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KNOWLEDGE AND PRACTICES REGARDING WEANING CRITERIA OF MECHANICAL VENTILATION AMONG INTENSIVE CARE UNIT NURSES IN TERTIORY CARE HOSPITAL LAHORE

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Abstract

Background:
Mechanical ventilation is a life-saving intervention in critical care, but timely and safe weaning is essential to reduce complications and improve outcomes. Nurses play a central role in the weaning process; however, their knowledge and practice may vary depending on training, experience, and institutional protocols.

Aim:
The study aimed to assess the knowledge and practices of ICU nurses regarding weaning criteria from mechanical ventilation and to explore the association between demographic factors and their knowledge and practice levels.

Methods:
A descriptive cross-sectional study was conducted among 133 ICU nurses working in the Emergency ICU and Cardiac Surgery ICU of a tertiary care hospital. Data were collected using a validated structured questionnaire assessing demographic characteristics, knowledge, and practice regarding weaning criteria. Descriptive statistics, frequencies, percentages, and chi-square tests were applied for analysis.

Results:
The majority of respondents were female (94%), aged 27–31 years (86.5%), and diploma-qualified (83.5%). Knowledge regarding weaning criteria was found to be inadequate, with high error rates in areas such as patient tolerance of spontaneous breathing (66.9% incorrect) and hemodynamic stability (62.4% incorrect). In contrast, practices were largely satisfactory, with strong compliance in essential steps such as oxygen supplementation (100%), documentation (100%), and cuff deflation (100%). Knowledge was significantly associated with age ($p = 0.041$), qualification ($p = 0.018$), and experience ($p = 0.026$), while practice was associated with experience ($p = 0.047$) and department ($p = 0.032$).

Conclusion:
ICU nurses demonstrated strong practical adherence but insufficient theoretical knowledge regarding weaning criteria. Structured training, simulation-based learning, and protocol reinforcement are needed to bridge this gap and optimize patient outcomes.

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INTRODUCTION

The knowledge and practices of nursing play a vital role in achieving patient safety in mechanical ventilation. Other important terms like weaning mean the step-by-step withdrawal of ventilatory care as the patient attains the capacity to breathe on his own. The term criteria refers to the collection of clinical indicators, such as respiratory, hemodynamic, and neurological ones, by which the decision making process is based. The intensive care nurse must observe and apply these requirements to the bedside (Alkubati et al., 2022). Their perception is directly associated with patient outcomes and the success of the mechanical ventilator weaning (Mwakanyanga et al., 2018).

Respiratory illness, trauma and postoperative complications continue to contribute to high global rates of patients in intensive care units who require mechanical ventilation. A substantial fraction of such patients ultimately wean, which may be up to 40 percent of the overall ventilation time. It is assumed that the weaning latency (or latent) could lead to the rise of ICU and mortality (Al-Kubati et al., 2021). The incidence of problematic weaning is between 20 and 30 percent in critically ill populations across the globe. ICU nurses should be able to prevent complications and save lives according to their level of knowledge (Marshoud, 2025).

Mechanical ventilation is a life-saving intervention, which can be dangerous unless it is stopped in time. Extensive ventilation can lead to ventilator-associated pneumonia, muscle weakness and excessive costs. Weaning programs have been shown to prevent such complications (Zeb et al., 2022). The most acute in decreasing the number of undesirable outcomes is the nursing practice and the field of monitoring preparedness and preventing extubation failures, in particular. Inadequate awareness of the evidence-based guidelines has been associated with the inefficient delivery of care (Mwakanyanga et al., 2018).

Mechanical ventilation weaning is a dynamic process, dependent upon the state of the patient, technology and the expertise of the healthcare staff. Successful spontaneous breathing trial, stable oxygen saturation, and stable hemodynamic state are the most popular indicators (Nadeem et al., 2023). Although protocols are available, there are differences in the methods of assessing readiness to wean between nurses. This information gap confirms the reality that ICU nurse training and education needs to be held on a regular basis (Ahmad et al., 2022). The outcome of knowledge improvement is patient safety and timely ventilator disposition (Kumar et al., 2021).

The ability of ICU nurses to make decisions plays a vital role in identifying the early signs of patient preparedness to weaning. The poor knowledge in this area contributes to late extubation, re-intubation, and death. This reduction of the ICU stay and patient outcomes can be attributed to the understanding of the weaning criteria by nurses (Mwakanyanga et al., 2018). Learning theory and applying it to a clinical situation enhances their skill in dealing with complicated situations. The culture of continuous learning in an ICU will improve the weaning practices drastically (Marshoud, 2025).

