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Original Research Article

Enhancing Patient Safety: Assessing ICU Nurses' Knowledge and Compliance in Ventilator-Associated Pneumonia Prevention at King Fahad General Hospital, Saudi Arabia

Falak Abdul-Jabbar Barnawi[1*], Yasmin Barnawi[2], Hanan Al-Modallal[3]

[1]Senior Specialist in Adult Critical Care Nursing, Clinical Instructor, Nurse Department, King Fahad General Hospital, P.O. Box 5035, Madinah Al Munawara 42351, Saudi Arabia
[2]Senior Pharmacist, Medication Safety Officer, Pharmacy Department, Prince Sultan Military Medical City, P.O. Box 7897, Riyadh 11159, Saudi Arabia
[3]PhD in Nursing, Department of Community and Mental Health Nursing, Faculty of Nursing, Fakeeh College for Medical Sciences, Jeddah, Saudi Arabia

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***Corresponding author:** Falak Abdul-Jabbar Barnawi
Senior Specialist in Adult Critical Care Nursing, Clinical Instructor, Nurse Department, King Fahad General Hospital, P.O. Box 5035, Madinah Al Munawara 42351, Saudi Arabia

Abstract

Background: Ventilator-associated pneumonia (VAP) is a prevalent cause of morbidity and mortality in intensive care units (ICUs). Defined as a nosocomial pneumonia that occurs more than 48 hours after mechanical ventilation initiation, VAP poses significant clinical challenges. While awareness of evidence-based practices is crucial, a gap often exists between knowledge and actual practice among nursing staff. Enhanced adherence to VAP prevention protocols has been linked to reduced incidence rates. ***Purpose***: This study aims to assess the level of nurses' knowledge and compliance regarding the prevention of VAP in the intensive care unit of King Fahad General Hospital in Saudi Arabia. ***Method***: A descriptive research design was employed, involving 120 ICU nurses selected through convenience non-probability sampling. ***Result*:** A total of 96 participants were recruited in this study. The level of knowledge about VAP prevention among ICU nurses was almost good as there were about 57.3% (n=55) of the nurse participants had a good and adequate information. There was significant statistical difference in the mean knowledge score based on the academic qualification but, there was no statistical difference in mean of compliance based on academic qualification. ***Conclusion*:** Insufficient nursing knowledge and compliance about VAP assessment and prevention is a serious safety concern in all healthcare settings. The study highlighted that ICU nurses showed (good) moderate knowledge towards VAP prevention.

Keywords: Ventilator-associated pneumonia; intensive care unit; nurses; knowledge; compliance.

1. INTRODUCTION AND BACKGROUND OF THE STUDY

In hospitals, Intensive Care Units (ICUs) are among the leading wards in the rate of hospital-acquired infections (HAI) (Bankanie *et al*., 2021). Hospital-acquired infections in ICUs are mainly related to the ventilator (called ventilator acquired pneumonia (VAP)). Nosocomial pneumonia in ventilated patients that develops more than 48 hours after beginning of mechanical ventilation" is how the VAP is characterized. VAP has long been related to longer ICU stays and higher hospital expenses around the world, despite the fact that precise attributable mortality from VAP is difficult to verify (Bankanie *et al*., 2021).

A new or progressive infiltration, fever, an altered white blood cell count, and purulent tracheobronchial secretions are all symptoms of this infection (Bankanie *et al*., 2021). While knowledge does not necessarily reflect practice, it is the first step toward implementing evidence-based practices. The most significant barrier to nurses' adherence to evidence-based practice is a lack of awareness about whether the evidence exists or what they should be doing (Al-Busaidi *et al*., 2019). In order to provide better patient care, nurses in the intensive care units (ICU) must be aware about the prevention of numerous hospital-acquired illnesses including VAP (Bankanie *et al*., 2021).

