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Original Article

Assessment of Intensive Care Nurses' Knowledge of Evidence-Based Practices for Preventing Ventilator-Associated Pneumonia in Duhok City

Amar Khalid Saber; *Department Pediatric Nursing, College of Health and Medical Techniques|Shekhan, Duhok Polytechnic University, Kurdistan Region, Duhok, Iraq* (Correspondence: ammar.sabir@dpu.edu.krd)
Khalid Ibrahim Mohammed Saber; *Department of Nursing, College of Nursing, University of Duhok, Kurdistan Region, Duhok, Iraq .*
Salar Omar Abdulqadir; *Department of Nursing, College of Nursing, University of Raparin, Rania, Sulaymaniyah, Kurdistan Region, Sulaymaniyah, Iraq .*

ABSTRACT

Backgrounds and Objectives: A common hospital-acquired illness that affects patients who are seriously ill from mechanical ventilation and intubation is ventilator-related pneumonia. A lack of understanding may limit nurses' adherence to evidence-based guidelines for preventing ventilator-associated pneumonia. This study aimed to assess the knowledge of those nurses who are working in the intensive care unit about mechanical ventilator-related pneumonia prevention.

Methods: A descriptive cross-sectional study was carried out in the 144 intensive care nurses' units of major hospitals in Duhok City from 1 June through 31 December in 2025. Data were obtained using a structured questionnaire consisting of 4 demographic items and 17 knowledge-based questions adapted from a validated tool and supplemented by researcher-developed items. Independent sample t-tests, one-way ANOVA, and multiple regression were used in conducting inferential analysis.

Results: A total of 114 intensive care unit nurses were involved in the study; the majority of the participants were female (64.0%), and most of them had bachelor's degrees (81.6%). In terms of overall knowledge about the prevention of ventilator-related pneumonia, 61.40% of participants in the present study were found to have poor knowledge (their scores were below 60).

Conclusions: Participants with higher degrees and those who had finished ICU training programs showed greater knowledge. These results point out the need for ongoing education, ICU-specific training, and frequent refresher courses to enhance nurses' skills and expertise. Patient safety, the incidence of ventilator-associated pneumonia, and the standard of care in intensive care units can all be improved by strengthening nursing education, implementing standardized ventilator -associated pneumonia prevention guidelines, and encouraging advanced training.

Keywords: Knowledge; Nurse; Critical Care Unit; Ventilator-related Pneumonia; Prevention

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INTRODUCTION

After 48 hours of being connected to a ventilator, a patient may develop pneumonia caused by the machine (1). One of the most prominent infections acquired in intensive care units (ICUs) and the primary cause of death for patients hospitalized in ICUs is ventilator-associated pneumonia (VAP) (2). If bacteria penetrate into the ventilator's oxygen-supplying tube and enter the patient's lungs, it might become a gateway to infection. In critically ill patients, endotracheal (ET) intubation is the main risk factor for VAP. Mucociliary clearance hinders coughing and makes it easier for bacteria-laden secretions to microaspirate above the endotracheal tube cuff. The ET tube also compromises the airway's defenses. Therefore, the first ten days following intubation are when there is the greatest risk of VAP. The hallmark signs and symptoms of pneumonia caused by a ventilator in a patient who ison a ventilation machine include changes in a respiratory parameter such as increasing hypoxemia and purulent discharges, leukocytosis, fever, and a chest X-ray showing new or progressive widespread infiltration (3).

VAP is the most prevalent hospital-acquired illness among patients on mechanical ventilation, according to the World Health Organization (2021). In a comparable direction, about 28% of patients on mechanical ventilationreceive VAP. Depending on the location and diagnostic criteria, the incidences range widely from 5% to 40%. Therefore, VAP is linked to extended hospital stays and the length of mechanical breathing (3). Furthermore, an estimated 10% of patients died from pneumonia caused by ventilator machines. This is greater than the death rates of patients with mid-range severity scores and those in the surgical intensive care unit (4).

