DOI: https://doi.org/10.71317/kjard.2.11.2026. 1036

Kashmir Journal of Academic Research and Development

Journal homepage: https://rjsaonline.org/index.php/KJARD

Assessment of Critical Care Nurses' Knowledge Regarding the Prevention of Ventilator-Associated Pneumonia (VAP) in Critical Care Settings

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ARTICLE INFO

Received:
September 31, 2026
Revised:
October 17, 2026
Accepted:
October 30, 2026
Available Online:
November 11, 2026

Keywords:
Ventilator-associated pneumonia, Critical care nurses, Knowledge, VAP prevention, Training, Barriers.

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ABSTRACT

Background: Ventilator-associated pneumonia (VAP) is a common healthcare-associated infection among mechanically ventilated patients. Critical care nurses play an important role in preventing VAP through evidence-based nursing interventions. However, gaps in knowledge and workplace barriers may affect the implementation of preventive measures. **Objective:** To assess critical care nurses' knowledge regarding VAP prevention, determine its association with professional characteristics, and identify perceived barriers to implementing preventive measures. **Methods:** An analytical cross-sectional study was conducted among 57 critical care nurses working in the intensive care unit of a hospital in Lodhran. Data were collected using a structured Google Forms questionnaire covering demographic characteristics, VAP prevention knowledge, and perceived barriers. Knowledge was assessed through 15 True/False questions. Data were analyzed using IBM SPSS Statistics version 26. Descriptive statistics and the chi-square test were used for analysis. **Results:** Among 57 participants, 43.9% demonstrated moderate knowledge, 38.6% had good knowledge, and 17.5% had poor knowledge regarding VAP prevention. The highest percentage of correct responses was observed for hand hygiene (93%), followed by head-of-bed elevation (84.2%) and patient positioning (80.7%). Lower knowledge was observed regarding ventilator circuit changes (45.6%), acid-suppressive drugs (49.1%), and daily sedation interruption (52.6%). The most frequently reported barriers were time constraints (73.7%), staff shortages (70.2%), and high patient-to-nurse ratios (66.7%). A statistically significant association was found between previous VAP prevention training and knowledge level (χ^2 = 12.34, p = 0.002).**Conclusion:** Most critical care nurses demonstrated moderate knowledge regarding VAP prevention, with gaps in specific preventive measures. Regular training, continuous education, and improved institutional support are recommended to strengthen nurses' knowledge and VAP prevention practices.

Introduction

Ventilator-associated pneumonia (VAP) is one of the most common healthcare-associated infections among critically ill patients receiving invasive mechanical ventilation. It develops in patients who have been mechanically ventilated for at least 48 hours and is associated with increased morbidity, prolonged intensive care unit (ICU) stays, higher healthcare costs, and increased risk of mortality. The prevention of VAP has therefore become an important priority in critical care nursing, where nurses play

a central role in implementing evidence-based infection prevention measures and maintaining the safety of mechanically ventilated patients. Despite significant advances in critical care practices, VAP continues to represent a substantial clinical challenge, particularly in healthcare settings where adherence to standardized prevention protocols remains inconsistent.

VAP prevention involves a comprehensive range of evidence-based nursing interventions, commonly organized into ventilator care bundles. These interventions include maintaining appropriate head-of-bed elevation, providing regular oral hygiene, performing appropriate hand hygiene, monitoring endotracheal tube cuff pressure, ensuring proper management of ventilator circuits, and implementing appropriate suctioning techniques. Additional preventive strategies include minimizing unnecessary sedation, assessing readiness for ventilator weaning, and maintaining appropriate infection prevention practices. The effectiveness of these interventions largely depends on healthcare professionals' knowledge, clinical competence, and consistent implementation of recommended guidelines. However, studies have demonstrated considerable variations in nurses' knowledge regarding individual VAP prevention measures, suggesting that awareness of ventilator care protocols does not always translate into comprehensive clinical understanding.