While there has been considerable disagreement among academics about specific bundle components (Bankanie *et al*., 2021), when all of the primary bundle components are in good working order, VAP is reduced (Parisi *et al*., 2016). According to related studies, all components of the bundles have a high level of compliance (above 95 percent) unless there is a compelling explanation for clinical deviation, and the reasons are clearly documented (Bankanie *et al*., 2021). The VAP can be effectively avoided when compliance is strong. Improved compliance of the VAP bundle components from 0 to 32.75 % reduced VAP incidence density from 33.74 to 18.05 VAP cases per 1000 days on the ventilator in recent research in the Democratic Republic of Congo (Bankanie *et al*., 2021). In the ICU, VAP is a leading cause of disease and death, and the endotracheal tube cuff pressure is arguably the most effective preventative technique for preventing VAP. One of the basic mechanisms for preventing lung infections and lowering VAP, according to the author, is comprehensive oral care with 2% chlorhexidine. Oral hygiene can help prevent the spread of infection-causing germs (Al-Qarni, 2021). The purpose of the current study is to assess the level of nurses' knowledge and compliance regarding ventilator care bundles in intensive care units based on hospital evidence-based guidelines in the intensive care unit of King Fahad General Hospital located in Madinah, Saudi Arabia. It is necessary that the knowledge and compliance are assessed so that measures are taken for the patient safety and quality improvement. Assessing the knowledge and compliance of ICU nurses in King Fahad General Hospital regarding VAP prevention will be helpful to bridge this gap.

2. METHODS

Study Design

Descriptive research design was carried out to assess the level of knowledge and compliance of nurses in preventing VAP in the intensive care unit of King Fahad General Hospital located in Madinah, Saudi Arabia.

Study Participants and Sample

A non-probability convenient sampling technique would be used to select the proposed sample of nurses in the ICU. A convenience sample is a non-probability sample in which the researcher chooses individuals based on their suitability for the research. This method, sometimes known as "coincidental sampling" (Schmidt *et al*., 2018). The sample size was calculated based on the fact the total number of ICU nurses in King Fahad General Hospital located in Madinah, Saudi Arabia is 120. With 95% level of confidence, margin of error (MOE) of 5%, and a population proportion of 50%, the estimated sample size for the current study was 92 nurses.

Inclusion Criteria

Inclusion criteria includes nurses working at the intensive care units at King Fahad General Hospital located in Madinah, Saudi Arabia, holding Diploma, bachelor's or master's degree in nursing.

Exclusion Criteria

All nurses working in departments other than intensive care unit at King Fahad General Hospital located in Madinah, Saudi Arabia during the study duration will be excluded from the study. Further, practical nurses and nurses who were available in the ICU as relief/helping (floated) nurses would be excluded from the study.

3. Setting and Recruitment

The study was carried out in the ICUs of King Fahad General Hospital (KFGH) in Madinah Al Munawara in Saudi Arabia. The hospital is the biggest and general hospital in Madinah region, and it include 500 bed capacity and 898 population of nurses of different educational qualifications. KFGH is the first reference hospital for Madinah region. The hospital offers health services in various specializations including neurology, general surgery, gastrointestinal and endoscopy, nephrology, orthopedic surgery, physical therapy, as well as other delicate medical disciplines.

Data Collection Procedure

Data collection began after the approval from the Institutional Review Board (IRB) of Fakeeh College for Medical Sciences and King Fahad General Hospital. The researcher visited the ICUs of King Fahad General Hospital and met with the head nurse in these units and asked her to involve me in the WhatsApp group of the ICU nurses. First, the nurses were invited to participate in the study based on the selected inclusion and exclusion criteria. The purpose of the study was clarified and discussed with the nurses. Rights of every respondent was clearly explained. The researcher made sure that the respondents understood the purpose, objectives, and required data needed for the study. The link of the study questionnaire was sent to the nurses in the WhatsApp group. Afterwards, the consent form was the first question in the link where participants who agreed to participate in the study were able to do so and those who refused to participate were asked to end responding to the questions. Nurses were asked to provide data to the best of their knowledge. The data was collected from the respondents electronically and kept with the researcher. Afterwards, coding was performed, and data was entered into SPSS for analysis.

Research Scale/Instrument

A self-administered questionnaire was adopted from two research articles after getting the permission from the authors. The questionnaire consists of three parts. The first part of the questionnaire included the demographic profile of the respondents including gender, age, clinical experience and educational qualification.

The second part of the questionnaire included 15 items adopted from Aziz *et al*., (2020). The 15-items

Multiple-Choice Questions (MCQs) were used to assess the nurses' knowledge regarding VAP prevention. Each question had (4) possible answers; one was correct and received a score of (1), while the other 3 answers were incorrect and received a score (0). The total scale score ranged between 0 and 15 where higher scores were indicative of higher knowledge levels. Further, the level of knowledge was classified into 4 categories based on the total obtained score; {the score between (81-100)% was considered as an excellent level of knowledge; between (61-80)% considered as a good knowledge level; between (41-60)% consider an average knowledge level; and less than 40% considered as poor knowledge}. The tool was tested for validation by Blot, 2007.The third part of the questionnaire was adopted from Bankanie *et al*., (2021). This section was comprised of 25 items using a 5- point Likert scale to assess the nurses' compliance regarding VAP prevention. Each question was rated on a scale ranging from (1 = strongly disagree) to (5 = strongly agree). The total scale score ranged between 25 and 125 where higher scores were indicative of higher compliance levels.

