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ASSESSMENT OF CLOSED SUCTIONING SYSTEM KNOWLEDGE AND PRACTICES AMONG ICUS RESPIRATORY THERAPISTS & CRITICAL CARE NURSES (CCN) IN PESHAWAR

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Abstract

Backgrounds: Closed Suctioning System (CSS) In-line technique to perform ET suctioning while maintaining PEEP, oxygenation and minimizing exposure to aerosol. The AARC 2022 Clinical Practice Guideline recommends it, but it is not that CSS among ICU Clinicians in Pakistan has been systematically assessed. **Objective:** To evaluate the knowledge, self-reported practices and perceived barriers to Closed Suctioning System (CSS) among Respiratory Therapists (RTs) and Critical Care Nurses (CCNs) in Tertiary care Intensive Care Unit (ICU) of Peshawar. **Methods:** This descriptive cross-sectional study was carried out among 120 (39 RTs and 81 CCNs) staff members of the ICU in three tertiary care teaching hospitals in Peshawar from October 2025 to April 2026. A structured questionnaire mapped according to AARC was used and 100% response rate was achieved (Cronbach's alpha 0.845 for knowledge and 0.898 for practice). Scores were grouped by the modified Bloom's cut-off and analyzed in SPSS v25 with p value < 0.05 considered significant. **Result:** Mean knowledge score: 4.81/8 (60.1%): Good (33.3%), Moderate (24.2%) and Poor (42.5%) with the lowest scores relating to suction-pass duration (32.5%) and routine saline installation

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(38.3%). Mean score for practice was 17.25/20 (86.2%) with 79.2% Good and 27.5% always avoided routine saline instillation. Equipment shortage was listed as the most common barrier (47.5%) and 100% agreed that there was a need for more structured CSS training. Formal training significantly improved both knowledge ($t = 3.23$, $p = 0.002$) and practice ($t = 3.46$, $p < 0.001$) scores. There was no significant difference between RTs and CCNs on either outcome ($p > 0.05$).**Conclusion:** ICU Respiratory Therapists and Critical Care Nurses of Peshawar have good practices in general but lack technical knowledge about evidence-based CSS (suction time and saline instillation). Structured interprofessional training along with equipment procurement is suggested.

1. INTRODUCTION:

The Intensive Care Unit (ICU) represents the highest level of hospital care, where critically ill, mechanically ventilated patients require precise nursing and respiratory interventions. Endotracheal suctioning (ETS) is a routine yet high-risk procedure used to clear airway secretions, maintain airway patency, and ensure adequate oxygenation in intubated patients (1). Despite its routine use, ETS is associated with complications such as hypoxemia, mucosal injury, atelectasis, hemodynamic instability, and ventilator-associated pneumonia (VAP), a major cause of morbidity and mortality in ICUs worldwide (2, 3). VAP remains a significant challenge in low- and middle-income countries such as Pakistan, where reported incidence ranges from 10–41.7 per 1,000 ventilator days, exceeding international benchmarks (4). Local ICU studies show VAP affecting nearly 30% of ventilated patients, contributing to prolonged ICU stay and increased mortality (5). In Khyber Pakhtunkhwa, weak infection prevention and control (IPC) systems further increase the burden of healthcare-associated infections (6).

The closed suction system (CSS), also known as in-line suctioning, allows tracheal suctioning without disconnecting the ventilator circuit, thereby maintaining positive end-expiratory pressure (PEEP) and oxygenation while reducing aerosol exposure and potential cross-contamination (1, 3, 7). In contrast, the open suction system (OSS) requires ventilator disconnection for each procedure, leading to loss of PEEP and higher risk of desaturation. CSS has therefore been widely recommended in patients requiring high ventilatory support and in infectious conditions such as COVID-19 (8). However, evidence comparing CSS and OSS remains inconclusive, with some studies showing modest reduction in VAP while others report no significant differences in outcomes such as mortality or ICU length of stay (10–14). Despite guideline availability, a persistent gap exists between evidence and clinical practice in critical care settings. International studies report poor adherence to suctioning protocols among ICU staff, and similar deficiencies have been documented in developing countries, including Pakistan, where gaps in knowledge and practice among nurses have been reported (16–18). However, limited data exist regarding CSS-specific knowledge and practices among critical care nurses (CCNs) and respiratory therapists (RTs) in Peshawar, highlighting a clear research gap.

