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Original Article

Critical care nurses' compliance and barriers toward ventilator-associated pneumonia prevention guidelines: cross-sectional survey

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الملخص

أهداف البحث: تقييم مدى التزام كوادر التمريض العاملين في وحدات الرعاية الحرجة بإرشادات الوقاية من الالتهاب الرئوي المصاحب للتنفس الصناعي، والعوامل التي تؤثر على التزامهم، والعوائق التي تحول دون تنفيذ الإرشادات.

طرق البحث: تم استخدام مسح وصفي مقطعي مستعرض عن طريق استبانة ذاتية تحتوي على ١٧ إجراء موصى به للوقاية من الالتهاب الرئوي المصاحب للتنفس الصناعي و١٥ عائقا محتملا. شملت هذه الدراسة جميع كوادر التمريض العاملين في وحدات الرعاية الحرجة للبالغين بغض النظر عن مؤهلاتهم وخبراتهم وجنسياتهم. خلال الفترة من يناير ٢٠١٨ إلى مارس ٢٠١٨، تم توزيع الاستبانة على ٢٨٣ ممرض وممرضة في ٨ وحدات للرعاية الحرجة في ٥ مستشفيات عامة في المدينة المنورة بالمملكة العربية السعودية.

النتائج: أكمل الاستبانة ٢٢٩ ممرض وممرضة. وبلغ متوسط درجة الالتزام ٨٥.٩٪. وأظهر حوالي ٥٤٪ من كادر التمريض درجة التزام عالية أو مقبولة. وكانت أدنى درجة التزام في الإجراء المتعلق بشفط الإفرازات المتجمعة تحت الحنجرة فوق بالون أنبوبة القصبة الهوائية. وكانت العوائق الرئيسة التي تحول دون تنفيذ الإرشادات هي النقص في كادر التمريض ونسيان الإرشادات وسياسات التحكم بالتكاليف في المستشفيات. العمل في وحدات الرعاية الحرجة العامة أو وحدات الرعاية الحرجة التي تحتوي على ١٠-١٥ سريرا، أو تلقي تعليم حول الوقاية من الالتهاب الرئوي المصاحب للتنفس الصناعي هي العوامل التي كان لها تأثير على التزام كادر التمريض بالإرشادات.

الاستنتاجات: كادر التمريض ملتزم بإرشادات الوقاية من الالتهاب الرئوي المصاحب للتنفس الصناعي بدرجة كافية. العوائق الرئيسة التي تحول دون تنفيذ الإرشادات هي النقص في كادر التمريض ونسيان الإرشادات وسياسات التحكم بالتكاليف في المستشفيات. نوع وحدة الرعاية الحرجة، وعدد الأسرّة في الوحدة، وتلقي تعليم ارشادات الوقاية هي العوامل التي كان لها تأثير على التزام كادر التمريض.

الكلمات المفتاحية: عوائق؛ الالتزام؛ كوادر التمريض العاملين في وحدات الرعاية الحرجة؛ إرشادات الوقاية؛ الالتهاب الرئويالمصاحب للتنفس الصناعي.

Abstract

Objectives: This study aims to determine the compliance of critical care nurses with the ventilator-associated pneumonia prevention guidelines and the factors that affect their compliance. We also explored the barriers faced by the nurses in the implementation of these guidelines.

Methods: A cross-sectional descriptive survey was conducted using a self-administered questionnaire containing 17 recommended strategies to prevent ventilator-associated pneumonia and 15 possible barriers. All critical care nurses of varying qualifications, levels of experience, and nationalities working in adult ICUs were invited. Between January and March 2018, the questionnaire was distributed to 283 nurses at eight ICUs in five public hospitals in Almadinah Almunawwarah, KSA.

Results: A total of 229 invitees responded to the questionnaire. The mean compliance score was 85.9%. More than half (54%) of the sample had a high or acceptable compliance level. The lowest compliance rate was reported for the suctioning of subglottic secretions. The main reported barriers were the shortage of nursing staff, forgetfulness, and hospital cost control policies. Working in general ICUs with the capacity of 10–15 beds or prior education related to ventilator-associated pneumonia prevention influenced the nurses' compliance.