Critical care nurses are particularly important in preventing VAP because they provide continuous bedside care to mechanically ventilated patients and are directly involved in airway management, oral care, secretion clearance, infection control, and ventilator monitoring. Inadequate knowledge of evidence-based preventive practices may result in inappropriate nursing interventions, inconsistent bundle implementation, and increased exposure of critically ill patients to preventable infections . Research conducted among intensive care nurses has identified gaps in their understanding of recommended VAP prevention guidelines, particularly regarding specific preventive procedures and their clinical application. Similarly, studies have highlighted that nurses' knowledge is influenced by professional education, clinical experience, institutional training, availability of resources, and accessibility to updated clinical guidelines . These findings emphasize that VAP prevention is not solely dependent on the availability of protocols but also requires adequate theoretical knowledge and continuous professional development among nursing personnel.

International evidence further highlights variations in critical care nurses' knowledge regarding VAP prevention. A study by Alreshidi et al. examined nurses' knowledge concerning VAP prevention among critically ill patients and emphasized the importance of strengthening nurses' understanding of preventive interventions. Similarly, Akın Korhan et al. assessed the knowledge levels of intensive care nurses and identified the importance of evaluating their understanding of recommended preventive measures. Research conducted by Labeau et al. [15] also demonstrated the need to assess critical care nurses' knowledge of evidence-based guidelines through standardized evaluation approaches. Moreover, Lin et al. identified important considerations regarding nurses' understanding of measures intended to prevent VAP, indicating that knowledge assessment is an essential component of infection prevention strategies. Evidence from Ethiopia by Getahun et al. further highlighted the importance of evaluating intensive care nurses' knowledge in different institutional settings to identify educational and professional development needs.

In addition to knowledge-related challenges, the implementation of VAP prevention measures is influenced by institutional and professional factors. Jansson et al. [13] explored critical care nurses' knowledge, adherence, and perceived barriers to evidence-based VAP prevention guidelines, highlighting the relationship between clinical knowledge and guideline implementation. Similarly, El-Khatib et al. [11] evaluated critical care clinicians' knowledge of evidence-based preventive guidelines, reinforcing the importance of standardized education and professional competency. Studies conducted in India by Kalyan et al. [14] and Bhandari et al. [10] also examined nurses' knowledge and practices regarding VAP prevention bundles, demonstrating the relevance of assessing preventive competencies across different critical care environments. Furthermore, Aziz et al. [4] investigated ICU nurses' knowledge and practices concerning ventilator bundles in Pakistan, providing contextually relevant evidence regarding the importance of nursing knowledge in preventing ventilator-associated infections.

In Pakistan, the prevention of VAP remains an important concern for critical care services, particularly in hospitals where mechanically ventilated patients require continuous nursing surveillance and comprehensive infection prevention practices. Meherali et al. [17] examined nurses' knowledge of evidence-based guidelines for VAP prevention in critical care areas through a pre- and post-test design, emphasizing the importance of educational interventions in improving nurses' understanding. Similarly, Aziz et al. [4] assessed ICU nurses' knowledge and practices regarding ventilator care bundles, highlighting the need to evaluate nursing competencies in the Pakistani healthcare context. However, critical care environments differ in terms of staffing patterns, availability of training opportunities, institutional policies, workload, and access to updated clinical guidelines. These differences may influence nurses' understanding and application of recommended VAP prevention measures.

The broader infection prevention context also emphasizes the importance of nurses' knowledge and adherence to standardized clinical practices. Research examining infection prevention knowledge and practices among ICU nurses in Punjab has highlighted the relevance of strengthening infection control competencies within critical care settings . Similarly, Danish et al.

examined nurses' knowledge and practices regarding safe medication administration, demonstrating the broader importance of assessing nursing knowledge in relation to patient safety. These areas of nursing competency are particularly relevant in critical care environments, where multiple clinical interventions are performed simultaneously and even minor deviations from established protocols may compromise patient safety. Therefore, assessing nurses' knowledge of VAP prevention is an essential step toward identifying educational gaps and improving the quality of critical care nursing.

