



HOSPITAL-ACQUIRED PNEUMONIA IN MECHANICALLY VENTILATED PATIENTS

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Abstract: Evidence-based interventions can reduce the risk and incidence of complications such as nosocomial infections. VAP is a pulmonary infection that appears after two days of endotracheal intubation and when invasive mechanical ventilation is used. Nurses' knowledge would facilitate optimal delivery of patient care, increase confidence in making appropriate decisions, and prevent poor outcomes in the recovery of mechanically ventilated patients. We aimed to assess critical care nurses' knowledge regarding EBGs for the prevention of VAP.

Method: A cross-sectional study that was conducted in the adult ICU at King Faisal Hospital in Makah in the period between January and June 2019. A valid and reliable self-administered questionnaire was adapted and used to achieve the study objectives

Results: A total of 100 nurses participated in the study. The mean knowledge score for the study participants was 17.9 (SD: 2.5) out of 25 (representing 71.6% out of the maximum score) and ranged between 9 and 23. Around 41% of the participants achieved less than 60% (fail), 35% achieved a score between 60-75% (poor knowledge), and only 24% of the participants showed satisfactory scores ($\geq 75\%$). Nationality, level of education, and professional years of experience were important factors that influenced nurses' knowledge regarding the EBGs for the prevention of VAP. Non-Saudi nurses, those with a master's degree, and those with a longer duration of professional experience showed higher knowledge scores compared to others ($p \leq 0.05$).

Conclusion: ICU nurses showed a high level of knowledge concerning basic nursing interventions. However, nurses lack knowledge concerning interventions recommended in the EBGs for the prevention of VAP. Nationality, years working in ICU and level of education were important factors that influenced nurses' knowledge of EBGs for the prevention of VAP.

Keywords: Intensive Care Units; Knowledge; Nurses; Ventilator-Associated Pneumonia Nurses; Saudi Arabia.

I. INTRODUCTION

Patients in the intensive care unit (ICU) are at risk of dying not only from their critical illness but also from secondary processes such as nosocomial infections. Pneumonia is the second most common nosocomial infection in critically ill patients, affecting 27% of all critically ill patients. It is defined as an inflammation of the lung parenchyma caused by infection. Mechanical ventilation provides respiratory support for critically ill patients and is one of the most significant life-saving advancements in medical science and technology. The use of mechanical ventilation is a significant risk factor for hospital-acquired pneumonia associated with aspiration, lowering of consciousness level, excessive management and patient transport, and chronic lung disease [1]. Ventilator-associated pneumonia (VAP) develops within 48 to 96 hours after mechanical ventilation initiation. The incidence

rate varies between 9% and 67% [2] and the mortality rate varies between 13% and 94% [3]. This condition, which causes the prolongation of hospitalisation, is the cause of high morbidity and mortality [4].

Evidence-based interventions can reduce the risk and incidence of these complications. VAP is a pulmonary infection that appears after two days of endotracheal intubation and when invasive mechanical ventilation is used [5]. A systematic review was conducted to determine the incidence of VAP and its attributable mortality rate, length of stay and costs. Results indicated that 10% to 20% of patients receiving more than 48 hours of mechanical ventilation would develop VAP [6].

Critically ill patients who develop VAP appear to be twice as likely to die compared with similar patients without VAP [3]. Patients with VAP have significantly longer ICU stays of six days. Several risk factors are associated with VAP, including the microbiota, advanced age, immunocompromising conditions, pulmonary illness, length of mechanical ventilation, the aspiration technique, tracheostomy, supine positioning, enteral feeding, and previous antibiotic exposure, among other endogenous and exogenous factors [7].

Evidence-based practice (EBP) is currently one of the most important ways, if not the most important way, to provide the best quality care to patients in the ICU. As technology and research in health care expand, EBP is becoming essential in delivering high-quality care to critically ill patients [8]. Therefore, it is extremely important that intensive care nurses have knowledge of such strategies and can implement evidence-based nursing in ICUs, aiming at achieving high-quality care as well as optimal outcomes for their patients.

EBP has become a highly important tool in the prevention of nosocomial infections such as VAP in the ICU through the use of evidence-based strategies (guidelines), which ultimately increases positive outcomes for patients [9].