This study is significant as it provides baseline evidence on CSS knowledge, practices, and barriers among ICU staff in tertiary care hospitals of Peshawar. It contributes to the understanding of the theory–practice gap in respiratory care within low-resource settings (15). Findings may inform infection control

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policies, improve clinical training, and support curriculum development for allied health professionals in Pakistan (19).

The study aims to assess knowledge, practices, and perceived barriers related to CSS among RTs and CCNs in tertiary ICUs of Peshawar. Specifically, it evaluates theoretical knowledge of CSS indications and complications, assesses adherence to recommended practices, and identifies barriers to guideline-based care. The study is guided by the Knowledge–Attitude–Practice (KAP) model, which suggests that clinical practice is influenced not only by knowledge but also by institutional, organizational, and resource-related factors (15, 20).

This dissertation argues that improving CSS practice requires a multi-level intervention addressing training, workload, equipment availability, and institutional culture. The subsequent chapters present literature review, methodology, results, discussion, limitations, and recommendations to support evidence-based improvement in ICU respiratory care.

METHODOLOGY:

This study followed a positivist (post-positivist), quantitative, and deductive approach using a descriptive cross-sectional design in accordance with STROBE guidelines (29). The design was selected to assess the current level of knowledge, self-reported practices, and perceived barriers regarding Closed Suction System (CSS) among respiratory therapists (RTs) and critical care nurses (CCNs) in tertiary ICUs of Peshawar. While this design is time-efficient and appropriate for prevalence estimation in low-resource settings, it does not allow causal inference and is subject to self-report and social desirability bias (30, 31).

The study was conducted in adult ICUs of three tertiary care hospitals in Peshawar: Lady Reading Hospital, Khyber Teaching Hospital, and Hayatabad Medical Complex, which collectively represent major ventilator care facilities in the region (6). Data collection was carried out over six months, including instrument development, pilot testing, ethical approval, data collection, and analysis.

The target population included RTs and CCNs directly involved in mechanical ventilation and endotracheal suctioning. A total sample of 120 participants was selected using non-probability convenience sampling due to the absence of a centralized registry. The sample size was calculated using a single-proportion formula assuming 50% prevalence, 95% confidence level, and 9% margin of error, consistent with similar regional studies (17, 23). Participants who were actively involved in ICU care and consented to participate were included, while those not involved in ventilated patient care, on extended leave, or with incomplete questionnaires were excluded.

Data were collected using a structured self-administered questionnaire based on the AARC 2022 guideline for airway suctioning (1). The instrument consisted of four sections: demographics, knowledge (8 items), practice (10 items), and barriers (4 items). Knowledge was scored as 1 for correct and 0 for incorrect responses, while practice items were rated on a 3-point Likert scale (Always, Sometimes, Never). Scores were converted into percentages and categorized using modified Bloom's cut-off points: good (≥80%), moderate (60–79%), and poor (<60%) (30, 31).

Content validity was ensured through expert review by intensivists, RTs, and nursing faculty, and calculated using Content Validity Index (CVI) following Polit and Beck's method (33). A pilot study on 12 participants assessed reliability using Cronbach's alpha (≥0.70 acceptable) (35), and these data were excluded from final analysis.

After informed consent, participants completed the questionnaire in a private setting. Data were coded anonymously and analyzed using SPSS version 25. Descriptive statistics were used for

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demographic and score distribution. Inferential analysis included chi-square or Fisher's exact test for categorical associations, and independent t-test (or Mann–Whitney U test) to compare RTs and CCNs. Normality was assessed using Shapiro–Wilk test, and statistical significance was set at $p < 0.05$.

