

Original Article

Evaluating the Knowledge and Implementation of Evidence-Based Practices in Airway Management among Respiratory Therapists in Critical Care Units across Lahore

Shakeel Ahmad¹, Tasra Bibi², Muhammad Naveed Babur³

¹ Faculty of Allied Health Sciences, The Superior University, Lahore, Pakistan

² Faculty of Allied Health Sciences, The Superior University, Lahore, Pakistan

³ Professor, Faculty of Allied Health Sciences, The Superior University, Lahore, Pakistan

✉ **Correspondence:** Tasra Bibi, tasra.bibi@superior.edu.pk

Received: 12/4/2025

Accepted: 1/8/2026

Published: 1/15/2026

HOW TO CITE

Shakeel Ahmad et al. 2026. Evaluating the Knowledge and Implementation of Evidence-Based Practices in Airway Management among Respiratory Therapists in Critical Care Units across Lahore. Journal of Health, Wellness and Community Research. 4(1). DOI: <https://doi.org/10.61919/6h2jxx66>

ARTICLE INFORMATION

Author Contributions	Concept: SA, MNB; Design: SA, TB, MNB; Data Collection: SA, TB; Analysis: SA, TB, MNB; Drafting: SA, TB, MNB.
Ethical Approval	The study was approved by research ethical board of The Superior University, Lahore, Pakistan
Informed Consent	Written informed consent was obtained from all participants
Conflict of Interest	The authors declare no conflict of interest.
Funding	No external funding.
Data Availability	Available from the corresponding author on reasonable request.
AI Declaration	No generative AI was used for conceptualization, analysis, or content generation. AI use was limited to language refinement, and the authors remain fully responsible for the accuracy, originality, validity, and integrity of the manuscript's content.

ABSTRACT

Background: Evidence-based airway management is central to respiratory therapy practice in critical care because decisions concerning airway confirmation, suctioning, cuff management, preoxygenation, non-invasive ventilation, tracheostomy care, and liberation from mechanical ventilation can influence patient safety. **Objective:** To evaluate evidence-based-practice-related knowledge and self-reported airway-management implementation among respiratory therapists working in critical care units across Lahore. **Methods:** A descriptive cross-sectional study included 132 respiratory therapists working in critical care units. A structured questionnaire assessed demographic characteristics, airway-management knowledge, and self-reported implementation. Frequencies and percentages were calculated, and one-way ANOVA was used to compare composite knowledge and implementation scores across selected demographic groups. **Results:** Of 132 participants, 55.3% were male, 78.0% had 1–5 years of experience, 74.2% held a bachelor's degree, and 78.0% reported airway-management certification. End-tidal CO₂ monitoring was selected by 37.9% as the preferred method of endotracheal-tube confirmation, while 66.7% identified 20–30 cmH₂O as the appropriate cuff-pressure range. Closed suction was selected by 69.7%, semirecumbent positioning during non-invasive ventilation by 77.3%, and humidified oxygen through a tracheostomy collar by 94.7%. Knowledge scores differed by experience, $F=3.255$, $p=.042$, while implementation scores differed by age, $F=6.360$, $p=.002$, and qualification, $F=6.342$, $p=.002$. **Conclusion:** Respiratory therapists demonstrated heterogeneous knowledge and self-reported implementation across airway-management domains. Experience, age, and academic qualification were associated with selected composite scores, but the study does not establish causal effects or directly observed adherence to clinical guidelines. **Keywords:** Airway Management; Respiratory Therapists; Evidence-Based Practice; Critical Care; Mechanical Ventilation; Endotracheal Intubation.

INTRODUCTION

Evidence-based practice integrates the best available research evidence with clinical expertise, patient circumstances, and preferences to support clinical decision-making. Within respiratory care, evidence-based practice provides a framework for translating research findings and professional guidance into

bedside assessment, respiratory support, and airway-management decisions (1,2). Respiratory therapists have important responsibilities in airway management, mechanical ventilation, secretion clearance, oxygen therapy, tracheostomy care, non-invasive ventilation, and participation in ventilator-liberation protocols. These responsibilities are particularly important in critical care, where airway interventions are time sensitive and peri-intubation complications may have immediate clinical consequences (3,4).