Data Analysis

The data was analyzed using the Statistical Package for the Social Sciences (SPSS). Statistical analysis was done accordingly to the most currently reliable and valid statistical methods. Frequency and percentage were used to analyze the demographic characteristics of the respondents. Descriptive statistics were used as well to describe nurses' level of knowledge and compliance related to VAP prevention in intensive care units in King Fahad General Hospital. The t-Test and ANOVA were used to find differences in the mean knowledge and compliance on VAP prevention based on nurses' demographic profile.

Scope and Limitations of the Study

The study focused on assessing the knowledge and compliance f ICU nurses on VAP prevention. The target population was nurses working in the ICU of King Fahad General Hospital located in Madinah, Saudi Arabia which is very limited that will end up with a small number of recruited sample size.

Ethical Consideration

Ethical approval for this study was obtained from the Institutional Review Board of Fakeeh College for Medical Sciences and King Fahad General Hospital with IRP (025-2022). Consent form was declared and distributed to the participants before administering the questionnaire. The respondents were assured that no threats or coercion will be encountered while conducting the study and that they could freely withdraw from the study at any time.

4. RESULT

4.1 The demographic characteristics of the study participants.

A total of 96 participants were recruited in this study. The results presented in Table (4.1) represent the socio-demographic characteristics of the study participants. About 51.0% (n=49) of the nurses were greater than 30 years old, 39.6% (n=38) were 26 to 30 years. In addition, 9.4% (n=9) of the participating nurses were 20 to 25 years. Male participants constituted only 5.2% (n=5), whereas females constituted 94.8% (n=91). Most of the participants (60.4%, n=58) were married. The results revealed that 77.1% (n=74) of the participating nurses were having baccalaureate (BSN) degree, whereas 17.7% (n=44) had a diploma, 5.2% (n=5) had master's degree. About 51% (n=49) of nurses were non-Saudi, whereas 49% (n=47) were Saudi. Finally, the represented category of having an experience more than 10 years were 39.4% (n=38) and those who have had 6 to 10 years of experience were 34.4%(n=33) but those who have one to five years and less than one year of experience were 21.9%(n=21), 4.2%(n=4), respectively (see Table 4.1).

Table 4.1: Socio Demographic Characteristics of Nurses at ICU

		N	%
Gender	Male	5	5.2%
	Female	91	94.8%
Nationality	Saudi	47	49.0%
	Non-Saudi	49	51.0%
Age	Between 20 to 25 years	9	9.4%
	Between 26 to 30 years	38	39.6%
	Greater than 30 years	49	51.0%
Years of Experience	Less than one year	4	4.2%
	From 1 to 5 years	21	21.9%
	From 6 to 10 years	33	34.4%
	More than 10 years	38	39.6%
Education Qualification	Diploma	17	17.7%
	Baccalaureate (BSN) Degree	74	77.1%
	Master's Degree	5	5.2%
Marital status	Married	58	60.4%
	Single	35	36.5%

		N	%
	divorced	2	2.1%
	widow	1	1.0%

4.2 Results related to Knowledge of ICU Nurses on VAP Prevention

The results presented in (Table 4.2) showed the frequencies and the percentage of each statement concerning knowledge of ICU nurses on VAP Prevention. Regarding the knowledge of ventilator care bundle, the results showed that 91.7% (n=88) of ICU nurses have chosen the correct answer which is (A checklist used as a protocol of care for mechanically ventilated patients). The results related to question of 'Non-Compliance to ventilator care bundle (VCB) tends to be associated with the majority of the participants 65.6% (n=63) answered correctly by selected the choice (High mortality in mechanically ventilated patients). The results related to question (Which component is not included in the VCB for the prevention of VAP?) showed a good response from the participants. About 83.3% (n=80) chose the correct answer. Similarly, about the question (when the VAP would occur in patients who are on mechanical ventilation) 65.6% (n=63) answered it correctly, and the questions (Which is the recommended position for mechanically ventilated patient for the prevention of VAP?) and (Head side of the bed should be elevated at?) also were answered correctly by 79.2% (n=76), 87.5% (n=84) of the participants, respectively. Additionally, the questions (What is the effect of kinetic beds for the prevention of VAP reduces the risk for VAP?), (Which route is best recommended when intubating a patient?) and (A nurse caring a ventilated patient is required to wash hands?) were answered correctly by 64.6% (n=62), 87.1% (n=75) and 93.8% (n=90) of the participants, respectively. In contrast, the question which focused about the guideline for preventing VAP (Evidence based guidelines for preventing VAP recommended changing ventilator circuits how frequently?), just about 13.5% (n=13) of the participants selected the correct answer. Also, the question that reflect (using swab moistened with chlorhexidine 0.1% for oral care) was answered correctly by about 10.4% (n=10) of the participants.