Ethical approval was obtained from the institutional review board, and participation was voluntary with written informed consent. Confidentiality was strictly maintained, with anonymized data stored in password-protected files. The study posed minimal risk as it involved only questionnaire-based data collection.

Overall, this methodology provides a structured and feasible approach for assessing CSS-related knowledge and practice in a resource-limited ICU setting, while acknowledging limitations related to cross-sectional design, self-reporting, and sampling method.

RESULTS

This chapter presents the findings of a cross-sectional survey assessing knowledge, practices, and barriers related to Closed Suction System (CSS) among Respiratory Therapists (RTs) and Critical Care Nurses (CCNs) working in adult ICUs of tertiary care hospitals in Peshawar. A total of 120 questionnaires were completed (100% response rate). Results are presented as demographic characteristics, reliability and distributional properties, knowledge and practice findings, barriers, and inferential analyses. Data were analyzed using SPSS version 25 with statistical significance set at $p < 0.05$.

Demographic Profile of Participants

Most participants were young, with 43.3% aged 26–30 years and 25.8% aged 20–25 years, while 20% were above 35 years. Females constituted 64.2% of the sample. CCNs formed the majority (67.5%), while RTs accounted for 32.5%. Half of the participants had 1–3 years of ICU experience (50%).

Importantly, only 34.2% had received formal training in CSS, while 65.8% had not, indicating a major training gap.

Table 1: Demographic Characteristics (N = 120)

Variable	Category	n (%)
Age	20–25	31 (25.8)
	26–30	52 (43.3)
	31–35	13 (10.8)
	>35	24 (20.0)
Gender	Male	43 (35.8)
	Female	77 (64.2)
Profession	RT	39 (32.5)
	CCN	81 (67.5)
ICU Experience	<1 year	13 (10.8)
	1–3 years	60 (50.0)
	4–6 years	28 (23.3)
	>6 years	19 (15.8)
CSS Training	Yes	41 (34.2)

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Variable	Category	n (%)
	No	79 (65.8)

Reliability and Normality

The knowledge scale showed good internal consistency (α = 0.845), while the practice scale showed excellent reliability (α = 0.898). Both scales were non-normally distributed (Shapiro–Wilk p < 0.001), with scores skewed toward higher practice levels.

Table 2: Reliability and Normality

Scale	Items	α	Shapiro–Wilk p
Knowledge	8	0.845	<0.001
Practice	10	0.898	<0.001

Knowledge of CSS

The mean knowledge score was 4.81 ± 2.56 (out of 8). Only 33.3% had good knowledge, while 42.5% had poor knowledge.

Highest correct responses were seen in pre-oxygenation (78.3%), hypoxia as complication (75.8%), and purpose of CSS (74.2%). Lowest scores were for suction duration (32.5%) and saline instillation knowledge (38.3%).

Table 3: Knowledge Categories

Category	n (%)
Good (≥80%)	40 (33.3)
Moderate (60–79%)	29 (24.2)
Poor (<60%)	51 (42.5)

Practice of CSS

Mean practice score was 17.25 ± 3.34 (out of 20). Most respondents reported high adherence to infection control practices such as aseptic technique (90%), SpO_2 monitoring (89.2%), and hand hygiene (83.3%).

However, avoidance of saline instillation was low (27.5% always), indicating a persistent gap between evidence and practice.

Table 4: Practice Categories

Category	n (%)
Good (≥80%)	95 (79.2)
Moderate	14 (11.7)
Poor	11 (9.2)

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Barriers

The most common barrier was lack of equipment (47.5%), followed by lack of training (24.2%) and workload (21.7%). Only 17.5% reported adequate equipment availability. All participants (100%) stated that CSS training is needed.