Evidence-based knowledge does not necessarily translate into consistent implementation. Clark et al. demonstrated variability in evidence-based-practice knowledge, self-efficacy, critical appraisal, and clinical use among respiratory-therapy professionals and learners (2). Translation of complex critical-care evidence into routine clinical practice is influenced not only by individual knowledge but also by education, professional interaction, workflow, protocols, and implementation processes (1,2,5). Consequently, evaluating both knowledge and self-reported implementation is important when examining airway-management practices among respiratory therapists.

Airway management in critically ill patients requires a structured approach that incorporates assessment of airway difficulty, preparation, preoxygenation, airway-device selection, confirmation of tracheal placement, ventilation, hemodynamic support, and contingency planning for failed or difficult airway management (3,6). Confirmation of endotracheal-tube position is a particularly important safety step. Sustained waveform capnography and reliable detection of exhaled carbon dioxide are strongly emphasized for distinguishing tracheal from esophageal placement when technically feasible (7). Preoxygenation is similarly important because critically ill patients may have limited physiological reserve and can develop clinically important hypoxemia during emergency intubation. Recent randomized evidence and evidence synthesis indicate that the choice and adequacy of preoxygenation strategy can materially influence peri-intubation oxygenation, with non-invasive ventilation offering benefit in appropriately selected critically ill adults (8,9).

Artificial-airway suctioning is another core component of respiratory care. Current AARC guidance recommends suctioning when clinically indicated, with attention to secretion burden, catheter dimensions, suction pressure, oxygenation, and the patient's physiological response rather than unnecessary routine suctioning (10). Evidence comparing open and closed suction systems suggests that the selection of system should be individualized rather than assuming that one technique is universally superior for every mechanically ventilated patient (11). Endotracheal cuff management likewise requires a balance between providing an adequate airway seal and avoiding excessive cuff pressure. Objective monitoring is important because sustained control of cuff pressure can reduce periods of underinflation or excessive pressure and may contribute to prevention of airway-related complications (12).

Prevention of ventilator-associated complications has also evolved as evidence has accumulated. Contemporary approaches emphasize avoiding unnecessary intubation, minimizing unnecessary sedation, facilitating early liberation from ventilation, appropriate positioning and mobility, oral care, subglottic secretion management in selected patients, and coordinated evidence-based care bundles (13,14). Routine daily ventilator-circuit changes are not recommended as a VAP-prevention strategy, and chlorhexidine oral care should not automatically be regarded as a universally beneficial stand-alone intervention in all mechanically ventilated populations (13). Non-invasive ventilation can prevent endotracheal intubation in appropriately selected patients with acute respiratory failure, but its effectiveness depends on appropriate indication, interface management, close monitoring, and timely recognition of treatment failure (15).

Liberation from invasive mechanical ventilation is similarly a structured clinical process rather than a decision based on a single numerical variable. Spontaneous-breathing trials are central to assessing readiness for liberation, while respiratory mechanics, gas exchange, neurological status, airway protection, secretion burden, hemodynamic stability, and overall clinical trajectory remain relevant to extubation decisions (16,17). The rapid shallow breathing index may provide additional information, but systematic evidence indicates that it should not be interpreted as an isolated determinant of successful extubation (18). Appropriate humidification is another established component of artificial-airway and mechanical-ventilation care (19). Difficult-airway assessment should likewise use a multidimensional approach because individual bedside predictors such as the Mallampati classification or thyromental distance have limited sensitivity when used alone (6,20,21).

Professional experience, educational preparation, certification, institutional protocols, continuing professional education, and access to implementation support may therefore influence how airway-management evidence is understood and translated into clinical practice (1,2,5). The present study

evaluated airway-management knowledge and self-reported evidence-based practice among respiratory therapists working in critical care units across Lahore and explored differences according to demographic and professional characteristics.

MATERIALS AND METHODS

A descriptive cross-sectional study was conducted among respiratory therapists working in critical care units of hospitals across Lahore, Punjab.

The study duration was four months following institutional approval. The target population was approximately 200 respiratory therapists, from whom 132 participants were recruited using a non-probability sampling approach.