Conclusion: In our study, the overall compliance of the critical care nurses with the ventilator-associated pneumonia prevention guidelines is acceptable. Shortage of

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nursing staff, forgetfulness, and cost control policies were the main reported barriers to compliance.

Keywords: Barriers; Compliance; Critical care nurses; Prevention guidelines; Ventilator-associated pneumonia

Introduction

Tracheal intubation and invasive mechanical ventilation (MV) are life-saving procedures for a significant proportion of critically ill patients in intensive care units (ICUs). However, the use of MV is associated with various complications, with ventilator-associated pneumonia (VAP) being the most prevalent.[1] VAP is a parenchymal lung infection occurring in intubated patients treated with MV for 48 h or longer, with no prior signs or symptoms of lower respiratory infection before intubation and MV.[2] Healthcare-associated infections (HAIs) are an important patient safety issue. VAP is the most common type of HAI in ICUs globally.[3] The rates of VAP vary worldwide, but the highest rates are in developing countries. In the United States, the VAP rate is 1.1−7.4 episodes per 1,000 ventilator-days in adult ICUs[4]; however, the International Nosocomial Infection Control Consortium (INICC) prospective multicentre surveillance study in 43 developing countries from Europe, Latin America, Asia, and Africa, including KSA and other Middle East countries, reported the overall VAP incidence rate to be 14.7 episodes per 1,000 ventilator-days.[5] More recent review and meta-analysis involving 22 countries in Asia show VAP prevalence to be 12.7% for mechanically ventilated patients and the incidence rate to be 15.1 episodes per 1,000 ventilator-days.[6]

The INICC study conducted in five cities of the KSA from 2013 to 2015 reported the VAP rate to be 7.5 episodes per 1,000 ventilator-days.[7] Gaid et al. (2018)[8] conducted a retrospective cohort study using secondary data from 12 Ministry of Health (MoH) referral hospitals in different provinces of the KSA from 2013 to 2016 and found that VAP was the most common device-associated healthcare-associated infections (DA-HAIs) in medical or surgical ICUs (57.4%), with the incidence rate to be 0.9−51.6 episodes per 1,000 ventilator-days.[8]

VAP results in delayed extubation, prolonged stay in the hospital, increased mortality and morbidity rates, increased use of healthcare resources, and increased hospital care costs.[1−3] In KSA, VAP resulted in a longer stay of 17.5 days, an excess mortality rate of 31.8%,[7] and posed an extra cost of $40,000 per single episode of VAP in ICUs.[9,10] Given these consequences, the prevention of VAP became a priority target of healthcare delivery within ICUs, and the prevalence rate of VAP became an indicator of the safety and quality of care in the ICU.[2,11]

Several interventions have been evaluated to prevent VAP. Clinical guidelines have been formulated to improve the quality of care given to MV patients, and as a guide for decision making.[12,13] To prevent or at least reduce the VAP rate, appropriate multifaceted guidelines should be implemented at the time of intubation and maintained until extubation. Nurses, the backbone of any ICU, are in constant direct contact with the patient, more than other healthcare team members. Nurses have a key role in respiratory care, and they are responsible for implementing most of the VAP prevention strategies. They directly influence patient care and its outcomes.[2,14]

Although the accessibility of the guidelines and the awareness of its consistent implementation were increased, literature reports that the use of the guidelines in daily clinical practice is still suboptimal, and the rate of compliance is variable.[2,3,14,15] Notably, the availability of the guidelines does not reflect current practices, and a gap still exists between the current and ideal practice.[14] Barriers to implementing the guidelines and the factors that influence nurses' compliance with the guidelines vary from country to country and from institution to institution.[15−18]

Little is known about the critical care nurses' current practices, degree of compliance, and reasons for noncompliance with the VAP prevention guidelines in KSA. Hence, this study was conducted to determine the critical care nurses' compliance with the VAP prevention guidelines and the factors influencing their compliance.