Table 5: Barriers and Resources

Item	Response	n (%)
Main barrier	Equipment shortage	57 (47.5)
	Lack of training	29 (24.2)
	Workload	26 (21.7)
	Lack of guidelines	8 (6.7)
Confidence in CSS	Yes	95 (79.2)
Training needed	Yes	120 (100)
Equipment adequate	Yes	21 (17.5)
	Limited/None	99 (82.5)

Inferential Analysis

Formal CSS training significantly improved knowledge (p = 0.0017) and practice scores (p = 0.0007). RTs and CCNs showed no significant differences in knowledge or practice. ICU experience was associated with practice (p = 0.0398). Gender and profession were not significant predictors.

Table 6: Effect of Training and Profession

Comparison	Knowledge p	Practice p	Result
Training effect	0.0017	0.0007	Significant
RT vs CCN	0.5616	0.4508	Not significant

Table 7: Chi-Square Associations

Variable	Knowledge p	Practice p	Result
Training	0.0178	0.0081	Significant
Experience	0.0681	0.0398	Mixed
Profession	0.7085	0.1103	NS
Gender	0.4451	–	NS

Summary of Findings

The study found moderate to poor knowledge but high self-reported practice regarding CSS. Major gaps exist in specific evidence-based practices, particularly saline instillation and suction duration. Training deficiency was significant, with two-thirds of participants lacking formal CSS education. Equipment shortage was the most important barrier. Formal training significantly improved both knowledge and practice, while profession had

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no impact. Overall, results suggest that improving structured CSS training and resource availability is key to improving ICU suctioning practices.

DISCUSSION

The aim of this chapter was to interpret the empirical findings presented in Chapter 4 in light of the conceptual framework (Sections 1.6 and 2.6) and the relevant international and regional literature. The discussion can be summarised in five integrated parts: demographic context and instrument performance, knowledge findings, practice findings, perceived barriers, and inferential results, followed by theoretical integration, strengths, limitations, and overall summary.

The study population reflected a typical critical-care workforce in Khyber Pakhtunkhwa: predominantly young, mostly female, and largely composed of Critical Care Nurses (67.5%) with Respiratory Therapists (32.5%). Most had 1–3 years of ICU experience, indicating a relatively early-career workforce similar to previous Pakistani studies (18, 23). A key system-level concern was that only 34.2% had received formal CSS training, suggesting a consistent gap in in-service education even at tertiary teaching hospitals (17, 26). Instrument performance was strong, with good internal consistency (knowledge $\alpha = 0.845$; practice $\alpha = 0.898$) consistent with accepted standards (35). Non-normal score distributions likely reflect heterogeneity in knowledge and inflated self-reported practice patterns, as commonly reported in KAP studies (16, 21).

Knowledge levels were overall suboptimal: 42.5% of participants fell in the "poor" category and only 33.3% achieved "good" knowledge. This aligns with regional and international evidence from Yemen, China, and Pakistan showing persistent deficiencies in suctioning-related knowledge (16, 17, 21, 23). The most critical gaps were in suction duration (32.5% correct) and avoidance of routine saline instillation (38.3%), both directly contradicting AARC 2022 guidelines (1). These findings suggest not only a knowledge deficit but also persistence of outdated clinical habits, particularly regarding saline use, which has been widely described as a culturally embedded practice rather than a purely cognitive gap (24, 25).

In contrast, self-reported practice was high (79.2% "good"; mean 86.2%), with strong adherence to infection-control behaviours such as aseptic technique, hand hygiene, and SpO_2 monitoring. However, this contrast between weak knowledge and high reported practice indicates a classical theory–practice tension. Unlike the traditional model where knowledge exceeds practice, this study suggests an inverted pattern likely influenced by social desirability bias, habitual bedside routines, and apprenticeship-based learning rather than structured theoretical understanding (15, 16). The only area where knowledge and practice converged as a deficit was routine saline instillation, making it a high-priority intervention target.