Unquestionably, preventing pneumonia caused by ventilator machines in patients whoare on ventilators continues to be a significant clinical issue linked to high hospital expenses, high rates of morbidity, death, and longer hospital stays (5). VAP preventive measures must be maintained until critical patients are extubated, starting with intubation. As a result, nurses must have a thorough understanding of how ventilated patients develop VAP. Because of this, critical care nurses are crucial to the prevention of VAP. In patients who are on a mechanical ventilator, the early warning signs and symptoms nurses must identify will lower the hazard issue and help diagnose pneumonia causedby the ventilator. Critical care nurses must also regularly convert evidence-based results into care for ventilated patients and follow evidence-based protocols to prevent VAP. The bundle checklist for nurses is one of the tools and guidelines that the Centers for Disease Control and Prevention (2021) offers the medical society to help eliminate VAP instances. The Institute for Healthcare Improvement (2021)a bundle checklist, simple collection of tried-and-true, evidence-based procedures. The bundle includes five elements: efforts made each day to test the discontinuation of sedation along with determining if the patient is ready for liberation from mechanical ventilation; keeping the head of the bed elevated to 30-45 degrees; prophylaxis for peptic ulcer disease; prophylaxis for deep vein thrombosis; and daily oral care with chlorhexidine, which has been part of the bundle since 2010 (6). VAP is one of the most notable intensive care unit (ICU)-acquired infections and the leading cause of death among patients admitted to intensive care units (2).Through the implementation of evidence-based strategies that lower infection risk and enhance patient outcomes, nurses play a critical role in avoiding Ventilator-Associated Pneumonia (VAP).

As the primary caretakers at the patient's bedside, nurses ensurethat hand hygiene is strictly followed, that the head of the bed is raised appropriately, that antiseptic solutions are regularly used for oral care, and that airway secretions are managed with sterile suctioning techniques (7). Through arranging daily sedation interruptions and assessment of readiness for extubation, they also contribute to reducing the amount of time spent on mechanical ventilation. Further duties encompass upholding the integrity of ventilator circuits, encouraging early mobilization, and ensuring compliance with established VAP prevention protocols. Through consistently monitoring these practices and applying them reliably, nurses effectively reduce the occurrence of VAP and enhance patient safety overall (8). The purpose of this study was assessing the awareness of intensive care nurses regarding the prevention of ventilator-associated pneumonia.

METHOD

A cross-sectional and descriptive study design was used to evaluate the knowledge of intensive care nurses regarding the prevention of ventilator-associated pneumonia (VAP) from 1 June to 31 December 2025.The study was conducted in various ICUs across major hospitals, including Azadi Teaching Hospital, the Cardiac Center, Heave Pediatric Teaching Hospital, and the Emergency Teaching Hospital in Duhok City. The sample size was all nurses working in the intensive care unit, but those who had less than three months of experience, were not present during data collection, or did not consent were excluded. Data was collected from August 1 to November in 2025 through a structured questionnaire comprising two sections: Section A contained four demographic questions, which was created by the researcher to meet the study's objectives.

While Section B included 17 items assessing nurses' knowledge of VAP prevention. Several of these items were adapted from a validated questionnaire developed by Labeau et al., 2007 (9).The study's instrument for gathering participant data was a sociodemographic part, which was developed by researchers, and the standardized self-administered questionnaire, which was adapted from a previously validated (standardized) questionnaire with minor modifications to suit the study objectives. The objective of the questionnaire was to gather demographic data and evaluate nurses' knowledge about ventilator-associated pneumonia. Section A contained four demographic questions, like sex, educational level, ICU training, and years of experience distributed as 1-5 years, 6-10 years, and more than 10 years. Section B comprised standardized knowledge-based questions focusing on ventilator-associated pneumonia prevention and ncluded 17 items of a questionnaire that were used to assess nurses' knowledge of VAP prevention. Several of these items were adapted from a validated questionnaire developed by Labeau et al., 2007 (9), with additional items created by the researcher to meet the study's objectives. The questionnaire covered topics such as hand hygiene, oral care, patient positioning, ventilator care bundles, suctioning techniques, a daily attempt to pause sedation, and a readiness-to-wean from ventilator assessment, also known as atrial weaning. Each knowledge item has four possible answers for assessment, like "I never do it," "I seldom do it," "I mostly do it," and "I always do it. The dependent variable is the primary variable about the knowledge of intensive care unit nurses regarding ventilator-associated pneumonia. This variable was used to measure and evaluate the nurse's knowledge regarding ventilator-associated pneumonia preven-