Specific evidence-based guidelines (EBGs) or bundles of care have been developed both to prevent VAP and to treat it appropriately as soon as possible. Bundles of care are grouped to encourage the consistent delivery of these practices. Bundles are standard in the ICU and have been developed for the prevention of VAP. It includes elevation of the head of the bed (HOB) by 30 to 45 degrees, daily sedation interruption and assessment of readiness to extubate, use of subglottic secretion drainage, avoidance of scheduled ventilator circuit changes, and gastrointestinal stress ulcer prophylaxis [10, 11].

Although the prevention of VAP is a multidisciplinary issue, the role of intensive care nurses is crucial and should not be underestimated [12, 13]. Many nonpharmacological evidence-based strategies aimed at preventing VAP can be seen as part of primary and routine nursing care, which is the direct responsibility of the bedside intensive care nurse. They can quickly be instituted at minimal cost, and neglecting any of them could put the patient at risk for infection [14-16]. However, nurses need to have an awareness of the problem as well as evidence-based preventive strategies to adhere to such practices and integrate them into their nursing care.

Nurses' knowledge would facilitate optimal delivery of patient care, increase confidence in making appropriate decisions, and prevent poor outcomes in the recovery of mechanically ventilated patients. Several recent surveys reported a substantial lack of knowledge among intensive care nurses concerning evidence-based strategies for preventing VAP [12,

14, 16-18]. In the Kingdom of Saudi Arabia (KSA), only a limited number of studies evaluate intensive care nurses' knowledge about preventing VAP, and their knowledge levels are insufficient [19]. To this end, this study aims to assess critical care nurses' knowledge regarding EBGs for the prevention of VAP.

II. METHODS

A. Study design

A cross-sectional study that was conducted in the adult ICU at King Faisal Hospital in Makah in the period between January and June 2019.

B. Setting

A convenient sample of 100 registered nurses working in ICU and willing to participate in the study were enrolled. Exclusion criteria were 1) nurses who had been working less than six months in the selected units, and 2) nurses who were on extended leave such as career breaks or maternity leave at the time of the study.

C. Sample size

A total of (n=100) registered nurses who work in the adult ICU were recruited in the current study. Nurses on annual leave and maternity leave were excluded from this study. This sample size was calculated based on the confidence level and the margin of error. As we chose an estimated population size of 100, a margin of error of 5% and a confidence level of 95%, the sample size was 80 participants.

D. Data collection tool

The study questionnaire was distributed to the participants and consisted of the following sections: nurses' demographic data including age, sex, nationality, years of ICU experience and level of nursing education. A previously validated instrument regarding evidence-based knowledge about the prevention of CLABSI was used to assess critical care nurses' knowledge of evidence-based guidelines for CLABSI prevention [12]. The questionnaire's content is based on the CDC's CLABSI prevention guidelines.

E. Ethical Approval

This study was reviewed and approved by the ethical committee in the Standing Committee for Research Ethics on Living

Creatures (SCRELC), Imam Abdulrahman Bin Faisal University (IRB- PCS- 2019-04-165). Permission to conduct the study was obtained from King Faisal Hospital responsible authorities after an explanation of the proposal aim and methodology. Consent was obtained from the nurses who agree to participate in the study.

F. Questionnaire tool validity and reliability

A valid and reliable self-administered questionnaire was adapted from the other studies with the same objective as the current study [13, 20, 21]. It consists of two sections: a) a sociodemographic characteristics section comprised of eight questions including age, sex, nationality, education, years of ICU experience, type of ICU, current position in ICU and VAP-related workshops or lectures and b) a section about VAP knowledge, comprised of 25 multiple-choice questions covering the ten most updated areas of the EBGs for the prevention of VAP. Each multiple-choice question has four response alternatives or options (the correct answer and three alternatives that are not correct). This section is divided into two parts. Part I is titled Daily Process Measures. The process measures within the VAP prevention bundle are patient care activities that should happen every day for a patient on mechanical ventilation. This part includes questions to assess

the nurses' knowledge regarding the following measures: HOB, oral care, sedation vacation, stress ulcer prevention, and DVT prophylaxis. Part II is titled Policy Measures. Policy measures are the care activities that should happen every day as unit or hospital policies address the remaining supporting measures for the prevention of VAP. This part addresses the following measures: cuff pressure, closed suctioning vs open suctioning, oral vs nasal intubation, ventilator circuit and humidifier management, and kinetic bed.