Collectively, the available literature indicates that nurses' knowledge regarding VAP prevention is influenced by educational background, professional experience, clinical training, institutional support, and familiarity with evidence-based guidelines. Although several international studies have examined VAP prevention knowledge among critical care nurses, there remains a need for further context-specific research in Pakistan, particularly in South Punjab. Limited regional evidence systematically evaluates critical care nurses' knowledge of recommended VAP prevention measures and identifies potential gaps in their understanding of evidence-based preventive practices. Assessing these knowledge gaps is essential for developing targeted educational interventions, strengthening infection prevention policies, and improving the quality and safety of nursing care provided to mechanically ventilated patients.

Objectives of the Study

i. To assess critical care nurses' knowledge regarding the prevention of ventilator-associated pneumonia (VAP).

ii. To determine the association between nurses' demographic and professional characteristics and their knowledge of VAP prevention.

iii. To identify barriers affecting the implementation of VAP prevention measures among critical care nurses.

Research Questions

i. What is the level of knowledge of critical care nurses regarding VAP prevention?

ii. Is there an association between nurses' demographic and professional characteristics and their knowledge regarding VAP prevention?

iii. What are the perceived barriers affecting VAP prevention among critical care nurses?

Methodology

Study Design and Setting

An analytical cross-sectional study was conducted among critical care nurses working in ICU of XXX hospital. The study assessed nurses' knowledge of VAP prevention, related professional factors, and perceived barriers.

Study Population and Sampling

The sample size was calculated using Cochran's formula for a cross-sectional study. A 90% confidence level was considered, with a Z-score of 1.645, an anticipated population proportion (p) of 0.70, and an absolute precision (d) of 0.10 (10%). Based on these parameters, the calculated sample size was approximately 57 participants. Therefore, the final sample size for this study was determined to be 57 participants.

Inclusion Criteria

- Registered nurses working in ICUs.
- At least six months of ICU experience.
- Willingness to participate and provide electronic consent.
- Ability to understand the questionnaire in English or Urdu.

Exclusion Criteria

- Nursing students, interns, and trainees.
- Nurses on extended leave.
- Nurses who declined participation or submitted incomplete questionnaires.

Data Collection Instrument

Data were collected through a structured Google Forms questionnaire consisting of three sections:

Section A: Demographic Information

Age, gender, nursing qualification, ICU experience, and previous VAP prevention training.

Section B: Knowledge Regarding VAP Prevention

This section contained 15 True/False questions covering hand hygiene, head-of-bed elevation, oral care, suctioning, ventilator circuit management, sedation practices, and other VAP prevention measures.

Each correct answer received one point, while incorrect or unanswered responses received zero points.

Section C: Perceived Barriers

This section assessed barriers such as staff shortages, inadequate resources, high patient-to-nurse ratios, time constraints, insufficient training, limited administrative support, and lack of updated guidelines.

Data Collection Procedure

Data were collected through Google Forms. Electronic informed consent was obtained before participants accessed the questionnaire. Participation was voluntary, and responses were collected anonymously and kept confidential.

Data Analysis

Data were analyzed using IBM SPSS Statistics version 26. Frequencies and percentages were calculated for categorical variables, while means and standard deviations were used for knowledge scores.

Chi-square tests were used to examine associations between participant characteristics and knowledge levels. Independent t-tests or ANOVA were applied where appropriate. A p-value below 0.05 was considered statistically significant.

Ethical Considerations

Ethical approval and institutional permissions were obtained before data collection. Electronic informed consent was taken from all participants. Participation was voluntary, confidentiality was maintained, and data were used only for research purposes.

Study Variables

Dependent Variable: Knowledge regarding VAP prevention.

Independent Variables: Age, gender, nursing qualification, ICU experience, and previous VAP training.

Additional Variables: Perceived barriers to VAP prevention.

Knowledge Scoring Criteria

Each correct answer was assigned one point, while incorrect or unanswered responses received zero points. The total knowledge score was calculated as a percentage by dividing the number of correct answers by the total number of questions and multiplying by 100. Based on the overall score, knowledge levels were classified as good (≥75%), moderate (50-74%), and poor (<50%).