The degree of knowledge was evaluated by a standardized questionnaire; the resulting findings were classified into good and poor knowledge. The independent variable in the study consists of the demographic characteristics of the participants, which are used to gather information about them and to determine if there is a relationship between this information and the level of the nurses' knowledge regarding VAP prevention. Understanding all these variables is important for identifying the gap in nurses' knowledge levels regarding ventilator-associated pneumonia. The general directorate of health in the Duhok governorate provided the college approval letter and research ethics committee on 23 December 2024. We made it in two parts according to time; the first part started earlier than the second part. In the second part, we considered the actual study from Jun 2025. With the reference number 23122024-11-2, for the conduct of the study. Participants' privacy was preserved, and they gave both verbal and written agreement. Statistical analysis in SPSS version 27 and JASP version 0.95.4 was performed. The Kolmogorov–Smirnov test was employed to assess the normal distribution of the distance variables evaluated in this study, and all variables conformed to a normal distribution. The Bloom's taxonomy approach was utilized to classify the participants' overall knowledge, with scores below 60 being poor, scores from 60 to 79 considered moderate, and scores of 80 and above classified as good knowledge (10). To assess the significant differences in sociodemographic baseline characteristics of participants and their knowledge regarding Ventilator-Associated Pneumonia (VAP) Prevention Bundle Compliance scores, the independent t-test was employed to compare the means of two independent variables, while the one-way ANOVA test was utilized for comparisons of variables with more than two independent variables. Moreover, multiple linear regression was used to identify predictive factors for knowledge toward ventilator-associated pneumonia (VAP) prevention bundle compliance The p-value was set at ≤0.05 for statistical significance.

RESULTS

Table 1: Baseline socio demographic characteristics of the participants (no. 114).Put the table here The present study revealed that 64% of the participants were female. Among them, a significant majority, 81.6%, held bachelor's degrees. Additionally, 56.1% had not previously completed ICU training courses, and 57% had 6-10 years of professional experience.

Table 1: Baseline socio demographic characteristics of the participants (no. 114).

Variables	Items	F. (%)
Sex	Male	41 (36)
	Female	73 (64)
Educational level	Diploma degree	17 (14.9)
	Bachelor degree	93 (81.6)
	Master degree	4 (3.5)
ICU Training	Yes	50 43.9)
	No	64 (56.1)
Years of work experience as a critical care nurse?	1-5	33 (28.9)
	6-10	65 (57)
	>10	16 (14)

F: frequency; %: percentage

Table 2: Ventilator-Associated Pneumonia (VAP) Prevention Bundle Compliance Checklist items distribution (no. 114).Put the table hereThe table above illustrates the distribution of items within the study sample. Specifically, 36.8% of participants reported elevating the head of the bed at an angle of 30–45 degrees; however, 41.2% answered that they do not routinely monitor and regulate tracheal cuff

pressure with a manual manometer. Furthermore, they refrain from changing the ventilator circuit when it is contaminated or physically defective, nor do they utilize the oxygen tube, mask, and ambu bag assigned to one patient for another person. Moreover, 36% of participants infrequently verify the correct placement of the nasogastric tube, administer oral care with chlorhexidine, or perform oral care every 4 –8 hours, and they avoid using the oxygen tube, mask, and Ambu bag designated for one patient on another. 40.4% of participants confirm that they clean secretions from the upper tube cuff before deflating, repositioning, or changing the patient's posture, and they do daily natural breathing trials. Furthermore, 35% of participants conduct daily spontaneous awakening trials with sedatives discontinued. 35% infrequently adhere to aseptic technique during the management of the tracheostomy site and the replacement of the tracheostomy tube.In conclusion, 33.3% of individuals utilize sterile water for filling ventilator humidifiers, and in cases involving an open suction system, a sterile disposable suction catheter and sterile water should be employed for each suction

Table 2: Ventilator-Associated Pneumonia (VAP) Prevention Bundle Compliance Checklist items distribution (n= 114).