Eligible participants were respiratory therapists working in intensive or critical care areas who had more than one year of clinical experience, were actively involved in airway-management activities, and held a diploma, bachelor's degree, or master's degree in respiratory therapy. Relevant airway-management activities included assistance with intubation, airway suctioning, management of artificial airways, non-invasive ventilation, and mechanical-ventilation-related care.

Respiratory therapists working exclusively in outpatient pulmonary-function testing, home care, administrative or educational roles, trainees, locum staff, and personnel without direct airway-management responsibilities were excluded.

A structured questionnaire was developed with reference to professional respiratory and airway-management guidance covering airway confirmation, artificial-airway suctioning, prevention of ventilator-associated complications, non-invasive ventilation, ventilator liberation, humidification, and difficult-airway principles (6,7,10,13,15,16,19). The questionnaire contained three broad components: demographic and professional information, knowledge-related airway-management questions, and self-reported implementation practices.

A pilot assessment was conducted on a small group of respiratory therapists who were subsequently excluded from the primary study sample. Demographic variables included age, sex, professional experience, designation, qualification, and airway-management certification.

Knowledge and practice items addressed endotracheal-tube confirmation, cuff pressure, suctioning, positioning during non-invasive ventilation, prevention of ventilator-associated complications, extubation readiness, difficult-airway assessment, neuromuscular blockade, oxygen administration through tracheostomy, preoxygenation, and capnography.

Data were summarized using frequencies and percentages. Composite knowledge and implementation scores were compared across selected demographic categories using one-way analysis of variance. Statistical significance was defined as $p < 0.05$.

Ethical approval was obtained from the Institutional Review Board of Superior University, Lahore, Pakistan. Participation was voluntary, written informed consent was obtained, and confidentiality was maintained throughout the study.

RESULTS

A total of 132 respiratory therapists completed the study. Seventy-three participants were male and 59 were female. The majority were aged 20–25 years and had 1–5 years of professional experience.

Table 1. Demographic and Professional Characteristics

Characteristic	Category	n (%)
Sex	Male	73 (55.3)
	Female	59 (44.7)
Age	20–25 years	67 (50.8)
	25–35 years	39 (29.5)
	>35 years	26 (19.7)
Experience	1–5 years	103 (78.0)
	5–10 years	23 (17.4)
	>10 years	6 (4.5)
Designation	Junior respiratory therapist	89 (67.4)
	Senior respiratory therapist	43 (32.6)
Qualification	Diploma	2 (1.5)
	Bachelor's degree	98 (74.2)

Airway-management certification	Master's degree	32 (24.2)
	Yes	103 (78.0)
	No	29 (22.0)

Responses to individual airway-management questions demonstrated substantial variation. End-tidal carbon dioxide monitoring was chosen by 50 participants as the preferred method of endotracheal-tube placement confirmation. Chest radiography was selected by 42 participants and auscultation by 35. Eighty-eight participants identified 20–30 cmH₂O as the target cuff-pressure range.

Table 2. Airway-Management Knowledge and Self-Reported Practice Responses

Domain	Response	n (%)
Preferred ETT-placement confirmation method	ETCO ₂ monitoring	50 (37.9)
	Chest radiograph	42 (31.8)
	Auscultation	35 (26.5)
	Chest rise	5 (3.8)
ETT cuff-pressure range	10–15 cmH ₂ O	29 (22.0)
	20–30 cmH ₂ O	88 (66.7)
	35–40 cmH ₂ O	9 (6.8)
	45–50 cmH ₂ O	6 (4.5)
Airway-suction method	Closed system	92 (69.7)
	Open system	11 (8.3)
	Both equally	8 (6.1)
	Depends on patient condition	21 (15.9)
Position during NIV	Semirecumbent 30–45°	102 (77.3)
	Supine	14 (10.6)
	Lateral	11 (8.3)
	Prone	5 (3.8)
Selected VAP-related intervention	Daily sedation interruption/readiness for extubation	56 (42.4)
	Subglottic secretion drainage	33 (25.0)
	Routine daily ventilator–circuit change	24 (18.2)
	Chlorhexidine oral care	19 (14.4)
Extubation/readiness assessment	SBT and RSBI	105 (79.5)
	SBT alone	13 (9.8)
	RSBI alone	7 (5.3)
	Respiratory rate alone	7 (5.3)
Difficult–airway assessment	Mallampati score	47 (35.6)
	Thyromental distance	6 (4.5)
	Neck circumference	10 (7.6)
	All listed assessments	69 (52.3)
Primary role of neuromuscular blocker	Facilitate endotracheal intubation	92 (69.7)
	Improve oxygenation	19 (14.4)
	Reduce pain	15 (11.4)
	Decrease secretions	6 (4.5)
Oxygen delivery through tracheostomy	Humidified tracheostomy collar	125 (94.7)
	Nasal cannula	4 (3.0)
	Simple mask	2 (1.5)
	Non-rebreather mask	1 (0.8)
Routine preoxygenation	Always	92 (69.7)
	Often	17 (12.9)
	Sometimes	9 (6.8)
	Rarely	6 (4.5)
Capnography for ETT confirmation	Never	8 (6.1)
	Always	40 (30.3)
	Often	27 (20.5)
	Sometimes	21 (15.9)
	Rarely	24 (18.2)
	Never	20 (15.2)