Training, education, and intervention programs play a vital role in bridging knowledge gaps in nurses working in the ICU. This has been met with simulation and workshops to increase awareness of ventilatory support and preparations to extubate (Kumar et al., 2021). Poor practice in low resource environments is a result of lack of access to guidelines and sufficient development of staff. Other expert training in nursing and ICU also correlates with confidence and standardization of care in the nursing field (Alkubati et al., 2022). Efficiency in the use of ICU resources and patient safety are linked to knowledge-based practices (Nadeem et al., 2023).

Weaning success is not only dependent on physiological readiness, but also on the systematic evaluation of nurses who give round-the-clock care at the bedside. They will investigate clinically significant areas including spontaneous breathing and stable hemodynamics and adequate oxygenation (Blackwood et al., 2019). Any erroneous choice in the process can cause undue delays in the liberation of the ventilator or premature extubation failure (Figueroa-Casas et al., 2019).

The combination of standard weaning guidelines based on nurse training and clinical judgment is crucial in the provision of the best care to patients. It has been shown that institutional commitment to

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training also reduces complications that occur in weaning considerably (Jubran et al., 2017). Reduction in the incidence of ventilator dependence and ICU outcomes, in its turn, may be facilitated by the focus on nurse-initiated interventions (Burns et al., 2021).

Methodology

A descriptive cross-sectional study design was used to assess the knowledge and practices of intensive care unit (ICU) nurses regarding weaning criteria for mechanical ventilation. The study was conducted at a tertiary care hospital in Lahore, Pakistan. The study was carried out over a duration of six months following ethical approval.

The study population consisted of ICU nurses, and a sample size of 133 was calculated using Slovin's formula from a population of 250. A convenience sampling technique was employed to select participants. The inclusion criteria comprised male and female nurses working in the Emergency ICU and Cardiac Surgery ICU. Nurses working outside these ICUs, trainee nurses, and head nurses were excluded.

Data Collection

Data were collected using an adopted questionnaire divided into three sections: Section A (demographic information), Section B (20 knowledge items), and Section C (26 practice items). Permission was obtained from the affiliated academic institution and hospital administration. Written informed consent was obtained from all participants, and confidentiality was maintained. Nurses unwilling to participate were allowed to withdraw at any stage without penalty.

Data Analysis

Ethical approval was granted by the Department of Nursing, Superior University. Participants were assured of confidentiality, voluntary participation, and absence of potential harm. Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 26. Descriptive statistics such as frequencies, percentages, means, and standard deviations were calculated for demographic variables, knowledge, and practices. Cross-tabulations were performed to explore associations between demographic factors (e.g., years of ICU experience, educational qualification, and prior training) and knowledge and practice levels. Inferential statistics, including chi-square tests, were used, with a p-value of <0.05 considered statistically significant.

Results and Analysis

The demographic analysis (Table 4.1) shows that the majority of respondents were female nurses (94%), while only 6% were male, highlighting the gender imbalance in ICU nursing. Most participants belonged to the 27–31 years age group (86.5%), followed by 32–36 years (6.8%), indicating a relatively young workforce. In terms of educational qualification, the majority held a Diploma in General Nursing (83.5%), while only a small proportion had BSN (11.3%) or Post-RN BSN (5.3%), suggesting limited higher education representation. Regarding work experience, almost all respondents (94.7%) had 5–9 years of ICU experience, with very few having less than 4 years. Department-wise, most participants worked in the Emergency ICU (77.4%), while 22.6% were from Cardiac Surgery ICU. These findings indicate that the sample consisted predominantly of young, diploma-qualified, female nurses with moderate ICU experience. [Table 1].

Table 1 Demographic Characteristics of Respondents (n = 133)

Variable	Categories	Frequency (n)	Percentage (%)
Gender	Male	8	6.0
	Female	125	94.0
Age (years)	22–26	5	3.8
	27–31	115	86.5
	32–36	9	6.8
	37–41	4	3.0

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Qualification	Diploma in General Nursing	111	83.5
	BSN (Post RN)	7	5.3
	BSN	15	11.3
Experience (years)	1–4	7	5.3
	5–9	126	94.7
Department	Cardiac Surgery ICU	30	22.6
	Emergency ICU	103	77.4