Materials and Methods

Design and setting

A descriptive cross-sectional self-reported survey was conducted. All critical care nurses of varying qualifications, levels of experience, and nationalities, working in the adult ICUs of public hospitals in Almadinah Almunawwarah, KSA, were included in this study. Nurses unwilling to participate in the survey were excluded.

Tools and data collection

The self-reported questionnaire consisted of three sections. The first section contained ten items related to the nurse and ICU characteristics: age, gender, nationality, education, years of experience in an ICU, position, type of ICU, the number of beds, prior education regarding ventilator management and VAP prevention. The second section consisted of 17 items, in the form of a 3-point Likert scale, to assess the compliance of the critical care nurses with the VAP prevention guidelines. The 17 items (Table 1) are rated from 0 to 2 points (never = 0, sometimes = 1, and always = 2), and the total scores of compliance range from 0 to 34 points, with a higher total score reflecting greater compliance with guidelines. Then, this score is converted to a percentage of the score relative to the total score.

The third section contained 15 items investigating possible barriers that prevented compliance with the VAP prevention guidelines. The 15 statements are in the form of a

3-point Likert scale (Table 2), and the responses are: agree, neither agree nor disagree, or disagree.

The 17 items related to compliance were nursing-relevant VAP prevention strategies, identified and selected based on evidence from systematic reviews,[19–21] VAP bundles,[22–24] current comprehensive guidelines[25–27] and questionnaires.[11,18] The 15 items in the third section were adopted from a previously validated questionnaire by Aloush et al.[18]

A panel of 4 senior critical care nurses with a bachelor's degree, two nursing faculty members, and two infection control experts assessed the questionnaire's face and content validity. Their suggestions improved the clarity of the statements. The content validity index (CVI) of the compliance section was 0.94. The revised questionnaire was pretested with 15 nurses in two ICUs to evaluate its difficulty and readability and the time required to complete it. Some modifications in wording were made in the final version of the questionnaire. The internal consistency of the compliance section, measured with the Cronbach's alpha coefficient, was 0.79. From January 2018 to March 2018, the questionnaire was distributed to all nurses working in the chosen ICUs.

Statistical analysis

The Statistical Package for Social Sciences (SPSS Inc., Chicago, IL, USA) software version 16 for Windows was used for statistical analysis. Statistical significance was set at $p < 0.05$ and 95% confidence intervals. Frequency and percentage describe the demographic variables and each item's responses in the compliance and barriers sections. Continuous variables are described as mean and standard deviation. Skewness and kurtosis for the compliance scores were normally distributed. The sum and mean of the scores for the items in the compliance section were calculated for each participant, and the overall score was calculated. The compliance scores were categorized as follows: total scores <50th percentile (which is <30) were considered unsafe compliance; scores between the 50th and 75th percentiles (which is 30–32) were considered acceptable compliance; scores >75th percentile (which is >32) were considered high compliance. Differences between the participants' compliance were measured using the independent sample t-test and ANOVA test. If the ANOVA test indicated a significant difference, the Scheffé's test was performed. A multiple linear regression analysis was performed to identify the factors affecting compliance.

Results

Critical care nurses from eight adult ICUs of five public hospitals in Almadinah Almunawwarah, KSA, participated in the study. Of the 283 nurses approached, 229 participated, resulting in an 80.9% response rate. The mean age was 30.1 ± 5.5 years. The majority of respondents were female (93.4%), non-Saudi (72.5%), had a bachelor's degree (79.5%), were a staff nurse (96.9%), and had 1–5 years of ICU experience (64.2%). The highest proportion worked in a general ICU (30.6%) and ICUs with 16–20 beds (40.6%). The majority received education related to mechanical ventilator management (73.4%) and education related to VAP prevention (69.4%).