Item	I Never Do It No. (%)	I Seldom Do It No. (%)	I Mostly Do It No. (%)	I Always Do It No. (%)
Except for contraindicated patients, elevate at an angle of 30–45 degrees the head of the bed	19 (16.7)	27 (23.7)	42 (36.8)	26 (22.8)
Cuff pressure should be maintained at 20–30 cm H2O	31 (27.2)	33 (28.9)	34 (29.8)	16 (14)
Regularly check and control of tracheal cuff pressure using a manual manometer	47 (41.2)	36 (31.6)	26 (22.8)	5 (4.4)
Regularly check the proper positioning of the nasogastric tube	16 (14)	41 (36)	35 (30.7)	22 (19.3)
Oral care is performed with chlorhexidine (0.12% or 2%)	19 (16.7)	41 (36)	28 (24.6)	26 (22.8)
Oral care is performed every 4–8 h	26 (22.8)	41 (36)	31 (27.2)	16 (14)
Perform subglottic secretion suction (subglottic secretion: oropharyngeal secretions in the subglottic region above the cuff of the endotracheal tube)	31 (27.2)	38 (33.3)	29 (25.4)	16 (14)
Before deflating the cuff of an endotracheal tube, before moving the tube, or patient position change ensure that secretions are cleared from above the tube cuff	11 (9.6)	39 (34.2)	46 (40.4)	18 (15.8)
Except for contraindicated patients, daily perform spontaneous awakening trials with sedatives turned off	11 (9.6)	36 (35)	35 (30.7)	32 (28.1)
Daily perform spontaneous breathing trials once a day	9 (9)	38 (33.3)	46 (40.4)	21 (18.4)
Change the ventilator circuit when it is visibly soiled or mechanically malfunctioning	15 (13.2)	34 (29.8)	47 (41.2)	18 (15.8)
Do not flush condensate water from the ventilator circuit into the machine or onto the patient	14 (12.3)	37 (32.5)	42 (36.8)	21 (18.4)
Use sterile water to fill ventilator humidifiers	10 (8.8)	34 (29.8)	38 (33.3)	32 (28.1)
In patients using an open suction system, use a sterile disposable suction catheter and sterile water for each suction.	38 (33.3)	33 (28.9)	24 (21.1)	19 (16.7)
In patients using a closed suction system, a closed suction catheter should be used for each new patient	28 (24.6)	30 (26.3)	35 (30.7)	21 (18.4)
Observe aseptic technique when managing the tracheostomy site and replacing the tracheostomy tube	9 (7.9)	35 (30.7)	40 (35.1)	30 (26.3)
Do not use the oxygen tube, mask, and ambu bag used for one patient on another patient.	4 (3.5)	22 (19.3)	47 (41.2)	41 (36)

No: number, %: percentage

Figure 1 illustrates that 61.40% of the study participants showed a low level and 19.30% showed moderate and high levels of knowledge.

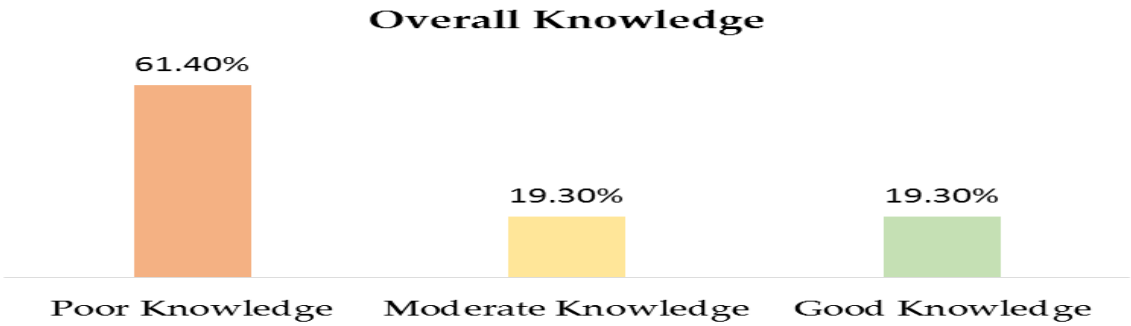

Figure 1: The overall knowledge of the participants (no.114)

Table 3: The comparison between socio-demographic characteristics and knowledge scores (no. 114).Put the table hereAs the results show in the table above, there were significant differences between the mean scores of knowledge scores of respondents according to their educational level with p<0.001, the mean score of knowledge was 37.82 ± 8.35 for diplomas, 43.58 ± 7.08 for bachelor and 56.75±7.88 for MSc degrees. Furthermore, the results of the Bonferroni post hoc test indicated that there were significant differences between the mean scores of the knowledge of participants with diplomas and bachelor's degrees (p=0.010), diploma and MSc (p<0.001), and bachelor's and MSc (p=0.002). Finally, significant differences were observed in the mean knowledge scores of respondents based on their ICU training, with p<0.001. The mean score for those who had previously completed ICU training was 47.76±7.85, while for those without ICU training, it was 39.60±6.01.

Table 3: The comparison between sociodemographic characteristics and knowledge scores (n= 114).