Results

Demographic Characteristics of Participants

Table 3.1 presents the demographic characteristics of the study participants. The majority of nurses were aged 26-30 years (35.1%), followed by 31-35 years (26.3%) and 20-25 years (21.1%). Most participants were female (86%). Regarding educational qualifications, over half held a BSN degree (52.6%), while 31.6% held a Diploma and 15.8% held an MSN degree. In terms of ICU experience, the largest group had 4-6 years of experience (31.6%). Furthermore, only 42.1% of participants had received formal VAP prevention training.

Table .1 | Demographic Profile of ICU Nurses (n=57)

Variable	Category	Frequency	Percentage
Age	20-25	12	21.1
	26-30	20	35.1
	31-35	15	26.3
	36-40	7	12.3
	>40	3	5.3
Gender	Male	8	14.0
	Female	49	86.0
Qualification	Diploma	18	31.6
	BSN	30	52.6
	MSN	9	15.8
ICU Experience	Less than 1 year	5	8.8
	1-3 years	15	26.3
	4-6 years	18	31.6
	7-10 years	12	21.1
	More than 10 years	7	12.3
VAP Training	Yes	24	42.1
	No	33	57.9

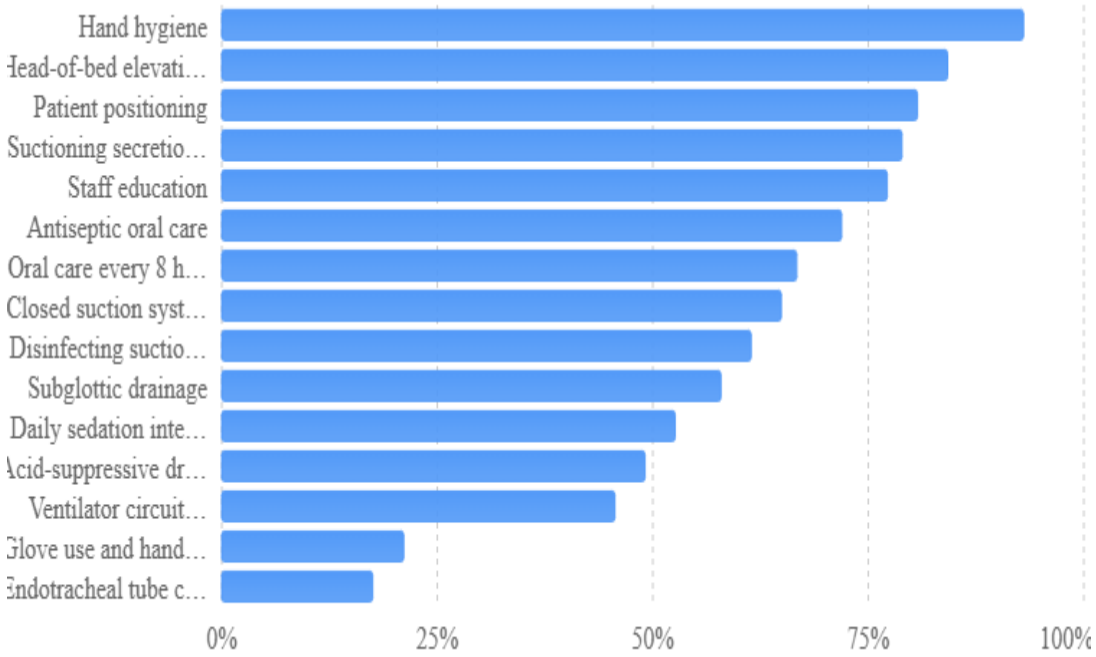
Interpretation: Most participants were female (86%), aged 26-30 years (35.1%), and held a BSN degree (52.6%). Only 42.1% had received formal VAP prevention training.

Knowledge Regarding VAP Prevention

Figure .1 illustrates the percentage of correct responses regarding different VAP prevention measures among ICU nurses. The highest knowledge was observed for hand hygiene (93%), followed by head-of-bed elevation (84.2%) and patient positioning (80.7%). However, knowledge was comparatively lower regarding daily sedation interruption (52.6%), acid-suppressive drugs (49.1%), and regular ventilator circuit changes (45.6%).