Only 30.3% of participants reported always using capnography for endotracheal-tube confirmation, whereas 15.2% reported never using it.

Additional self-reported implementation responses showed that 80.3% consistently monitored cuff pressure, 63.6% used humidified gases, 40.2% reported chlorhexidine oral care, and 47% reported preference for non-invasive ventilation rather than proceeding directly to intubation where clinically considered.

Composite Knowledge and Implementation Scores

Knowledge scores did not differ significantly by age, designation, or qualification. Knowledge differed across experience categories, $F=3.255$, $p=.042$. Implementation differed significantly according to age and qualification.

Table 3. ANOVA of Knowledge and Implementation Scores

Outcome	Grouping Variable	F	p	η^2
Knowledge	Age	3.033	.052	0.045
Implementation	Age	6.360	.002	0.090
Knowledge	Experience	3.255	.042	0.048
Knowledge	Designation	0.391	.533	0.003
Knowledge	Qualification	0.024	.977	<0.001
Implementation	Qualification	6.342	.002	0.090

The η^2 values for the statistically significant comparisons were 0.048 for knowledge according to experience and 0.090 for implementation according to both age and qualification. Because group-specific mean scores were not available, the direction of these differences could not be determined from the available analysis.

DISCUSSION

The present study identified a mixed pattern of evidence-related knowledge and self-reported airway-management implementation among respiratory therapists working in critical care units in Lahore. Most participants recognized several commonly applied airway-management principles, including the 20–30 cmH₂O cuff-pressure range, use of closed suction systems, semirecumbent positioning during non-invasive ventilation, combined SBT/RSBI assessment, humidified oxygen delivery through a tracheostomy collar, and facilitation of endotracheal intubation as a major role of neuromuscular blockade. Nevertheless, substantial variability was observed in endotracheal-tube confirmation, capnography use, VAP-related practices, preoxygenation, and difficult-airway assessment.

One of the most important findings concerned confirmation of endotracheal-tube placement. Only 37.9% selected end-tidal carbon dioxide monitoring as the preferred confirmation method, and only 30.3% reported always using capnography. This represents an important practice gap because sustained waveform capnography and exhaled-carbon-dioxide detection are strongly emphasized for detecting inadvertent esophageal intubation when reliable CO₂ detection is technically possible (7). Critically ill patients are particularly vulnerable during airway management, and international data demonstrate substantial rates of cardiovascular instability and other adverse peri-intubation events in this population (3,4). Consistent availability, staff familiarity, and protocolized use of waveform capnography should therefore remain priorities in critical-care airway management.

Airway-suctioning responses were comparatively favorable, with 69.7% selecting a closed suction system. However, contemporary AARC guidance emphasizes suctioning according to clinical indication, assessment of secretions and airway patency, appropriate suction pressure and catheter dimensions, and monitoring of physiological responses rather than routine suctioning according to a fixed schedule (10). Evidence comparing closed and open suction systems has not established universal superiority of one system for every clinical circumstance, supporting an individualized approach based on patient condition, infection-control requirements, ventilatory stability, and available equipment (10,11). Similarly, 66.7% correctly identified the commonly used cuff-pressure range and 80.3% reported consistent cuff-pressure monitoring. Maintaining controlled cuff pressure is important because both inadequate and excessive pressure may be clinically undesirable, and continuous or structured cuff-pressure control improves the proportion of time that pressure remains within the intended range (12).