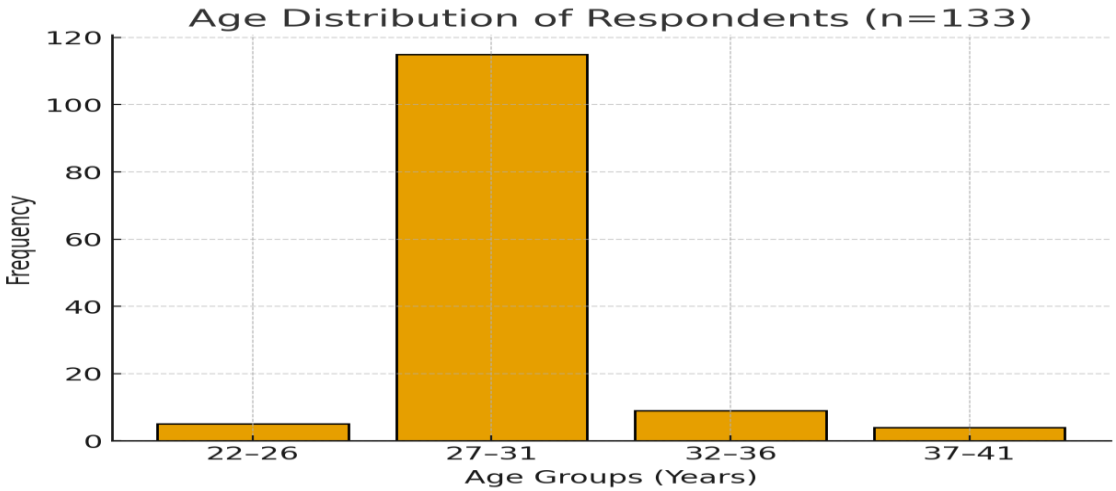

Figure 1 Age distribution of study participants

The majority of respondents (86.5%) were aged 27–31 years, while only a small proportion belonged to the age groups 22–26 (3.8%), 32–36 (6.8%), and 37–41 (3.0%). This indicates that most ICU nurses were relatively young adults in their late twenties to early thirties.

The findings indicate that overall knowledge regarding weaning criteria was inadequate among ICU nurses. More than half of the respondents answered incorrectly in most items, particularly on patient tolerance of spontaneous breathing (66.9% incorrect), hemodynamic stability (62.4%), and respiratory screening (63.2%). Similarly, critical aspects like oxygenation requirements (59.4% incorrect) and anesthesia/sedation strategies for early extubation (59.4% incorrect) were poorly understood. However, better performance was observed in items related to weaning from long-term ventilation (57.1% correct), recommended parameters (57.1% correct), nursing care during weaning (57.1% correct), and identifying indicators of weaning failure (58.6% correct). Only a few items, such as extubation criteria (50.4% correct), showed balanced responses. These results highlight gaps in critical knowledge areas, particularly regarding physiologic criteria and extubation parameters, suggesting a need for targeted training and standardized protocols to strengthen ICU nurses' knowledge. [Table 2].

Table 2 Nurses' Knowledge Regarding Weaning Criteria (n = 133)

Item No.	Knowledge Question (Summary)	Correct n (%)	Incorrect n (%)
Q1	Patient tolerance of spontaneous breathing	44 (33.1)	89 (66.9)
Q2	Adequate oxygenation for weaning	54 (40.6)	79 (59.4)
Q3	Hemodynamic stability criteria	50 (37.6)	83 (62.4)
Q4	Respiratory screening	49 (36.8)	84 (63.2)

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Q5	Problem causing need for MV	60 (45.1)	73 (54.9)
Q6	Spontaneous breathing requirements	54 (40.6)	79 (59.4)
Q7	Weaning from long-term ventilation	76 (57.1)	57 (42.9)
Q8	Ventilator mode requiring weaning	76 (57.1)	57 (42.9)
Q9	Repeat wean attempt after rest	56 (42.1)	77 (57.9)
Q10	Recommended weaning parameters	76 (57.1)	57 (42.9)
Q11	Recommended time for assessment	69 (51.9)	64 (48.1)
Q12	Nursing care during weaning	76 (57.1)	57 (42.9)
Q13	Nursing role during weaning	66 (49.6)	67 (50.4)
Q14	Indicator of weaning failure	78 (58.6)	55 (41.4)
Q15	Failure of spontaneous breathing trial	66 (49.6)	67 (50.4)
Q16	Hemodynamic stability for weaning	56 (42.1)	77 (57.9)
Q17	Best mode after failed weaning	78 (58.6)	55 (41.4)
Q18	Extubation criterion	67 (50.4)	66 (49.6)
Q19	Parameters for extubation	55 (41.4)	78 (58.6)
Q20	Anesthesia/sedation strategies for early extubation	54 (40.6)	79 (59.4)