The questionnaire was pre-tested for internal validity by a group of critical care nurses (n = 10) who did not participate in the primary study [20].

Data analysis

SPSS (Statistical Package for Social Science) version 25 was used to analyse the data. Descriptive statistics (frequency and percentage) were used to describe the demographic characteristics of the study sample. Continuous data were presented as mean (standard deviation). The student t-test or analysis of variance (ANOVA) test was used to explore the difference in the mean value between different demographic groups as appropriate.

Each correct answer for the knowledge scale scored 1, based on which the maximum obtainable knowledge score was 25. Participant scores were categorised as follows: weak = < 60; average = 60 to <75, and high ≥ 75). A confidence interval of 95% ($p \leq 0.05$) was applied to represent the statistical significance of the results, and the level of significance assigned was 5%.

III. RESULTS

The questionnaire was distributed to a total of 100 nurses working in the ICU of King Faisal Hospital. The response rate was 100%.

A. Sociodemographic characteristics

Table 1 describes the sociodemographic characteristics of the study participants. The vast majority (94%) were aged between 26 and 35 years. The majority (79%) were non-Saudi, and 92% had a bachelor's degree. More than half of them (57%) had work experience between six months and five years. The majority (81%) were working in general ICU settings and 89% were staff nurses. When the participants were asked whether they had attended VAP-related training, 75% confirmed that they had. For further details on the sociodemographic characteristics of the study participants.

TABLE 1: SOCIODEMOGRAPHIC CHARACTERISTICS OF THE STUDY PARTICIPANTS.

Variable	Percentage
Age	
Less than 25 years	2%
26 – 35 years	94%
36 years and above	4%
Nationality	
Non-Saudi	79%
Education	
Diploma	3%
Bachelor degree	92%
Master degree	5%
Work experience	
6 months – 5 Years	57%
5 – 10 years	33%
10 – 15 years	7%
15 years and above	3%
Type of ICU	
General-ICU	81%
Medical-ICU	16%
Coronary care-ICU	3%
Position in ICU	
Staff Nurse	89%
Charge Nurse	5%
Nurse educator	5%

Head Nurse	1%
Attendance of VAP – related training?	
Yes	75%

B. Nurse' knowledge about ventilator-associated pneumonia

The questionnaire comprises 25 questions, four of which (Questions 1 – 4) are concerned with the general information about VAP and the other 14 of which (Questions 5 – 25) are concerned with the VAP bundle measures used to prevent VAP (Table 2).

TABLE 2: RESPONDENTS' CORRECT ANSWERS FOR EACH OF THE 25 ITEMS INCLUDED IN THE QUESTIONNAIRE.

Items (Questions)	Percentage of participants with correct answer
1. Ventilator Associated Pneumonia (VAP) is defined as pneumonia that develops in an intubated patient after _____hours or more of mechanical ventilation support. Correct Response: 48 hrs.	86.0%
2. Which of the following are symptoms of VAP Correct Response: Fever, purulent tracheobronchial secretions, leucocytosis, increased respiratory rate, decreased tidal volume, increased minute ventilation, and decreased oxygenation.	77.0%
3. What kind of infection is VAP? Correct Response: Airway	96.0%
4. Which of the following anatomic areas is the primary route for ventilator-associated pneumonia (VAP)? Correct Response: Oropharynx	80.0%
5. To reduce the risk of VAP, the head of the bed (HOB) should be placed at ---- Correct Response: >30 degrees	86.0%
Items (Questions)	Percentage of participants with correct answer
6. Which of the following interventions helps lower pulmonary aspiration of gastric contents? Correct Response: a and b	66.0%
7. Which of the following suctioning techniques is recommended for minimizing the risk of VAP: Correct Response: Closed suction technique	78.0%
8. How often should Oral Care with Chlorhexidine (CHG) be performed? Correct Response: Q12 hrs.	28.0%
9. What is the benefit of performing Oral Care? Correct Response: Reduces microbiological burden	79.0%
10. Which route is best recommended when intubating a patient?	92.0%