Variable	Item	Number	Mean	SD	Parametric Tests	
					T/F	p-value
Gender	Male	41	42.46	7.93	-0.723	0.471
	Female	73	43.58	8.00		
Education level	Diploma	17	37.82	8.35	11.611	<0.001
	Bachelor	93	43.58	7.08		
	MSc	4	56.75	7.88		
ICU Training	Yes	50	47.76	7.85	6.278	<0.001
	No	64	39.60	6.01		
Years of work experience as a critical care nurse?	1-5	33	43.57	8.58	1.111	0.333
	6-10	65	43.66	7.34		
	>10	16	40.43	8.97		
	Total	114	43.18	7.96		

SD: standard deviation, T: t value, F: f value

Table 4: to find out the predictive factors that increase knowledge toward ventilator -associated pneumonia (VAP) prevention bundle compliance scores, a multiple regression test was conducted. Using a scatterplot, it can be seen that there were no outliers in the positive and linear relationships between knowledge toward ventilator-associated pneumonia (VAP) prevention bundle compliance scores, diploma degrees, MScs, and taking an ICU training course before. Due to the residuals' Durbin-Watson statistic of 1.693, it may be concluded that they are independent. A plot of the standardized residuals versus the predicted values was used to test linearity and homoscedasticity. There were no bivariate outliers (R (Std. Residual Min. = -2.582, Std. Residual Max. = 2.757)), and the results of the collinearity tests indicated that multicollinearity was not an issue (the diploma degree, tolerance = 0.982, VIF = 1.018; MSc, tolerance = 0.951, VIF = 1.052; the trained ICU courses, tolerance = 0.942, VIF = 1.061). The Pearson correlation between the diploma degree and knowledge toward Ventilator-Associated Pneumonia (VAP) Prevention Bundle Compliance scores was r (114) = -0.297, p<0.001. The regression equation for predicting the knowledge toward Ventilator-Associated Pneumonia (VAP) Prevention Bundle Compliance scores from the diploma degree, MSc, and trainingwas $\hat{y}$ = 40.543 - 4.981x + 8.817x + 6.889x. The r^2 for this equation was 0.358; that is, 35.8% of the variance in knowledge toward ventilator-associated pneumonia (VAP) prevention bundle compliance scores was predictable from the level of the participant's diploma degree, MSc, and training. The bootstrapped 95% confidence interval for the slope to predict knowledge toward ventilator-associated pneumonia (VAP) prevention bundle compliance scores from participants' diploma degrees range from -8.328 to -1.635; thus, for each one-unit increase of participants' diploma degrees, knowledge toward ventilator-associated pneumonia (VAP) prevention bundle compliance scores decreases by about 1.635 to 8.328 points. Moreover, the bootstrapped 95% confidence interval for the slope to predict knowledge toward ventilator-associated pneumonia (VAP) prevention bundle compliance scores from MSc ranges from 2.232 to 15.402; thus, for each one unit of increase of participants' MSc, knowledge toward ventilator-associated pneumonia (VAP) prevention bundle compliance scores increases by about 2.232 to 15.402 points. Finally, the bootstrapped 95% confidence interval for the slope to predict knowledge toward ventilator-associated pneumonia (VAP) prevention bundle compliance scores from trained ICU courses ranges from 4.437 to 9.342; thus, for each one-unit increase of participants' trained ICU courses, knowledge toward ventilator-associated pneumonia (VAP) prevention bundle compliance scores increases by about 4.437 to 9.342 points.

Table 4: Predictive factors increasing the level of knowledge toward Ventilator-Associated Pneumonia (VAP) Prevention Bundle Compliance (n= 114).

Vaiables	Unstandardized Coefficients		Standardized Coefficients	t	P value	95.0% Confidence Interval for B		Collinearity Statistics	
	B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
(Constant)	40.543	0.856		47.349	<0.001	38.846	42.240		
Diploma	-4.981	1.689	-.227	-2.950	0.004	-8.328	-1.635	0.982	1.018
MSc	8.817	3.323	.208	2.654	0.009	2.232	15.402	0.951	1.052
Trained	6.889	1.237	.438	5.567	<0.001	4.437	9.342	0.942	1.061

Note. Dependent Variable: knowledge toward Ventilator-Associated Pneumonia (VAP) Prevention Bundle Compliance scores, Total R^2 =0.358, adjusted R=0.341, F= 20.45, P=<0.001.