The results show that ICU nurses generally demonstrated good practices regarding weaning from mechanical ventilation. High compliance was observed in essential areas such as deflating the ETT cuff (100%), providing supplemental oxygen (100%), documentation (100%), encouraging deep breathing (99.2%), oral suctioning and cough encouragement (99.2%), and T-piece connection (99.2%). Similarly, practices like gradually decreasing FiO_2 (97.7%), semi-sitting positioning (97.7%), ABG monitoring (97.7%), smooth ETT removal (97.7%), and preparing extubation equipment (95.5%) were also well followed.

However, notable gaps exist. Only 3.8% of nurses performed chest physiotherapy, while a significant number did not adequately assess hemodynamic stability (25.6% not done) or manage pain/anxiety/agitation (26.3% not done) during weaning. Likewise, hand hygiene compliance was moderate (82.7% done, 17.3% not done). [Table 3].

Table 3 Nurses' Practices Regarding Weaning Criteria (n = 133)

Item No.	Practice Item (Summary)	Done n (%)	Not Done n (%)
P1	Decrease $FiO_2 \leq 40\%$ and PEEP ≤ 5 cmH_2O	109 (82.0)	24 (18.0)
P2	Assess spontaneous breathing trial	111 (83.5)	22 (16.5)
P3	Assess hemodynamic stability	99 (74.4)	34 (25.6)
P4	Manage pain/anxiety/agitation	98 (73.7)	35 (26.3)
P5	Stop sedation & muscle relaxants	129 (97.0)	4 (3.0)
P6	Mouth care & oral suctioning	122 (91.7)	11 (8.3)
P7	Hand hygiene before/after care	110 (82.7)	23 (17.3)
P8	Semi-sitting position 30–45°	130 (97.7)	3 (2.3)
P9	Chest physiotherapy	5 (3.8)	128 (96.2)
P10	Gradually decrease mandatory breathing	127 (95.5)	6 (4.5)
P11	Gradually decrease FiO_2	130 (97.7)	3 (2.3)
P12	Convert to PSV	129 (97.0)	4 (3.0)
P13	Decrease PSV ≤ 10 cm H_2O	127 (95.5)	6 (4.5)
P14	Assess tolerance ≥ 2 hrs	122 (91.7)	11 (8.3)
P15	Check ABGs & adjust MV	130 (97.7)	3 (2.3)
P16	Discontinue MV & connect to T-piece	132 (99.2)	1 (0.8)

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P17	Assess for extubation criteria	129 (97.0)	4 (3.0)
P18	Prepare equipment for extubation/re-intubation	127 (95.5)	6 (4.5)
P19	Place patient in upright sitting	130 (97.7)	3 (2.3)
P20	Oral & ETT suctioning	128 (96.2)	5 (3.8)
P21	Deflate ETT cuff	133 (100)	0 (0.0)
P22	Encourage deep breathing	132 (99.2)	1 (0.8)
P23	Smooth ETT removal	130 (97.7)	3 (2.3)
P24	Suction oral cavity & encourage cough	132 (99.2)	1 (0.8)
P25	Provide supplemental oxygen post-extubation	133 (100)	0 (0.0)
P26	Documentation before, during, after weaning	133 (100)	0 (0.0)

The analysis revealed mixed associations between demographic characteristics and the knowledge/practice levels of ICU nurses regarding weaning criteria. Gender showed no significant association with either knowledge ($p = 0.214$) or practice ($p = 0.387$), indicating similar performance among male and female nurses.

In contrast, age group was significantly associated with knowledge levels ($p = 0.041$), suggesting that knowledge improves with maturity and experience, though no significant effect was observed on practice ($p = 0.072$). Qualification also demonstrated a significant effect on knowledge ($p = 0.018$), where nurses with higher education (BSN/Post RN) tended to score better.

Experience played a critical role, showing significant associations with both knowledge ($p = 0.026$) and practice ($p = 0.047$), confirming that longer ICU experience enhances both theoretical understanding and clinical execution of weaning practices. Moreover, the department variable showed no association with knowledge ($p = 0.154$) but had a significant impact on practice ($p = 0.032$), indicating that the type of ICU setting may shape practical competencies. [Table 4].