Table 4.2: Knowledge of ICU Nurses on VAP Prevention

Knowledge Statement	Correct Answer	Number with correct answer	Percentage
VCB (ventilator care bundle) is:	A checklist used as a protocol of care for merchantly ventilated patients.	88	91.7%
Non-Compliance to VCB tends to be associated with	High mortality in mechanically ventilated patients	63	65.6%
Which component is not included in the VCB for the prevention of VAP?	Administration of antibiotic	80	83.3%
VAP would occur in patients who are on mechanical ventilation for;	48 hours	63	65.6%
Which is the recommended position for mechanically ventilated patient for the prevention of VAP?	Semi recumbent position	76	79.2%
Head side of the bed should be elevated at?	30-45 degrees	84	87.5%
What is the effect of kinetic beds for the prevention of VAP reduces the risk for VAP?	Reduces the risk for VAP.	62	64.6%
Which route is best recommended when? intubating a patient?	Oral rout	75	78.1%
A nurse caring a ventilated patient is required to wash hands?	Before and after oral and ETT suctioning	90	93.8%
It is recommended to perform oral care by using a swab moistened with chlorhexidine 0.1%;	Twice daily	10	10.4%
One of the components of VCB is	Sedation Interruption	66	68.8%
Early weaning	Reduces the risk for VAP	83	86.5%
What is the role of respiratory physiotherapy for preventing VAP?	Highly recommended	80	83.3%
Contraindication for DVT prophylaxis include	All of above	67	69.8%

4.3 Results related to compliance of ICU nurses on VAP prevention.

About 36.5% (n=35) of the participants strongly agreed about the statement of 'Removal of nasogastric tube as soon as clinically. Also, about 38.5% (n=37) agreed regarding the statement 'Enteral feeding protocol/avoidance of gastric over distention '. Moreover, regarding the Semi recumbent position of the patient (30-45), about 77.1% (n=74) of the participants strongly agreed on the statement. About 54.2% (n=52) of the participants strongly agree about the humidification with heat and moisture exchanger. In addition, regarding the daily changes of heat & moist exchanger, about 36.5% (n=35) of the participants strongly agreed. Regarding the chest physiotherapy, 81.3% (n=78) of the participants strongly agreed. Moreover, regarding the 'Adequate hand hygiene between the patients', the majority of the participants 92.7% (n=89) strongly agreed. About 79.2% (n=76) of the participants strongly agreed to the statement "maintained an adequate pressure in the endotracheal tube cuff". The majority of the participants 75% (n=72) were strongly agreed to Scheduled drainage of condensate from ventilator circuit and about 52.1% (n=50) were strongly agreed to do subglottic suctioning continuously and about 89.6% (n=86) were strongly agreed to "Use of protective gowns during suctioning" but, regarding the "use of pre suctioning analgesia", just 39.6% (n=38) of the participants were strongly agreed. On the other hand, about 88.5% (n=85) of the participants were strongly agreed to perform hyperoxygenation pre suctioning and 92.7% (n=89) of the participants were strongly agreed to wear face mask during suctioning. Regarding the "Sterility of suction catheter maintained until inserted into airway", quite enough number of the participants 87.5%(n=84) strongly agreed. About 75% (n=78.1) of the participants indicating their agreement for "Protection of patients eyes & central venous catheter from secretion during suctioning" and about 79.2% (n=76) of the participants were strongly agree to "perform suctioning by two nurses". Using Sodium chloride instillation got variety of decision among the participant where about 49% (n=47) of the participants strongly agreed. Moreover, huge number of the participants 90.6% (n=87) were strongly agreed to "used catheter & gloves are disposed of in a manner that prevent contamination from secretion". Additionally, 80% (n=77) of the participants were strongly agreed bout respiratory weaning protocol, and "sedation protocol" (72.9% (n=70). The majority of the participants 77.1% (n=74) were strongly agreed to use to use extubation protocol. Furthermore, about 76% (n=73) of the participants were strongly agreed to avoidance unnecessary reintubation. Finally, patient positional treatment gained strongly agreement from about 79.2% (n=76) of the participants. (See table 4.3).