Figure 1 | Knowledge of ICU Nurses Regarding VAP Prevention (n=57)

Percentage of participants providing correct responses to each knowledge item.



Interpretation: The findings indicate that nurses demonstrated good knowledge of basic VAP prevention practices, particularly hand hygiene and head-of-bed elevation. However, knowledge gaps were observed in several other preventive measures, highlighting the need for continuous education and training.

Overall Knowledge Score

The overall knowledge assessment revealed that 25 nurses (43.9%) had moderate knowledge, 22 (38.6%) had good knowledge, and 10 (17.5%) had poor knowledge.

Figure 2 | Overall Knowledge Level of ICU Nurses (n=57)



■ Good (≥75%)

■ Moderate (50-74%)

■ Poor (<50%)

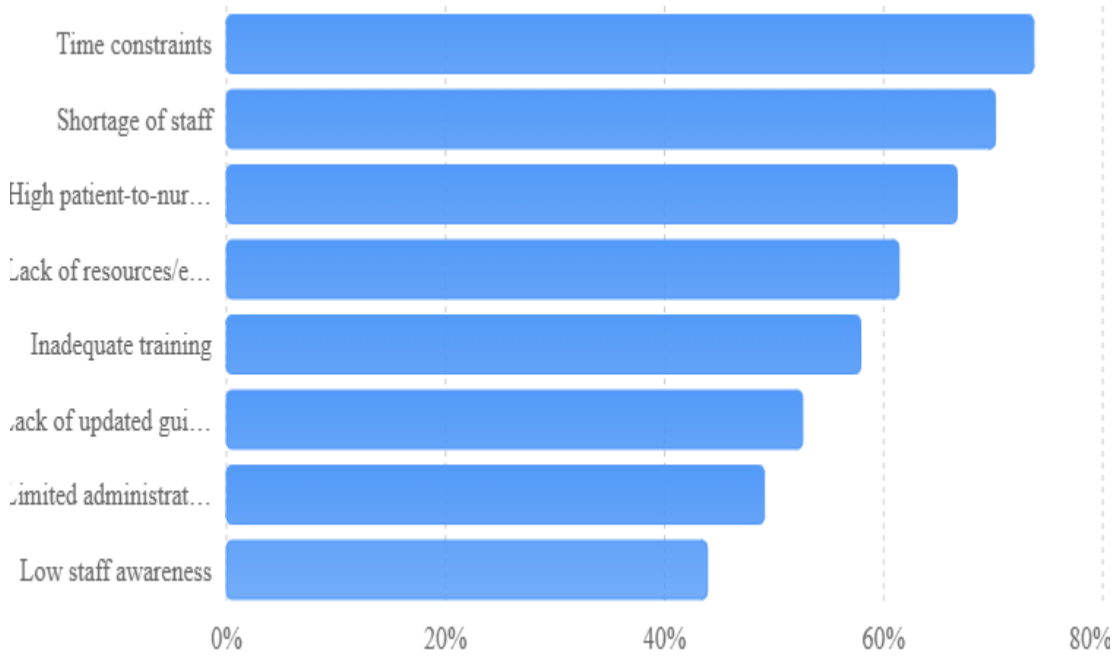
Interpretation: The majority of nurses (43.9%) demonstrated moderate knowledge regarding VAP prevention, indicating a need for further educational interventions to improve their knowledge.

Barriers to VAP Prevention

Figure 3 presents the perceived barriers to implementing VAP prevention measures among ICU nurses. Time constraints were the most frequently reported barrier (73.7%), followed by staff shortages (70.2%) and a high patient-to-nurse ratio (66.7%). Other commonly reported barriers included a lack of resources or equipment (61.4%), inadequate training (57.9%), and a lack of updated guidelines (52.6%).

Figure 3 | Perceived Barriers to VAP Prevention Among ICU Nurses (n=57)

Percentage of nurses reporting each barrier to VAP prevention.