Perceived barriers further clarified the system context. The most frequently reported barrier was lack of equipment (47.5%), followed by lack of training (24.2%) and workload (21.7%), while very few cited lack of guidelines. Equipment availability data confirmed this issue, with only 17.5% reporting adequate access. This suggests that even motivated and knowledgeable staff may be constrained by resource limitations. Importantly, 100% of participants supported the need for structured CSS training, reflecting unanimous recognition of educational gaps and aligning with findings from similar studies (21, 25). Confidence levels were relatively high (79.2%), although a notable minority lacked confidence, which may have implications for patient safety (28).

Inferential analysis showed that formal CSS training was the strongest and most consistent

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predictor of higher knowledge and practice scores. Both parametric and non-parametric tests confirmed statistically significant differences between trained and untrained participants, with medium effect sizes. This finding is consistent with previous studies in Pakistan and internationally (17, 21), reinforcing the importance of structured training as a key intervention within the KAP framework (15). In contrast, no significant differences were found between Respiratory Therapists and Critical Care Nurses, suggesting convergence in competencies rather than profession-specific advantages. This may reflect shared clinical exposure in ICUs and similar system-level constraints that override curricular differences. ICU experience showed a modest association with practice but weaker effects on knowledge, indicating that experience reinforces routine behaviour more than conceptual understanding.

When integrated within the KAP and theory–practice gap framework, the findings suggest that practice behaviours in this setting are driven more by routine, workplace culture, and informal learning than by formal cognitive knowledge structures. The pattern of high reported practice despite moderate-to-poor knowledge likely reflects a combination of habitual clinical routines and reporting bias. This represents a shift from the classical theory–practice gap to a context where practice precedes or exceeds explicit knowledge, particularly in procedural tasks.

Overall, the study contributes three key interpretations: CSS knowledge among RTs and CCNs is moderate to poor and reflects broader regional trends; self-reported practice is high but likely influenced by habit and reporting bias, creating an inverted knowledge–practice relationship; and formal training and equipment availability are the most important system-level determinants of performance, while professional category has no meaningful effect.

The study has several strengths, including the use of an AARC 2022-aligned instrument, strong reliability coefficients, adherence to a prespecified analytical plan, inclusion of both RTs and CCNs for comparison, and a complete response rate which reduces non-response bias. However, limitations include the cross-sectional design (preventing causal inference), reliance on self-reported practice, limited generalisability beyond Peshawar, and absence of detailed measurement of training characteristics and frequency of CSS use.

In summary, the findings highlight that improving CSS practice in tertiary ICUs of Peshawar will require more than individual knowledge enhancement. The evidence points toward a multi-level strategy combining structured training, improved equipment availability, and reinforcement of guideline-based practice at the bedside. The absence of a profession-based difference further supports the need for unified, interprofessional training interventions. The next chapter translates these findings into formal conclusions and practical recommendations.

The aim of this final chapter is to integrate the empirical findings (Chapter 4) and their interpretation (Chapter 5) to summarise answers to the research questions, draw the overall conclusion, and present actionable recommendations across clinical, educational, institutional, and research domains.

The study addressed three research questions. First, the level of Closed Suctioning System (CSS) knowledge among ICU Respiratory Therapists and Critical Care Nurses in Peshawar was moderate to poor. Only 33.3% achieved “Good” knowledge, while 42.5% were in the “Poor” category, with a mean score of 60.1%. Key deficiencies were identified in suction duration (K4, 32.5% correct) and avoidance of routine saline instillation (K7,

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38.3%), both directly contrary to the AARC 2022 Clinical Practice Guideline (1). These findings align with regional and international literature, indicating a persistent global gap in airway suctioning knowledge rather than an isolated local issue.

Second, CSS practice was generally high, with 79.2% of respondents classified as "Good" and a mean score of 86.2%. High compliance was observed in infection-control behaviours such as aseptic technique, hand hygiene, and SpO_2 monitoring. However, avoidance of routine saline instillation (P6) was notably poor, with only 27.5% reporting "always" adherence. This mismatch between moderate-to-poor knowledge and high self-reported practice suggests an inverted theory–practice gap, likely influenced by habitual bedside routines, social desirability bias, and lack of formal training in 65.8% of respondents.