Table 1 summarizes the responses for each of the 17 items. The compliance with the VAP prevention guidelines was higher than expected for most items. The items were handwashed before and after approaching a patient, protective gloves were used while approaching a patient, sterile gloves were used when open suction was necessary, regular oral care was provided at least once per shift, and the patient was elevated to the semi-Fowler position.

Table 1: Compliance with VAP prevention guidelines.

Guidelines	Never n (%)	Sometimes n (%)	Always n (%)
1. Hand-washing before any approach to a patient.	1 (0.4)	4 (1.7)	224 (97.8)
2. Use of protective gloves at every approach to a patient.	2 (0.9)	5 (2.2)	222 (96.9)
3. Hand-washing after any approach to a patient.	0 (0.0)	7 (3.1)	222 (96.9)
4. Use of closed-circuit suction systems.	26 (11.4)	59 (25.8)	144 (62.9)
5. Change the closed-circuit suction systems for every new patient (or when clinically indicated).	24 (10.5)	59 (25.8)	146 (63.8)
6. Use sterile gloves when open suction is necessary.	1 (0.4)	4 (1.7)	224 (97.8)
7. Provide regular oral care at least once per shift.	6 (2.6)	8 (3.5)	215 (93.9)
8. Use chlorhexidine solution for oral care.	19 (8.3)	26 (11.4)	184 (80.3)
9. Use the heat and moisture exchanger humidifiers.	16 (7.0)	31 (13.5)	182 (79.5)
10. Change the heat and moisture exchanger humidifiers weekly or when clinically indicated.	26 (11.4)	66 (28.8)	137 (59.8)
11. Change ventilator circuit only when visibly soiled or malfunctioning.	26 (11.4)	51 (22.3)	152 (66.4)
12. Check the endotracheal tube cuff pressure at least once per shift and maintain it at 20–30 cmH2O.	17 (7.4)	25 (10.9)	187 (81.7)
13. Suction of the subglottic secretions through an extra lumen in the endotracheal tubes.	68 (29.7)	64 (27.9)	97 (42.4)
14. Provide scheduled and regular respiratory physiotherapy.	2 (0.9)	37 (16.2)	190 (83.0)
15. Interrupt sedation daily and assess readiness to extubate by daily spontaneous breathing trials.	4 (1.7)	21 (9.2)	204 (89.1)
16. Maintain the patient in a semi-fowler position.	6 (2.6)	12 (5.2)	211 (92.1)
17. Use of kinetic beds.	43 (18.8)	43 (18.8)	143 (62.4)

Abbreviations: VAP = ventilator associated pneumonia.

Table 2: Barriers related to the compliance with VAP prevention guidelines.

Barriers	Disagree n (%)	Neither agree, nor disagree n (%)	Agree n (%)
1. Shortage of nursing staff	59 (25.8)	9 (3.9)	161 (70.3)
2. Unavailability of resources (for example, sterile gloves, closed suction systems, kinetic beds, etc.)	153 (66.8)	3 (1.3)	73 (31.9)
3. Hospitals' cost control policies	82 (35.8)	13 (5.7)	134 (58.5)
4. Unavailability of written protocols for VAP Prevention	160 (69.9)	10 (4.4)	59 (25.8)
5. No continuous education on VAP	126 (55.0)	4 (1.7)	99 (43.2)
6. Lack of education in the university about the VAP prevention	148 (64.6)	3 (1.3)	78 (34.1)
7. Lack of professional role model and guidance	149 (65.1)	11 (4.8)	69 (30.1)
8. Practice in ICUs not based on research findings	143 (62.4)	3 (1.3)	83 (36.2)
9. Some research findings contradict nurses' previous education	165 (72.1)	7 (3.1)	57 (24.9)
10. Fear of unpredictable adverse effect and undesirable patient outcomes	127 (55.5)	8 (3.5)	94 (41)
11. Nurses' forgetfulness to perform some evidence-based procedures	72 (31.4)	6 (2.6)	151 (65.9)
12. Nurses do not have enough time to perform evidence-based procedures	149 (65.06)	3 (1.3)	77 (33.6)
13. Nurses lack required skills	189 (78.6)	8 (3.5)	41 (17.9)
14. Lack of patient cooperation	158 (69.0)	13 (5.7)	58 (25.3)
15. Some VAP prevention procedures are not nurses' responsibility	153 (66.8)	7 (3.1)	69 (30.1)

Abbreviations: ICU = intensive care units; VAP = ventilator-associated pneumonia.