The VAP-related responses require interpretation in the context of changing evidence. Daily assessment for ventilator liberation and appropriate subglottic secretion management remain components of contemporary prevention strategies, whereas routine daily ventilator-circuit changes are not recommended for VAP prevention (13). Chlorhexidine oral care has also undergone substantial reassessment and should not be assumed to be universally beneficial as an isolated intervention in all mechanically ventilated patients (13). Current prevention strategies increasingly emphasize coordinated care bundles that address unnecessary ventilation, sedation, mobility, positioning, oral hygiene, secretion management, and early liberation from invasive ventilation rather than reliance on a single intervention (13,14). The questionnaire findings should therefore be interpreted as reflecting participants'

knowledge of selected airway and VAP-related practices rather than as a direct measure of compliance with one current guideline.

Preoxygenation was reportedly performed routinely by 69.7% of participants. This is clinically relevant because critically ill patients may desaturate rapidly during emergency tracheal intubation, and structured preoxygenation is an important component of airway preparation (3,8). Recent randomized evidence demonstrated clinically meaningful differences between preoxygenation strategies in critically ill adults, and contemporary evidence synthesis supports tailoring the method to the patient's respiratory physiology and risk of hypoxemia (8,9). Similarly, 47% reported preference for non-invasive ventilation rather than proceeding directly to intubation where clinically considered. NIV is evidence based for selected forms of acute respiratory failure, but its use requires appropriate patient selection and close monitoring so that unsuccessful NIV does not delay necessary invasive airway management (15).

Approximately 79.5% of participants selected the combination of spontaneous-breathing trial and rapid shallow breathing index for assessment of extubation readiness. The high recognition of SBT-based assessment is broadly consistent with contemporary ventilator-liberation practice because spontaneous-breathing trials remain central to determining readiness for separation from invasive ventilation (16,17). The RSBI can provide supplementary information; however, its diagnostic performance is insufficient for it to function as an isolated determinant of successful extubation (18). Liberation decisions should therefore remain clinically integrated, incorporating respiratory stability, gas exchange, neurological status, airway protection, secretion burden, hemodynamic stability, and the overall clinical course (16–18).

Difficult-airway assessment also demonstrated variation. Just over half of participants selected the combination of all listed assessments, whereas 35.6% selected the Mallampati score alone. Modern difficult-airway guidance recommends systematic assessment and preparation rather than dependence on a single bedside predictor (6). Large systematic reviews have shown that commonly used tests such as the modified Mallampati assessment and thyromental distance generally have limited sensitivity when used individually, supporting combined evaluation of multiple anatomical and clinical features (20,21). These findings reinforce the importance of teaching difficult-airway assessment as a multidimensional process rather than as a single-test decision.

Professional experience was significantly associated with the composite knowledge score. This finding is compatible with the broader concept that knowledge acquisition and evidence implementation depend on repeated exposure, professional education, access to evidence, and experience applying clinical information to practice (1,2). Clark et al. similarly demonstrated that respiratory-therapy professionals can possess general EBP knowledge while showing variability in self-efficacy, critical appraisal, and actual use of evidence (2). Implementation of complex critical-care practices also depends on educational and organizational processes, suggesting that continuing education alone may be insufficient unless supported by protocols, interprofessional learning, resources, and local implementation systems (5).

Age and academic qualification were significantly associated with implementation scores, although group-specific means were unavailable. Consequently, the present analysis establishes that differences existed among categories but does not identify which age or qualification groups achieved higher implementation scores. These cross-sectional associations should not be interpreted causally. In particular, the predominance of participants with only 1–5 years of experience and the very small number of diploma-qualified participants restricts the stability and generalizability of comparisons involving less-represented professional categories.

Another important limitation is the reliance on self-reported clinical practice. Self-report instruments can be affected by recall and information bias, and participants may not always report clinical behavior in precisely the same way that it occurs during direct observation (22). Consequently, the reported frequencies cannot be interpreted as direct measurements of bedside guideline adherence. Future research could strengthen implementation assessment through structured clinical observation, electronic-record review, simulation-based assessment, equipment-use audits, or prospective quality indicators.