Correct Response: Oral intubation is recommended	
11. The recommended route of intubation in Qn. 10 decrease the risk of VAP because Correct Response: It is not associated with sinusitis	61.0%
12. What kind of endotracheal tubes are recommended for the prevention of VAP? Correct Response: Cuffed endotracheal tube with in line dorsal lumen	54.0%
13. Which of the following policies should be used to prevent colonization of the aerodigestive tract? Correct Response: A policy to encourage the use of Orotracheal intubation over nasotracheal whenever oro tracheal intubation is not contraindicated.	43.0%
14. How often should you attempt Spontaneous Awakening and Breathing Trial (Sedation Vacation)? Correct Response: Daily	98.0%
15. What is the benefit of performing Spontaneous Awakening Trial & Spontaneous Breathing Trial? Correct Response: Reduces the number of days patients are on mechanical ventilation	90.0%
16. Which of the following safety criteria is not contraindication for attempting the Spontaneous Awakening and Breathing Trials (Sedation Vacation)? Correct Response: Patient receiving antihistamine blockers	36.0%
17. How often should the ventilation circuitry be changed? Correct Response: Only if damaged or soiled	66.0%
18. How often should you change the Ventilator Humidifier (HME)? Correct Response: b and c	10.0%
19. Which of the following is a drawback of prolonged using of Stress Ulcer Prophylaxis to a ventilated patient? Correct Response: Increase the colonization density of the aero digestive tract leading to VAP	50.0%
20. Adjustable (kinetic bed) vs. non-adjustable beds Correct Response: Adjustable beds reduce the risk for VAP	83.0%
21. A nurse caring a ventilated patient is required to wash hands Correct Response: Before and after oral / ETT suctioning	99.0%
22. Which of the following best describes the effect of early weaning of the patient from mechanical ventilator? Correct Response: Reducing the risk for VAP	96.0%
23. During the care of ventilated patient, maintenance of adequate cuff pressure -- ----- decreases the risk of VAP. Correct Response: 20 – 25 mmHg	65.0
24. Which of the following interventions has a top priority in the prevention of VAP according Bundle of care? Correct Response: DVT prophylaxis	84.0%

25. Graduate compression stockings are

Correct Response: Appropriate venous thromboembolism (VTE) prevention strategy for the patient at moderate risk 82.0%

B.1. General VAP-related information (Questions 1 - 4)

The majority of the participants (86%) correctly answered the question “Ventilator-associated pneumonia (VAP) is defined as pneumonia that develops in an intubated patient after _____ hours or more of mechanical ventilation support”. Concerning the question “Which of the following are symptoms of VAP?” slightly over three-quarters (77%) of the participants gave a correct answer. Concerning the question “What kind of infection is VAP?” the vast majority (96%) answered correctly. A total of 80% of participants gave a correct answer to the question “Which of the following anatomic areas is the primary route for ventilator-associated pneumonia (VAP)?”

B.2 VAP bundle-related information (Questions 5 – 25)

Concerning the question "To reduce the risk of VAP, the HOB should be placed at ----", 86% of the participants knew that the HOB should be elevated more than 30 degrees to prevent the occurrence of VAP. Regarding the appropriate method that could help in lowering the incidence of pulmonary aspiration of gastric contents, only 66% of the participants knew the correct answer, putting 44% of patients at risk for developing VAP. Concerning Question 7, about the recommended suctioning techniques that might reduce the risk of VAP, 78% of participants answered correctly.

Amongst all participants, only 28% correctly answered the question “How often should oral care with chlorhexidine (CHG) be performed?” showing that nurses’ lack of knowledge in this area might increase the risk of VAP. Concerning the benefits of performing oral care, which is addressed in Question 9, 79% of participants answered correctly.

Concerning Questions 10, 11 and 12, which are concerned with the best-recommended route when intubating a patient, the rationale behind the ideal route and the kind of endotracheal tube for prevention of VAP, 92% of participants knew that oral intubation is the recommended method; however, only 61% knew the rationale behind it. Furthermore, only 54% correctly identified the cuffed endotracheal tube with an inline dorsal lumen.

According to the EBGs, spontaneous awakening and breathing trials (sedation vacation) should be performed daily to reduce the number of days patients are on mechanical ventilation, and patients who are receiving antihistamine blockers are not contraindicated for attempting the spontaneous awakening and breathing trials (Questions 14, 15 and 16).