Table 3: Compliance scores according to the characteristics of the nurse and ICU.

Characteristic	n (%)	Compliance Score		Test p-value
		Score from 34 Mean ± SD	Score from 100 Mean ± SD	
Total sample	**229** (100)	29.2 ± 3.85	85.9 ± 11.3	
Gender				
Female	214 (93.4)	29.3 ± 3.7	86.1 ± 11.0	
Male	15 (6.6)	27.9 ± 5.3	82.1 ± 15.5	0.183
Age (years)				
20−30	146 (63.3)	29.3 ± 4.2	86.1 ± 12.4	
>30−40	69 (30.1)	29.2 ± 3.3	86.0 ± 9.4	
>40	14 (6.1)	28.6 ± 3.0	84.2 ± 8.9	0.849
Nationality				
Saudi	63 (27.5)	29.3 ± 4.6	86.3 ± 13.5	
Non-Saudi	166 (72.5)	29.8 ± 3.5	85.8 ± 10.4	0.777
Level of qualification				
3-year diploma	47 (20.5)	29.5 ± 3.6	86.7 ± 10.55	
Bachelor's degree (BSN)	182 (79.5)	29.1 ± 3.9	85.7 ± 11.5	0.584
Position				
Staff nurse	222 (96.9)	29.25 ± 3.9	86.0 ± 11.4	
Head Nurse/In-charge nurse	7 (3.1)	28.1 ± 3.2	82.8 ± 9.4	0.456
Experience in ICU (years)				
1−5 years	147 (64.2)	29.5 ± 3.9	86.7 ± 11.5	
6−10 years	59 (25.8)	28.85 ± 3.85	84.8 ± 11.3	
>10 years	23 (10)	28.4 ± 3.5	83.5 ± 10.2	0.314
Type of Unit				
General ICU	70 (30.6)	30.2 ± 4.0	88.9 ± 11.7	
Medical ICU	47 (20.5)	28.0 ± 3.9	82.3 ± 11.6	
Surgical ICU	46 (20.1)	30.0 ± 2.8	88.4 ± 8.2	
Coronary Care Unit	35 (15.3)	29.3 ± 3.9	86.2 ± 11.5	0.002* (I#II,VI)†
Post cardiac surgery ICU	19 (8.3)	28.05 ± 3.5	85.9 ± 11.3	
Burn ICU	12 (5.2)	26.6 ± 4.25	78.2 ± 12.5	
Number of beds in ICU				
<10	33 (14.4)	27.3 ± 3.4	80.3 ± 10.0	
10−15	68 (29.7)	30.4 ± 4.1	89.4 ± 12.0	
16−20	93 (40.6)	29.0 ± 3.6	85.3 ± 10.45	0.002*
>20	35 (15.3)	29.3 ± 3.9	86.2 ± 11.5	(I#II)‡
Received education and training on mechanical ventilator management				
Yes	168 (73.4)	29.5 ± 3.7	86.8 ± 10.9	
No	61 (26.6)	28.4 ± 4.15	83.6 ± 12.2	0.062
Received education and training on VAP prevention				
Yes	159 (69.4)	29.6 ± 28.4	87.0 ± 10.7	
No	70 (30.6)	28.4 ± 4.2	83.4 ± 12.4	0.025

Abbreviations: ICU = intensive care units; VAP = ventilator associated pneumonia; SD = standard deviation.
*p-value indicates a significant difference between the subgroups, †Scheffé's test shows a significant difference between the nurse worked in general ICU from one side, and nurses work in the medical ICU and burn ICU from the other side. ‡Scheffé's test shows a significant difference between the nurse worked in ICUs contained 10−15 and nurses work in ICUs contained <10 beds.