Table 4 Association Between Demographic Variables and Knowledge/Practice Levels (n = 133)

Demographic Variable	Knowledge Level (p-value)	Practice Level (p-value)	Significance
Gender (Male vs. Female)	0.214	0.387	NS
Age Group (22–26, 27–31, 32–36, 37–41)	0.041	0.072	Knowledge significant
Qualification (Diploma, BSN Post-RN, BSN)	0.018	0.061	Knowledge significant
Experience (1–4 yrs vs. 5–9 yrs)	0.026	0.047	Both significant
Department (Cardiac Surgery ICU vs. Emergency ICU)	0.154	0.032*	Practice significant

Discussion

The results of this research indicated that most of the ICU nurses had poor knowledge on weaning criteria, especially on patient tolerance of spontaneous breathing, hemodynamic stability, and oxygenation demand. These findings indicate that practical competencies are firmly entrenched in the nursing practices but theoretical knowledge of evidence-based weaning parameters are a gap. A comparable study was conducted by Mostafa Mahrous and Faheem Gendy (2022), who noted that Egyptian ICU nurses exhibited the low level of theoretic understanding of the ventilator weaning requirements even though they are highly engaged in patient work. This is a pointer to an international dilemma whereby clinical practice tends to outweigh conceptual understanding.

Conversely, other authors have reported superior knowledge levels among the ICU nurses in the area

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of weaning of mechanical ventilation. Indicatively, Mohammed et al. (2023) identified that in their study, almost 70 percent of nurses working in ICUs had sufficient knowledge on ventilator care protocols. That gap with the existing results can be explained by the difference in training programs, continuous professional development, or the institutional focus on the protocol-based care. This implies that the gap in the knowledge-performance analysis we witnessed in our context could be affected by inadequate exposure to organized training or by the use of experiential learning.

Surprisingly, knowledge was not so good but the study revealed high compliance with the best practices on the extubation procedures. Adherence to requisite procedures like deflation of the ETT cuff, the provision of supplemental oxygen and proper documentation was nearly universal among the participants. These findings are consistent with Ntelele (2023), who found that bedside practices were usually well-integrated and consistent despite limitations in the awareness of underlying evidence-based criteria in nurses. This demonstrates the importance of institutional routines and checklists in institutionalizing care as a measure to guarantee patient safety even where there is a theoretical gap in knowledge.

The investigation also unveiled the weak areas in the chosen areas of practice, specifically, chest physiotherapy, pain and anxiety management, and the hemodynamic stability assessment. Chest physiotherapy was only 3.8% practised and about a quarter of nurses failed to evaluately measure the hemodynamics and patient discomfort during weaning. The same gap had been previously reported by Shahood (2022), who noted that supportive measures and psychosocial measures were frequently underestimated in respiratory management of the patient. Such omissions may have a negative effect on the outcome of the patients, and it may be worth considering the holistic training that would not be based on technical procedures.

There was no significant gender correlation with respect to knowledge or practice, in line with other researchers that have established the same about gender and its impact on either knowledge or practice in a critical care unit (Hussain et al., 2025). This indicates that training and experience are the two major factors that determine clinical competence in ICU settings and not gender disparity. On the contrary, Alfalih (2024) found minimal gender differences in knowledge and practical intelligence which they explained by the factors of cultural and role distribution in professional groups. We thus find that there is no single factor of gender determinance of weaning competence in our situation.

The correlation between age and the level of knowledge was found to be significant, which shows that maturity could boost conceptual knowledge. This is in line with Abu Farah and Khleif (2024), who established that nurses who were 30 years and older exhibited superior knowledge levels with respect to hemodynamic management as opposed to their younger counterparts. But age did not significantly correlate with practice in the present study. This implies that knowledge can upgrade with age and experience but it is the institutional protocols and standard operating procedures that dictate actual performance rather than experience.

Education level also emerged as a significant determinant of knowledge and BSN and Post-RN nurses were found to have a better knowledge level than diploma-qualified nurses. This observation agrees with Amutalla (2023) who found that academic qualifications above male level had a positive correlation with critical care knowledge of nursing. Nevertheless, there were no dramatic differences in practices between the qualification groups and it was evident that regular operations are more or less standardized despite different educational levels. This means that as the higher education enhances theoretical background, the institutional training balances practice performance.

Experience had a strong influence that presented important correlations between knowledge and practice. Nurses who had increased exposure in the ICU excelled in the two domains. These findings agree with the results of Asmar et al. (2025), who emphasized that one of the most effective predictors of competence in mechanical ventilation and associated critical care practice is clinical experience. The capability of implementing experiential learning into the clinical practice improves decision-making, thus closing the gap between theoretical and procedural gaps in the long run.