DISCUSSION

The findings of this research indicated that nurses' general understanding of VAP prevention was inadequate. Given the significance of evidence-based nursing practices in reducing ventilator-associated infections, this outcome is concerning. Preventive procedures like head-of-bed elevation, oral care with antiseptics, hand cleanliness, and adherence to ventilator care bundles may be inconsistently or incorrectly implemented due to a lack of awareness. Numerous prior research studies have found that a significant obstacle to effective VAP prevention is nurses' lack of knowledge (11). In this study, approximately 61.40% of the participants demonstrated poor knowledge regarding VAP prevention. This result agrees withprevious studies done in Palestine (12), Iran (13), the Eastern Mediterranean Region (14), Addis Ababa (15), Tanzania (16), Pakistan (17), andIraq (18). However, the present study participants had less knowledge about ventilator-associated pneumonia when compared to the results of previous studies in the United State of America (19) and in Jordan (20). Each country has special health care provider systems (19), and modifications in certain approvals and policies addressing teaching and evidence-based guidelines implemented for pneumonia caused by ventilator machine prevention in ICUs can both cause the differences in the level of knowledge in the study or may be due to the low level of knowledge found in this study, which could be caused by a lack of frequent in-service training, restricted access to continuing education, and a lack of focus on VAP preventive recommendations in clinical practice. Gaining confidence in making better decisions, providing the best possible care for patients, and improving the outcomes of ventilated patients are all made possible by having adequate nursing knowledge (21).ICU nurses' inadequate knowledge is caused by a variety of factors; in the present study, adequate knowledge was found to be substantially correlated with high academic credentials (master's degrees) and regular VAP training courses regarding VAP prevention. The present study findings indicated that nurses with a master's degree were more likely than those with a diploma or bachelor's degree to have adequate knowledge. This is consistent with the results of previous studies that had been conducted in Northwest Ethiopia (2021) and Australia (2020) (22, 23). Also, the present study results are consistent with the results of the studies conducted in Cyprus, 2021 (20), and in Iran, 2019 (13). This result implies that advanced nursing education enhances the acquisition of information and comprehension of difficult clinical matters. This phenomenon may be because, during their academic training, nurses with bachelor's or graduate degrees are more likely to encounter research-based learning, critical thinking abilities, and evidence-based practice. The finding of the current study showed there was no significant change in the level of nurses' knowledge regarding VAP prevention in terms of gender; this result agreed with the previous study done in Palestine (12), in Belgium (24), in Lebanon (19), and in Saudi Arabia (25).The findings of my study reveal that there were no significant differences between years of experience and the level of the nurse's knowledge regarding the VAP study. This result agrees with a number of previous studies (24, 26). This result agrees with previous studies in Iran (13, 16), and in Nepal (27). This finding implies that clinical expertise by itself does not guarantee sufficient knowledge about the latest evidence-based procedures. Those nurses who have longer experience might depend on routine or usual procedures that might not be

in line with evidence-based practice. In contrast, another study showed that there is significant (20). This variability may be due to differences in the health care system and time of working. According to the study's findings, those nurses who had received frequent training on pneumonia caused by ventilator prevention had a higher chance of having sufficient preventive knowledge. This is in line with the findings of other studies conducted in Cyprus (20, 28). And also agree with a study that was done in China (29). Additional research indicates that ongoing training and continued instruction lead to improved knowledge and performance in preventing pneumonia caused by ventilators (23). This advantage may be due to the fact that ICU training programs offer possibilities for practical learning, clinical simulation, and teaching based on guidelines, all of which improve information retention and practical application. Consequently, putting in place frequent ICU training programs could be a useful tactic to raise nurses' awareness and lower the prevalence of VAP.

Limitation of the study: The study has several limitations: it was done in a limited number of hospitals, and a limited number of nurses participated, which may impact the results' applicability to all intensive care unit nurses. The study consists of a self-administered questionnaire to evaluate the nurse's knowledge regarding VAP, which may lead to bias, as contributors can miscalculate or overestimate their knowledge. The study focused solely on nurses' knowledge and did not examine their actual practices related to VAP prevention, which means it failed to assess the correlation between knowledge and practice. Finally, factors that could influence knowledge and practice, such as workload, staffing numbers, or institutional policies, were not assessed.

CONCLUSION

The present study shows that the knowledge of nurses working in the critical place about pneumonia caused by ventilator prevention is inadequate. Having higher education and participating in critical care unit training are strongly linked to a high degree of knowledge. As a result, it demonstrates the need for extensive education and training. In order to prevent intensive care infections, the nursing school in Iraq/Kurdistan should update its curriculum. Additionally, VAP prevention guidelines should be implemented and updated by legislators and administrators. This will help to improve the quality of nursing care and increase nurses' knowledge so they can make the most accurate decisions.

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CONFLICT OF INTEREST

We confirm that this study has no known conflicts of interest and no significant financial support that could have influenced its outcome.

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