Table 4: Factors influencing nurses' compliance with VAP prevention guidelines.

Predictor value	*B*	Std. Error	Beta	T	*P*	95% Confidence Interval for B	
						Lower Bound	Upper Bound
(Constant)	21.2	1.5		14.2	<0.001	18.3	24.1
Type of ICU (reference group: Burn ICU)							
• General ICU	4.5	1.1	0.5	4.0	<0.001	2.3	6.75
• Medical ICU	6.0	1.6	0.6	3.8	<0.001	2.9	9.1
• Surgical ICU	7.9	1.6	0.8	5.0	<0.001	4.8	11.0
• Coronary care unit	5.9	1.7	0.4	3.4	<0.001	2.5	9.2
Number of beds in ICU (reference group: ≤10 beds)							
• 10–15 beds	4.7	1.1	0.6	4.5	<0.001	2.6	6.8
• >20 beds	7.5	1.6	0.7	4.7	<0.001	4.3	10.6
Received education on VAP prevention (reference group: No)							
Yes	1.1	0.5	0.1	2.1	0.043	0.07	2.1

Abbreviations: ICU = intensive care units; VAP = ventilator-associated pneumonia.
Note: Dependent variable was the compliance score. β is the unstandardized coefficient. $R^2 = 0.180$; adjusted $R^2 = 0.154$.

Lower compliance with the VAP prevention guidelines was noted with other items, including changing the heat and moisture exchanger humidifiers weekly, using and changing the closed-circuit suction systems for every new patient, and using kinetic beds. The lowest compliance rate was reported for the items related to subglottic secretion suctioning.

From Table 2, the most reported barriers to implementing the guidelines recommendations were the shortage of nursing staff, forgetting to perform some evidence-based procedures, the hospitals' cost control policies, lack of continuous education, and the fear of an unpredictable adverse effect and undesirable patient outcomes.

Table 3 displays the compliance scores ranging from 17 to 34 (50–100%). The overall mean score of compliance was 29.2 of 34 (85.9%). A small proportion (23%) of the sample was categorized in the high compliance category and 31% in the good compliance category. Notably, almost half (45.9%) of the sample was categorized in the unsafe compliance category. Nurses working in a general ICU reported significantly higher compliance than nurses working in a medical ICU or burn ICU (30.2 ± 4.0 versus 28.0 ± 3.9 and 26.6 ± 4.25, P = 0.002). Nurses working in an ICU with 10–15 beds reported significantly higher compliance than nurses working in ICUs containing <10 beds (30.4 ± 4.1 versus 27.3 ± 3.4, P = 0.002). Nurses who previously received education regarding VAP prevention reported higher compliance than nurses with the no previous education regarding VAP prevention (29.6 ± 28.4 versus 28.4 ± 4.2, $P = <0.025$).

From Table 4, the multiple linear regression analysis indicated that the nurses in the general ICU had an average compliance score of 4.5 higher than those in the burn ICU ($p < 0.001$). Nurses in the medical ICU had an average compliance score of 6.0 higher than those in the burn ICU ($p < 0.001$). Nurses in the surgical ICU had an average compliance score of 7.9 higher than those in the burn ICU ($p < 0.001$). Nurses in the coronary care unit had an average compliance score of 5.9 higher than those in the burn ICU ($p < 0.001$). Nurses in ICU with 10–15 beds had an average compliance score 4.7 higher than nurses who worked in ICU with <10 beds ($p < 0.001$). Nurses in ICU with >20 beds had an average compliance score of 7.5 higher than nurses who worked in ICU with <10 beds ($p < 0.001$). Nurses who received educational on VAP prevention education had a compliance score of 1.1 higher than those who did not ($p < 0.043$).