Interpretation: Time constraints (73.7%) and staff shortages (70.2%) were the most commonly reported barriers. These findings suggest that workload, inadequate staffing, and limited resources may negatively affect the implementation of VAP prevention practices in ICU settings.

Association Between VAP Training and Knowledge Level

The association between previous VAP training and nurses' knowledge levels was examined. Among nurses who had received VAP training (n=24), 62.5% demonstrated good knowledge, 33.3% had moderate knowledge, and only 4.2% had poor knowledge. In comparison, among nurses without previous training (n=33), 21.2% demonstrated good knowledge, 51.5% had moderate knowledge, and 27.3% had poor knowledge.

Table .2 | Association Between VAP Training and Knowledge Level (n=57)

VAP Training	Good Knowledge	Moderate Knowledge	Poor Knowledge	Total
Yes	15 (62.5%)	8 (33.3%)	1 (4.2%)	24
No	7 (21.2%)	17 (51.5%)	9 (27.3%)	33
Total	22	25	10	57

Chi-square test: $\chi^2 = 12.34$, df = 2, $p \approx 0.002$.

Interpretation: Nurses who had received formal VAP training were more likely to demonstrate good knowledge than those without training (62.5% versus 21.2%). The association was statistically significant (p less than 0.01), suggesting that formal training plays an important role in improving nurses' knowledge regarding VAP prevention.

Conclusion

This study assessed critical care nurses' knowledge regarding the prevention of ventilator-associated pneumonia (VAP) and identified the barriers affecting the implementation of preventive measures. The findings showed that most nurses had moderate knowledge (43.9%), followed by good knowledge (38.6%), while 17.5% had poor knowledge. Similar findings have been reported in previous studies, which also identified variations in nurses' knowledge regarding VAP prevention.

Nurses demonstrated better knowledge of basic preventive measures, particularly hand hygiene (93%), head-of-bed elevation (84.2%), and patient positioning (80.7%). However, knowledge gaps were identified regarding ventilator circuit management (45.6%), acid-suppressive drugs (49.1%), and daily sedation interruption (52.6%). These findings are consistent with previous research highlighting gaps in critical care nurses' understanding of evidence-based VAP prevention guidelines. Similar knowledge gaps have also been reported among critical care nurses in other settings.

The study also identified time constraints (73.7%), staff shortages (70.2%), and high patient-to-nurse ratios (66.7%) as the major perceived barriers to implementing VAP prevention measures. These findings are supported by previous research, which identified organizational and workplace-related barriers affecting nurses' adherence to evidence-based VAP prevention guidelines . Furthermore, a statistically significant association was found between previous VAP prevention training and nurses' knowledge levels ($\chi^2 = 12.34$, $p = 0.002$). Nurses who had received previous training were more likely to demonstrate good knowledge than those without training. This supports the importance of educational interventions in improving nurses' knowledge of VAP prevention.

In conclusion, the findings indicate that critical care nurses have a reasonable understanding of basic VAP prevention measures, but important knowledge gaps and workplace barriers remain. Regular educational programmes, updated clinical guidelines, adequate staffing, and institutional support are needed to strengthen VAP prevention practices and improve the quality of care provided to mechanically ventilated patients.

Recommendations

Based on the study findings, the following recommendations are proposed:

i. **Regular Training:** Conduct regular training sessions on evidence-based VAP prevention guidelines.

ii. **Continuous Education:** Focus on knowledge gaps, particularly sedation management and ventilator circuit care.

iii. **Updated Guidelines:** Ensure the availability of updated VAP prevention protocols in ICUs.

iv. **Practical Training:** Provide hands-on training to improve nurses' clinical competency.

v. **Further Research:** Conduct similar studies in multiple hospitals with larger sample sizes.

Limitations of The Study

The study had the following limitations:

Small Sample Size: Only 57 nurses participated, limiting the generalizability of the findings.

Cross-Sectional Design: Data were collected at one point in time; therefore, causal relationships could not be established.

Self-Reported Data: Responses were collected through Google Forms and may reflect individual interpretations.

Limited Generalizability: Differences in staffing, resources, and institutional policies may affect the applicability of findings to other hospitals.

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