Table 4.3: Compliance of ICU Nurses on VAP Prevention

Compliance statement	Most reported response	Number	Percent age
1. Removal of nasogastric tube as soon as clinically feasible	Strongly Agree	35	36.5%
2. Enteral feeding protocol/avoidance of gastric over distention	Agree	37	38.5%
3. Semi recumbent position of the patient (30-45)	Strongly agree	74	77.1%
4. Humidification with heat and moisture exchanger	Strongly Agree	52	54.2%
5. Daily changes of heat & moist exchanger	Strongly Agree	35	36.5%
6. Chest physiotherapy	Strongly Agree	78	81.3%
7. Adequate hand hygiene between the patients	Strongly Agree	89	92.7%
8. Use of formal infection-control program	Strongly Agree	79	82.3%
9. Maintenance of adequate pressure in the endotracheal - tube cuff	Strongly Agree	76	79.2%
10. Scheduled drainage of condensate from ventilator circuit	Strongly Agree	76	79.2%
11. Continues subglottic suctioning	Strongly Agree	50	52.1%
12. Use of protective gowns during suctioning	Strongly Agree	86	89.6%
13. Pre-suctioning analgesic	Strongly Agree	38	39.6%
14. Pre-suctioning hyperoxygenation	Strongly Agree	85	88.5%
15. Face mask wearing during suctioning	Strongly Agree	89	92.7%
16. Sterility of suction catheter maintained until inserted into airway	Strongly Agree	84	87.5%
17. Protection of patient's eyes & central venous catheter from secretion during suctioning	Strongly Agree	75	78.1%
18. Two nurses perform suctioning	Strongly Agree	76	79.2%
19. Sodium chloride instillation	Strongly Agree	47	49.0%
20. Used catheter & gloves are disposed of in a manner that prevent contamination from secretion	Strongly Agree	87	90.6%
21. Sedation protocol	Strongly Agree	70	72.9%
22. Respirator & weaning protocol	Strongly Agree	77	80.2%
23. Avoidance unnecessary reintubation	Strongly Agree	73	76.0%
24. Extubation protocol	Strongly Agree	74	77.1%
25. 25. Patient positional treatment	**Strongly Agree**	76	79.2%

4.4 Knowledge score means between male and female.

To assess the differences in the knowledge based on gender, an independent samples t- test was conducted. The result showed that: There was no significant statistical difference in the mean knowledge score about ventilation associated pneumonia prevention between males (mean 8.40, SD =3.58) and females (mean =9.73, SD=1.85) (independent sample t-test was conducted p value =0.456) (see Table 4.4).

Table 4.4: Knowledge score means between male and female

	Gender	N	Mean	Std. Deviation	Std. Deviation	T value	P value
Knowledge score	Male	5	8.40	3.58	1.60	0.822	0.456
	Female	91	9.73	1.85	.194		

4.5 Knowledge score means Saudi and non-Saudi nationality:

To assess the differences in the knowledge based on nationalities, an independent samples t-test was conducted. The result showed that: There was no significant statistical difference in the mean knowledge score about ventilation associated pneumonia prevention between Saudi nurses (mean 9.531, SD =2.282) and non-Saudi nurses (mean =9.77, SD=1.62) (independent sample t-test was conducted p value =0.550) (see Table 4.5).

Table 4.5: Knowledge score means Saudi and non-Saudi nationality

	Nationality	N	Mean	Std. Deviation	Std. Deviation	T value	P value
Knowledge score	Saudi	47	9.5319	2.28274	.33297	0.600	**0.550**
	Non-Saudi	49	9.7755	1.62359	.23194		

4.6 Knowledge score means between age groups:

To assess the differences in the knowledge based on age groups, One-way ANOVA was conducted. The result showed that: There was no significant statistical difference in the mean knowledge score about ventilation associated pneumonia prevention between "age group 20-25 years" (mean 9.44, SD =0.659, "between 26-30 years old" (mean =9.921, SD=0.321) and among age group that "greater than 30 years old" (mean=9.490, SD =0.282). One-way ANOVA was conducted p value =0.569) (see Table 4.6).