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The interesting fact was that departmental placement had a great impact on practice but not knowledge. Nurses of the Emergency ICU showed greater compliance with practical elements of weaning compared with the colleagues of the Cardiac Surgery ICU. This may be explained by high patient turnover and common ventilator weaning procedures in crisis contexts which offer more exposure and skills reaffirmation. The same results were indicated by Hussain and Dioso (2025), who demonstrated that competency and quality-of-life outcomes directly depend on clinical environment and patient load. This brings out the significance of contextual determinants in the development of clinical practices.

The relatively low knowledge scores in the study, as compared to international studies, will imply gaps in continued education and training at the systems level. As another example, a Middle East study conducted by Mostafa Mahrous and Faheem Gendy (2022) showed that the level of nurse knowledge was substantially higher due to the influence of structured guidelines of instruction on ventilator care. This comparison explains the importance of organized professional development in the maintenance of knowledge that is still undeveloped in most low-resource environments of healthcare.

The results also highlight the gap between knowledge and practice, which is broadly addressed in the scholarly literature on nursing education. As far as Benner theory of skill acquisition is concerned, nurses move between novice and expert by learning by experiences and they can sometimes work competently without adequate theoretical basis. Our findings empirically support this model, as they demonstrated that ICU nurses performed well in practice adherence even in the case of poor knowledge. Nonetheless, such recourse to experiential competence can jeopardize flexibility to complex or non-routine cases.

The other significant implication is that there is a risk associated with lack of knowledge in making critical decisions during extubation. Although standardized routines address most weaning factors, judgment areas, including the evaluation of hemodynamic stability and the state of extubation readiness, are affected in cases of poor knowledge. This is aligned with what Abu Farah and Khleif (2024) cautioned that lack of theoretical knowledge may slow down weaning, ventilation and morbidity. So, patient outcomes are to be optimized by means of knowledge improvement.

Lastly, the research implies that research-driven interventions are needed to fill knowledge gaps and support the best practices. Theoretical knowledge and decision-making skills can be enhanced by involving evidence-based training, simulation training, and life-long learning. This suggestion comports with Asmar et al. (2025) results, which added that knowledge and practice in ventilator management are greatly enhanced with structured training. Such approaches can be incorporated in the training programs of ICU nurses to fill the gaps that are evident in this study.

Conclusion

This paper has revealed a big gap between knowledge and practice of ICU nurses on ventilator weaning criterion. Although the participants were highly compliant with the daily routine activities like oxygen supplementation, documentation, and extubation practices, they still lacked appropriate theoretical knowledge of some important concepts, such as the spontaneous breathing tolerance, the hemodynamic stability, and the oxygenation parameters. Age, qualification and experience were strongly linked to knowledge whereas experience and departmental placement influenced practice. The results suggest that the institutional protocols are conducive to the safe and consistent practice, but it is possible that the absence of the solid theoretical foundation undermines clinical decision-making in a non-routine or a complicated scenario. To solve this gap, there should be specific interventions, including structured training, learning through simulation, and ongoing professional development. Increasing both practice and knowledge will see to it that nurses in ICU will be more empowered to maximize patient outcomes in the weaning process.

Recommendations

1. **Strengthen Continuous Professional Development (CPD):** Hospitals should organize regular workshops and refresher courses on ventilator weaning, focusing on evidence-based criteria such as

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hemodynamic stability, oxygenation parameters, and extubation readiness.

2. **Integrate Simulation-Based Training:** High-fidelity simulations should be incorporated into ICU nurse training programs to enhance decision-making in complex weaning scenarios that cannot be fully addressed by protocols alone.
3. **Update Nursing Curricula:** Nursing education institutions should revise curricula to emphasize mechanical ventilation, weaning strategies, and critical care protocols, particularly for diploma-level programs where theoretical grounding may be limited.
4. **Promote Interdisciplinary Collaboration:** ICU teams should implement joint training sessions involving nurses, respiratory therapists, and physicians to ensure uniform understanding and consistent application of weaning protocols.
5. **Develop and Enforce Standardized Protocols:** Hospitals should implement clear, evidence-based weaning protocols with built-in checklists to reduce practice variability and strengthen both knowledge and practice consistency.
6. **Encourage Research and Audit:** Nursing leadership should encourage staff participation in clinical audits and research projects related to ventilator weaning, fostering a culture of continuous learning and practice improvement.

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