Despite these limitations, the findings identify several practical targets for quality improvement. Greater emphasis is warranted on consistent waveform capnography, structured cuff-pressure monitoring, evidence-aligned airway suctioning, updated VAP-prevention education, systematic preoxygenation, multidimensional difficult-airway assessment, and standardized ventilator-liberation processes (7,10,12,13,16). Educational interventions may be most effective when combined with accessible

protocols, suitable monitoring equipment, regular competency assessment, clinical audit, and interprofessional implementation strategies (1,5).

CONCLUSION

Respiratory therapists working in critical care units across Lahore demonstrated heterogeneous evidence-related knowledge and self-reported airway-management implementation. Many participants identified established airway-management principles, but substantial variability remained in endotracheal-tube confirmation, capnography use, VAP-related practices, preoxygenation, and selected airway-assessment domains.

Professional experience was associated with knowledge scores, whereas age and academic qualification were associated with implementation scores. Because the study was cross-sectional and group-specific means were unavailable, these relationships should not be interpreted as causal or as demonstrating superiority of particular demographic groups.

The findings support targeted continuing professional education, protocol standardization, regular competency assessment, and direct clinical audit, while the questionnaire-based design does not establish objectively observed adherence to airway-management guidelines.

LIMITATIONS

The study used non-probability sampling and was limited to respiratory therapists working in Lahore, which may restrict generalizability to other geographical or institutional settings.

Clinical practice was self-reported rather than directly observed, and the study therefore cannot establish actual bedside adherence to airway-management protocols.

The sample contained relatively few participants with more than 10 years of experience and only two participants with diploma-level education, limiting interpretation of comparisons involving these groups. Composite knowledge and implementation score construction and psychometric characteristics require further validation.

Institution-level differences in equipment availability, staffing, workload, continuing education, and local airway-management protocols were not incorporated into the analysis.

RECOMMENDATIONS

Critical-care departments should periodically audit airway-management practices against current evidence and institutional protocols.

Continuing professional education should emphasize waveform capnography, artificial-airway suctioning, cuff-pressure monitoring, structured preoxygenation, difficult-airway assessment, ventilator liberation, and contemporary prevention of ventilator-associated complications.

Hospitals should combine education with standardized clinical protocols, competency assessment, suitable monitoring equipment, and periodic direct observation or audit of critical airway practices.

Future research should use validated scoring instruments, direct clinical observation, multicenter probability sampling, and institution-level analysis to distinguish knowledge from objectively measured clinical implementation.

REFERENCES

1. Hess DR. Evidence-based respiratory care. *Respir Care*. 2021;66(7):1105-1119. doi:10.4187/respcare.08950.
2. Clark KM, Brown P, Gill D, Karper W. Assessing evidence-based practice knowledge, self-efficacy, and use among respiratory therapists. *Respir Care*. 2024;69(8):913-923. doi:10.4187/respcare.10327.
3. Scott JA, Heard SO, Zayaruzny M, Walz JM. Airway management in critical illness: an update. *Chest*. 2020;157(4):877-887. doi:10.1016/j.chest.2019.10.026.
4. Russotto V, Myatra SN, Laffey JG, et al. Intubation practices and adverse peri-intubation events in critically ill patients from 29 countries. *JAMA*. 2021;325(12):1164-1172. doi:10.1001/jama.2021.1727.
5. Rak KJ, Kahn JM, Linstrum K, et al. Enhancing implementation of complex critical care interventions through interprofessional education. *ATS Scholar*. 2021;2(3):370-385. doi:10.34197/ats-scholar.2020-01690C.
6. Apfelbaum JL, Hagberg CA, Connis RT, et al. 2022 American Society of Anesthesiologists practice guidelines for management of the difficult airway. *Anesthesiology*. 2022;136(1):31-81. doi:10.1097/ALN.0000000000004002.