Discussion

There are large variations in the VAP rates among different countries. In 2008, a systemic review found that the incidence rate of VAP in developing countries ranged from 10 to 41.7 per 1,000 ventilator-days, with KSA reported rate of 16.8 episodes per 1,000 ventilator-days[28]; however, a recent review found that the VAP incidence rate in KSA was the lowest rate among 22 countries in Asia, with 3.6 episodes per 1,000 ventilator-days.[6] The low VAP incidence rate in KSA could be attributed to the compliance of critical care nurses with the VAP prevention guidelines. The compliance rate of the current study (85.9%) is higher than reported in Spain (77%),[14] Pakistan (77.5%),[29] 13 European countries (72%),[3] Middle East (68.3%),[18] Brazil (66.7%),[30] Iran (26.3%),[17] and Finland (65.8%).[15] This level of compliance could be attributed to the availability of policies and procedures related to VAP prevention in all ICUs. All hospitals in Almadinah Almunawwarah have an Infection Control Committee, continuous in-service education, and adequate resources. Recently, Aloush et al.[18] reported that Saudi hospitals had higher compliance scores to the VAP prevention guidelines than Jordanian and Egyptian hospitals. El-Saed et al.[31] also reported that Saudi hospitals implemented the VAP prevention bundle.

Several studies have reported significant reductions in the VAP incidence rates in ICUs of KSA after implementing the VAP prevention bundle.[9,10,32–39] There are direct and strong negative correlations between the VAP prevention bundle compliance and VAP incidence rates. Most VAP episodes are avoidable, and achieving VAP rates of zero or close to zero seems possible but requires continuous active surveillance and persistent adherence to VAP prevention bundle with >95% compliance rates.[9,32,40–44] The finding of the current study shows room for improvement in the nurse's compliance. Full compliance with VAP prevention

bundles and guidelines is required to decrease the VAP rates further. VAP-related educational courses must be initiated in each hospital with an expected outcome of full compliance with VAP prevention guidelines and reducing VAP incidence rates.

The critical care nurses reported high compliance with many measures of VAP prevention. These measures are often taught in nursing courses at the undergraduate level as an important component of basic nursing care and considered a nursing responsibility by most disciplines and hospital policies. This finding is consistent with multiple studies reporting 92% compliance with handwashing,[15] 93% with sterile gloves for open suction,[14] 87–100% with bed head elevation,[3,45,46] 77.8–94.8% with oral care at least once per shift,[16,30,47] 89–96.87% with chlorhexidine-based oral care,[14,15,46] and 93% with daily sedation vacation.[4] In contrast, studies reported only 11% compliance with handwashing,[14] 34.5% with bed head elevation,[30] 49.8% with oral care,[48] 0–59% with the chlorhexidine-based oral care,[17,18,47] and 31% with sedation vacation and assessment of readiness to extubate.[18]

In the current study, the items with a low compliance rate were changing the ventilator circuit, changing the heat and moisture exchanger (HME) humidifiers, using and changing the closed-circuit suction systems, and using kinetic beds. The lowest compliance rate was for subglottic secretion suctioning. These measures may not be included in the nursing curriculum and course contents at the undergraduate level. Only the nurses who received hospital-based education and training on VAP prevention performed these measures. Critical care nurses implement some measures, and respiratory therapists implement others. Ambiguities about the nurse's expected role in these measures have been reported.[2,15] Additionally, the implementation of some bedside measures depends primarily on the hospital's compliance. Limited availability of kinetic beds, closed-circuit suction systems, and endotracheal tubes with an extra lumen for subglottic-secretion suctioning are possible reasons.[18,46] However, this finding is comparable to the literature reporting 11%–47% compliance with subglottic-secretion suctioning,[45–47] 20% with the closed-circuit suction system,[47] 34% with changing the HMEs humidifier,[3] 12.9%–22% with changing the ventilator circuit[3,45] and 42.6% with kinetic bed therapy.[15] Additionally, 0% use was reported for subglottic secretion aspiration, HME humidifiers, and closed-circuit suction system.[17]

Working in a general ICU or ICU containing 10–15 beds or having had education regarding VAP prevention were significant factors influencing the nurses' compliance. Critical care nurses working in a general ICU reported higher compliance than nurses working in a medical and burn ICU. Lin et al.[48] report that the ICU type was a significant factor in compliance with oral care. Literature does not explain this, and in-depth research is required to investigate the possible causes.

