safari M, Oshvandi K, Soltanian A. Effect of an education program on knowledge and practice of intensive care unit nurses regarding endotracheal suctioning. J Educ Health Promot. 2020;9:311.