Third, perceived barriers were dominated by equipment shortages (47.5%), followed by lack of training (24.2%) and workload (21.7%). Only 17.5% reported adequate CSS equipment availability, confirming a structural constraint. Despite this, 100% of respondents supported the need for structured CSS training, highlighting strong consensus for educational intervention.

Inferential analysis showed that formal CSS training significantly improved both knowledge and practice scores ($p < 0.01$), with medium effect sizes. No significant differences were found between Respiratory Therapists and Critical Care Nurses, suggesting interprofessional convergence in CSS competency. ICU experience showed a modest association with practice but weaker association with knowledge.

Table . Summary of Principal Findings by Research Question

Research Question / Issue	Principal Finding
RQ1: CSS knowledge level	Moderate to poor knowledge; 33.3% good, 42.5% poor; weakest items K4 and K7
RQ2: Practice alignment	High practice (79.2% good); mean 86.2%; weakest item P6 (saline avoidance)
RQ3: Barriers	Equipment shortage dominant (47.5%); 100% need training
Inferential: Training effect	Training significantly improves knowledge and practice ($p < 0.01$)
Inferential: RT vs CCN	No significant difference between professions

Overall, the thesis concludes that CSS knowledge in this workforce is insufficient despite relatively high reported adherence to practice. This disconnect reflects an inverted theory–practice gap, shaped by informal learning, habitual clinical routines, and insufficient structured training. Equipment shortages further constrain optimal practice, while formal training remains the strongest predictor of improved performance. The absence of differences between professional groups indicates that CSS interventions should be designed interprofessionally rather than discipline-specific.

To address these findings, multi-level recommendations are proposed below.

The key recommendation is that improvement in CSS performance requires combined intervention across knowledge, behaviour, and system resources rather than education alone.

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Clinical Practice Recommendations

Bedside implementation of an AARC 2022–aligned CSS checklist (pre-oxygenation, ≤15-second suction duration, aseptic technique, and avoidance of routine saline) is recommended. Regular audits focusing on saline instillation are essential, as this represents the weakest practice area. Each ICU should appoint a CSS champion (trained RT/CCN) to support coaching, monitoring, and feedback. A bedside timer cue is recommended to enforce safe suction duration limits.

Education and Training Recommendations

A structured CSS module should be integrated into RT and CCN curricula at KMU and partner institutions, aligned with AARC 2022 guidelines. Quarterly interprofessional refresher sessions should be implemented to prevent skill decay. Special emphasis should be placed on suction duration (K4) and saline instillation (K7), combined with behaviour-change strategies. Training materials should also be developed in Urdu and Pashto to improve accessibility.

Institutional and Policy Recommendations

Hospitals should conduct procurement audits to address CSS equipment shortages, as 82.5% reported inadequate availability. CSS competency should be made a formal requirement for graduation and ICU induction. Provincial IPC policies should incorporate AARC-aligned CSS standards within VAP prevention bundles. Annual audits by a regional critical care body are recommended for monitoring progress.

Future Research Recommendations

Future studies should adopt pre-post or stepped-wedge designs to evaluate training effectiveness and VAP outcomes. Observational studies should validate self-reported practice to measure social desirability bias. Multi-centre studies across Pakistan are needed for generalisability. Qualitative research should explore barriers related to training and equipment access. Instrument refinement and cost-effectiveness analyses are also recommended.

Summary of Recommendations by Operational Level

Level	Key Recommendations	Supporting Evidence
Clinical practice	Checklist, saline audit, CSS champions, timer cues	AARC 2022, Chang et al., Ayhan et al.
Education	Curriculum integration, refresher training, focus on K4/K7, bilingual materials	KMU framework, Mastrogianni et al.
Institutional/policy	Procurement review, competency requirements, IPC integration, annual audit	Hassan et al., Ahmed et al.
Research	Intervention trials, observational validation, multi-centre studies, qualitative work, economic evaluation	Alkubati et al., Wang & Cheng