Concerning Question 16 “Which of the following safety criteria is not a contraindication for attempting spontaneous awakening and breathing trials (sedation vacation)?” around one-third (36%) of the participants answered correctly. While

98% of the participants correctly answered Question 14 “How often should you attempt spontaneous awakening and breathing trial (sedation vacation)?”, 90% gave the correct answer to Question 15 “What is the benefit of performing the spontaneous awakening trial and spontaneous breathing trial?”

Around two-thirds (66%) of the participants correctly answered Question 17 “How often should the ventilation circuitry be changed?” The EBGs on the prevention of VAP recommend changing ventilator circuits for every new patient, or when clinically indicated, such as when the circuit becomes soiled.

The EBGs on the prevention of VAP recommend changing humidifiers every week or when clinically indicated. Amongst all participants, only 10% answered Question 18 correctly. Concerning Question 19 on the drawback of prolonged use of stress ulcer prophylaxis in a mechanically ventilated patient, half of the participants (50%) knew

the correct answer (increase the colonisation density of the aerodigestive tract leading to VAP) while the other 50% did not know what is recommended by EBGs.

According to the EBGs for the prevention of VAP, kinetic beds reduce the risk of VAP. Amongst all participants, 83% answered correctly. The majority (96% and 99% respectively) answered Questions 21 and 22 correctly. They knew the EBGs recommend washing hands before and after oral / ETT suctioning and that early weaning of the patient from the mechanical ventilator is recommended to reduce the risk of VAP.

Of the 100 participants, (65%, 84% and 82% respectively) recognised correctly that cuff pressure should be maintained at 20 to 25 mmHg, that DVT prophylaxis has a top priority in the prevention of VAP according to the bundle of care and finally, that venous thromboembolism (VTE) is the appropriate prevention strategy for patients at moderate risk (Questions 23, 24, and 25).

C. Nurse's knowledge regarding EBGs for the prevention of VAP

The mean knowledge score for the study participants was 17.9 (SD: 2.5) out of 25 (representing 71.6% out of the maximum score) and ranged between 9 and 23. Around 41% of the participants achieved less than 60% (fail), 35% achieved a score between 60-75% (poor knowledge), and only 24% of the participants showed satisfactory scores ($\geq 75\%$). This reflects the possibility of putting critically ill patients under increased risk of VAP as less than a quarter of the sample (24%) had satisfactory knowledge scores.

D. Critical care nurses' knowledge scores

Table 3 presents the mean knowledge score regarding the EBGs for the prevention of VAP stratified by the sociodemographic characteristics of the participants. Nationality, level of education, and professional years of experience were important factors that influenced nurses' knowledge regarding the EBGs for the prevention of VAP. Non-Saudi nurses, those with a master's degree, and those with a longer duration of professional experience showed higher knowledge scores compared to others ($p \leq 0.05$).

TABLE 3: KNOWLEDGE SCORES AND SOCIODEMOGRAPHIC CHARACTERISTICS.

Knowledge		Knowledge			F or T	ANOVA or T-test	
		Mean	±	SD		Test value	P-value
Age	Less than 25 years	16.5	±	5.00	F	2.185	0.118
	26 – 35 years	17.8	±	2.5			
	36 years and above	20.3	±	1.9			
Nationality	Saudi	16.9	±	3.5	T	-2.061	0.042*
	Non - Saudi	18.1	±	1.0 2.1			
Level of education	Diploma	19.0			F	3.726	0.028*
	Bachelor	17.7	±	2.5			
	Master	20.6	±	1.7			
Professional experience year(s)	6 months – 5 years	17.3	±	2.7	F	3.195	0.027*
	5 – 10 years	18.4	±	2.0			
	10 – 15 years	18.7	±	2.1			
	15 years and above	20.7	±	2.1			
Type of ICU	Medical ICU	18.250	±	2.049	F	0.830	0.439
	General ICU			0.577			

Current position in ICU	Coronary Care Unit	17.716	±	2.637	F	1.259	0.293
	Staff Nurse	17.831	±	2.515			
	Charge Nurse	16.600	±	2.702			
	Head Nurse	17.000	±	0.000			
	Nurse Educator	19.600	±	2.302			
Training	No	17.000	±	2.986	T	1.259	0.293
	Yes	18.133	±	2.304			