7. Chrimes N, Higgs A, Hagberg CA, et al. Preventing unrecognised oesophageal intubation: a consensus guideline from the Project for Universal Management of Airways and international airway societies. *Anaesthesia*. 2022;77(12):1395-1415. doi:10.1111/anae.15817.
8. Gibbs KW, Semler MW, Driver BE, et al. Noninvasive ventilation for preoxygenation during emergency intubation. *N Engl J Med*. 2024;390(23):2165-2177. doi:10.1056/NEJMoa2313680.
9. Pitre T, Liu W, Zeraatkar D, et al. Preoxygenation strategies for intubation of patients who are critically ill: a systematic review and network meta-analysis of randomised trials. *Lancet Respir Med*. 2025;13(7):585-596. doi:10.1016/S2213-2600(25)00029-3.
10. Blakeman TC, Scott JB, Yoder MA, Capellari E, Strickland SL. AARC clinical practice guidelines: artificial airway suctioning. *Respir Care*. 2022;67(2):258-271. doi:10.4187/respcare.09548.
11. Kuriyama A, Umakoshi N, Fujinaga J, Takada T. Impact of closed versus open tracheal suctioning systems for mechanically ventilated adults: a systematic review and meta-analysis. *Intensive Care Med*. 2015;41(3):402-411. doi:10.1007/s00134-014-3565-4.
12. Maertens B, Lin F, Chen Y, Rello J, Lathyris D, Blot S. Effectiveness of continuous cuff pressure control in preventing ventilator-associated pneumonia: a systematic review and meta-analysis of randomized controlled trials. *Crit Care Med*. 2022;50(10):1430-1439. doi:10.1097/CCM.0000000000005630.
13. Klompas M, Branson R, Cawcutt K, et al. Strategies to prevent ventilator-associated pneumonia, ventilator-associated events, and nonventilator hospital-acquired pneumonia in acute-care hospitals: 2022 update. *Infect Control Hosp Epidemiol*. 2022;43(6):687-713. doi:10.1017/ice.2022.88.
14. Martinez-Reviejo R, Tejada S, Jansson M, et al. Prevention of ventilator-associated pneumonia through care bundles: a systematic review and meta-analysis. *J Intensive Med*. 2023;3(4):352-364. doi:10.1016/j.jointm.2023.04.004.
15. Rochweg B, Brochard L, Elliott MW, et al. Official ERS/ATS clinical practice guidelines: noninvasive ventilation for acute respiratory failure. *Eur Respir J*. 2017;50(2):1602426. doi:10.1183/13993003.02426-2016.
16. Roberts KJ, Goodfellow LT, Battey-Muse CM, et al. AARC clinical practice guideline: spontaneous breathing trials for liberation from adult mechanical ventilation. *Respir Care*. 2024;69(7):891-901. doi:10.4187/respcare.11735.
17. Fan E, Zakhary B, Amaral A, et al. Liberation from mechanical ventilation in critically ill adults: an official ATS/ACCP clinical practice guideline. *Ann Am Thorac Soc*. 2017;14(3):441-443. doi:10.1513/AnnalsATS.201612-993CME.
18. Trivedi V, Chaudhuri D, Jinah R, et al. The usefulness of the rapid shallow breathing index in predicting successful extubation: a systematic review and meta-analysis. *Chest*. 2022;161(1):97-111. doi:10.1016/j.chest.2021.06.030.
19. American Association for Respiratory Care, Restrepo RD, Walsh BK. Humidification during invasive and noninvasive mechanical ventilation: 2012. *Respir Care*. 2012;57(5):782-788. doi:10.4187/respcare.01766.
20. Wang Z, Jin Y, Zheng Y, Chen H, Feng J, Sun J. Evaluation of preoperative difficult airway prediction methods for adult patients without obvious airway abnormalities: a systematic review and meta-analysis. *BMC Anesthesiol*. 2024;24(1):242. doi:10.1186/s12871-024-02627-1.
21. Roth D, Pace NL, Lee A, et al. Airway physical examination tests for detection of difficult airway management in apparently normal adult patients. *Cochrane Database Syst Rev*. 2018;5(5). doi:10.1002/14651858.CD008874.pub2.
22. Althubaiti A. Information bias in health research: definition, pitfalls, and adjustment methods. *J Multidiscip Healthc*. 2016;9:211-217. doi:10.2147/JMDH.S104807.