Critical care nurses working in ICUs with an average bed capacity (10–15 beds) demonstrated higher compliance than those in ICUs with a lower or higher bed capacity. The reasons could be the occupation rate, the nurse per patient ratio, and the workload in these units. We did not assess the units' occupation rate, nurse per patient ratio, or the nurses' workload. In our study, the shortage of ICU nurses, shortage of time to perform evidence-based procedures, and cost control policies were reported as barriers preventing compliance, similar to other studies.[15,16] Cost control policies decrease the number of nurses in the ICU, decreasing the time available to perform procedures. Nurses working in units with a lower workload are more likely to comply with the guidelines. Increasing the number of nurses per ICU would probably result in higher compliance with the VAP prevention guidelines, improved patient care, and lower nosocomial infections.[18,41]

In the current study, about one-third of critical care nurses never received any education or training regarding VAP prevention in their hospitals. Moreover, the study shows that nurses who had prior education regarding VAP prevention had a significantly higher compliance score than the no education group. Regarding barriers, the lack of hospital-based education about VAP prevention and nurses' forgetfulness to perform some evidence-based procedures were reported by 43.2% and 65.9% of the nurses, respectively. This finding is congruent with other studies reporting a significant increase in compliance with VAP prevention guidelines after participating in an in-service educational intervention.[12,30] Similarly, studies reported the lack of education and knowledge of evidence-based practice guidelines as a barrier to compliance.[2,15,18,29]

The findings highlight the importance of education and modifying the contents of formal undergraduate education and in-service education programs. More focus on evidence-based undergraduate education guidelines and regular refresher courses by the in-service education after graduation[49] are required. In-service education should use multiple active implementation strategies, such as courses, lectures, seminars, printed materials, posters, reminders, rewards, regular auditing, and giving feedback to enhance the providers' awareness and compliance.[2,15,50]

Strengths and limitations

A major strength of the study is the high response rate and the inclusion of multitudes of nurses from all public hospitals in Almadinah Almunawwarah. However, this study has two limitations. Firstly, the instrument was a self-reported questionnaire, and secondly, only participants from only one region of KSA (Almadinah Almunawwarah) were included. Future studies should use a combination of a self-report and observation methodology, conducted in a wider setting to enhance the reliability of the findings.

Conclusions

The overall compliance rate reported by the nurses was acceptable. However, the recommended VAP prevention measures are not consistently and uniformly implemented. Working in a general ICU or an ICU containing 10–15 beds or having had education regarding VAP prevention improves the nurses' compliance. However, the shortage of nursing staff, forgetting to perform some evidence-based

procedures, and the hospital cost control policies are the main barriers to implementing the guidelines.

Recommendations

Based on the findings, continuous training and raising awareness of the critical care nurses regarding all VAP prevention strategies should be considered. Specific items requiring attention are the subglottic secretion suctioning, the frequency of changing the heat and moisture exchanger humidifiers, and the closed-circuit suction systems. Provision of standard staffing, equipment, and updated clinical guidelines and protocols are recommended.

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Conflict of interest

The author has no conflict of interest to declare.

Ethical approval

The research was performed according to the ethical standards and complied with the 1964 Helsinki Declaration and its later amendments. Ethical approval was obtained from the Institutional Review Board, general directorate of health affairs in Almadinah Almunawwarah (IRB-50). Permissions to conduct the study were granted by the hospitals' administrations and ICUs' managers. Nurses were provided with an information sheet containing all information about the study. Additionally, the study's purpose, the risks, and the benefits of their participation were explained before the nurses completed the questionnaire. Nurses were asked to participate in the study voluntarily. Confidentiality of nurses and ICUs was maintained. The date is in HIjiri calendar (7/6/1438H).

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