IV. DISCUSSION

VAP is a problem in ICUs worldwide and dramatically increases morbidity and mortality rates of mechanically ventilated patients. It is the most common infectious complication among patients admitted to ICUs. When VAP occurs, it prolongs the length of ICU stay, ultimately increasing hospital stay and the risk of death in critically ill patients. However, VAP is preventable and EBGs for the prevention of VAP have been shown internationally to reduce its incidence and burden on patient's outcomes. Knowledge of EBGs for the prevention of VAP and adherence to them would reduce the risk of occurrence of VAP and decrease morbidity and mortality of mechanically ventilated patients in the ICU [22].

Concerning the nurses' knowledge regarding the EBGs for the prevention of VAP, the current study revealed that 76% had poor knowledge and only 24 (24%) had satisfactory knowledge levels (participants who got ≥ 75) with a mean score of 17.9 ± 2.5 . This result raises the alarming possibility of increasing morbidity and mortality among critically ill patients and increases concerns about nurses' competency. Nurses should be equipped with EBGs to provide safe and effective care.

Measures related to the HOB, patient positioning in bed, prevention of unplanned extubation, the best method for intubation, the benefit of kinetic beds, and DVT prophylaxis were known by the majority of nurses. This may be related to the routine practices and to the fact that these strategies are usually taught in basic nursing education, considered a nursing responsibility, and directly under the control of nurses. However, most nurses had a significantly low level of knowledge regarding some important strategies or measures that have strong and significant correlations with the increasing incidence of VAP, such as oral care with chlorhexidine (CHG), frequency of ventilator circuit changes, cuff pressure, and frequency of changing the ventilator humidifier (HME). Low scores in these vital VAP-preventive measures might be attributed to deficiencies in training, differences in what is regarded as good practice, and/or a lack or absence of unit policies (EBGs are not included in the patient care policy). Those strategies are not usually addressed in basic education, and in-service education usually involves collaboration with physicians, so the concern is medically oriented.

The findings of the current study are in line with a previous study that was conducted in Sudan in 2014 and showed that Sudanese nurses had poor knowledge, where the mean percentage for total knowledge was 42.8% [23]. Additionally, a study conducted in Johannesburg, South Africa, in 2010 found the knowledge of ICU nurses to be lacking in the EBGs for VAP prevention [24]. A study conducted in Egypt in 2013 revealed that the participants had unsatisfactory knowledge scores (mean = 7.5 ± 2.4 out of 20 scores) [25]. Another study that was conducted by Al-Sayaghi in 37 ICUs of 23 hospitals in Sana'a City, Yemen, in 2014 concluded that knowledge of evidence-based strategies for preventing VAP is low among the majority of nurses working in Yemen ICUs (73.4% of nurses scored $<60\%$) [26]. It justified the low scores through several factors, including the staffing of Yemen ICUs with generally trained, diploma holder nurses, the lack of in-service training, and the absence of consistent policies in ICUs.

A study done by Biancofiore et al. in Italy in 2007 found that only 22.6% of nurses had satisfactory knowledge [27]. Similar findings were reported by Labeau et al., who concluded that ICU nurses in 22 European countries had low scores on a knowledge test of VAP prevention guidelines [13]. A study conducted in the United States by Sedwick et al. in 2012 confirmed that strict adherence to VAP bundled practices enhances accountability for initiating protocols by using a feedback system and that interdisciplinary collaboration most likely will improve patients' outcomes and produce marked cost savings for hospitals [28]. In 2013 Jansson et al. reported that professional experience was shown to be associated with better knowledge scores and emphasised the need for improvements in education and effective implementation strategies [29]. Moreover, in 2018, Nurten Özen stated that nurses' knowledge about the prevention of VAP should be assessed periodically, and they should be provided with regular training to fill their knowledge gaps [22].

A previous systematic review of evidence regarding critical care nurses' knowledge about preventing VAP confirmed that critical care nurses' knowledge of EBGs for preventing VAP is low in many countries and that knowledge varied according to the experience of the nurses and the size of the ICU [30]. Ongoing improvements in nursing school curricula and hospital education are needed and strict protocols must be considered to increase nurses' compliance with VAP guidelines [19]. In our study, no significant difference in knowledge was observed based on nurses' age ($P \geq 0.05$). This result is congruent with a previous study by Gomes. On the other hand, our study revealed significant differences based on the nationality of participants and their level of knowledge. The non-Saudi nurses showed a higher knowledge level than Saudi nurses ($P\text{value}=0.042$). This result raises the alarming possibility of increased morbidity and mortality among hospitalised patients throughout the KSA and heightens concerns about the educational preparation and professional competency of nurses. Nurses are under increased scrutiny to provide safe, effective care. Likewise, nursing education programmes are faced with increased pressure to produce graduates who are capable of providing safe patient care. To that end, nursing education programmes should develop curricula, hire qualified faculty, and select learning experiences that are evidence based and more technologically savvy to twenty-first-century students. In addition, strict protocols must be considered to increase nurses' compliance with VAP guidelines.

The current study revealed a significant difference in knowledge scores based on level of education ($P\text{-value}=0.028$). This result is in line with Ruba W. Yaseen's 2015 study [19]. Additionally, our study found a significant difference in knowledge scores based on years of professional experience ($P\text{-value}=0.027$). This result is in line with many other studies. In a study conducted by Stijn I. Blot, the researcher found that more experienced nurses had a higher knowledge level than those with less than one year of experience [31]. The knowledge level among nurses holding a special degree was also higher. Another study conducted by Jansson in 2013 revealed that more experienced nurses performed significantly better than their less-experienced colleagues ($p = 0.029$) [29]. The same result was concluded by Labeau et al. [13], that more experienced nurses performed significantly better than their less-experienced colleagues ($p<0.001$). Moreover, in her results, Ruba et al. mentioned that more experienced nurses performed significantly better than their less-experienced colleagues ($p<0.05$) [19]. On the other hand, in his 2014 study, Al-Sayaghi found that seniority does not indicate better knowledge scores [26].

V. RECOMMENDATIONS

V.1 Recommendations for nursing education

Ongoing in-service training must be introduced into hospitals and ICUs to improve knowledge about the prevention of VAP, which is a common nosocomial infection in ICUs. Orientation of new staff members in ICUs should include education on strategies for the prevention of VAP. Unit protocols and policies should be reviewed regularly as updates and new evidence for best practice are constantly emerging and staff should be educated on the updated protocols. Opinion leaders amongst nurses in the units should be encouraged to motivate their

colleagues to put guidelines for the prevention of VAP into practice. Resources such as articles, journals and electronic resources including computers and the internet should be made accessible to staff members in the units. Articles on the prevention of VAP should be discussed in unit meetings as part of staff education. Staff members should be motivated to develop their careers by studying further and gaining more knowledge and skills in the ICU field.

V.2 Recommendations for nursing education

This study should be extended to include other hospitals and possibly other provinces in KSA with a larger population and sample. Further research should be conducted to test the knowledge levels of nurses before and after the educational programme on EBGs for the prevention of VAP to assess if nurses gained knowledge after exposure to educational programmes. A study on protocols used nationally and their inclusion of EBGs on the prevention of VAP should be carried out to evaluate the nurses' adherence to the guidelines. Further study is recommended to observe the nurse's compliance with VAP prevention measures.

VI. LIMITATIONS OF THE STUDY

The present study has some limitations. The generalisation of the findings is limited due to the small size and the conduct of the study in one setting. The findings may be influenced by the intrinsic methodological limitations of the survey, which is based on self-report.

VII. CONCLUSION

ICU nurses showed a high level of knowledge concerning basic nursing interventions. However, nurses lack knowledge concerning interventions recommended in the EBGs for the prevention of VAP. Nationality, years working in ICU and level of education were important factors that influenced nurses' knowledge of EBGs for the prevention of VAP.

Data Availability

All data are available from the corresponding author upon reasonable request.

Consent

Consent was obtained from the respondents before administering the questionnaire, and participants were assured of the confidentiality of the information, and the data was collected anonymously.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

All authors made substantial contributions to conception and design, acquisition of data, or analysis, and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agreed to be accountable for all aspects of the work.

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