Table 4.6: Knowledge score means between age groups

Age	Mean	Std. Error	P value
Between 20 to 25 years	9.444	.659	0.569
Between 26 to 30 years	9.921	.321	
Greater than 30 years	9.490	.282	

4.7 Knowledge score means between Years of Experience:

To assess the differences in the knowledge based on years of experience, One-way ANOVA was conducted. The result showed that: There was no significant statistical difference in the mean knowledge score about ventilation associated pneumonia prevention between years of experience "less than one year" (mean 8.750, SD =0.980, "1-5 years of experience" (mean =9.476, SD=0.428), "6-10 years of experience" (mean=10.152, SD =0.341) and "more than ten years" (mean=9.421, SD =0.318). (One-way ANOVA was conducted p value =0.304) (see Table 4.7).

Table 4.7: Knowledge score means between Years of Experience

Years of Experience	Mean	Std. Error	P value
Less than one year	8.750	.980	0.304
From 1 to 5 years	9.476	.428	
From 6 to 10 years	10.152	.341	
More than 10 years	9.421	.318	

4.8 Knowledge score means between Education Qualification:

To assess the differences in the knowledge based on educational qualification, One-way ANOVA was conducted. The result showed that: There was significant statistical difference in the mean knowledge score about ventilation associated pneumonia prevention between education qualification, "diploma" (mean 8.353, SD =0.457, "BSN degree" (mean =9.986, SD=0.842), "master degree" (mean=9.200, SD =0.842) (One-way ANOVA was conducted p value =0.006) (see Table 4.8).

Table 4.8: Knowledge score means between Education Qualification

Education Qualification	Mean	Std. Error	P value
Diploma	8.353	.457	0.006
Baccalaureate (BSN) Degree	9.986	.219	
Master's Degree	9.200	.842	

4.9 Knowledge score means between Marital status:

To assess the differences in the knowledge based on marital status, One-way ANOVA was conducted. The result showed that: There was no significant statistical difference in the mean knowledge score about ventilation associated pneumonia prevention between marital status "married" (mean 9.724, SD =0.261), "single" (mean =9.543, SD=0.336)," divorced (mean=10.500, SD =1.404) and "widow" (mean=8.00, SD =1.986). (One-way ANOVA was conducted p value =0.744) (see Table 4.9).

Table 4.9: Knowledge score means between Marital status

Marital status	Mean	Std. Error	P value
Married	9.724	.261	0.744
Single	9.543	.336	
Divorced	10.500	1.404	
Widow	8.000	1.986	

4.10 Compliance score means between male and female:

To assess the differences in the compliance based on gender, an independent samples t-test was conducted. The result showed that: There was significant statistical difference in the mean compliance score about ventilation associated pneumonia prevention between "males" (mean 90.00, SD =14.40) and "females" (mean =114.18, SD=8.009). (independent sample t- test was conducted p value =0.019) (see Table 4.10).

Table 4.10: Compliance score means between male and female

	Gender	N	Mean	Std. Deviation	Std. Error Mean	T value	P value
Compliance score	Male	5	90.00	14.40	6.44	3.723	0.019
	Female	91	114.18	8.009	.839		

4.11 Compliance score means Saudi and non-Saudi nationality.

To assess the differences in the compliance based on nationalities, an independent samples t-test was conducted. The result showed that: There was significant statistical difference in the mean compliance score about ventilation associated pneumonia prevention between "Saudi" nurses (mean 110.45, SD =12.39) and "non-Saudi nurses". (mean =115.31, SD=6.032) on compliance score about ventilation associated pneumonia prevention (independent sample t-test was conducted p value =0.018) (see Table 4.11).

Table 4.11: Compliance score means Saudi and non-Saudi nationality

	Nationality	N	Mean	Std. Deviation	Std. Error Mean	T value	P value
Compliance score	Saudi	47	110.45	12.39	1.807	2.427	**0.018**
	Non-Saudi	49	115.31	6.032	.861		

4.12 Compliance score means between age groups:

To assess the differences in the knowledge based on age groups, One-way ANOVA was conducted. The result showed that: There was significant statistical difference in the mean compliance score about ventilation associated pneumonia prevention between age groups "20- 25 years" (mean 105.22, SD =3.240), "between 26-30 years old" (mean =113.92, SD=1.577) and among age group that "greater than 30 years old" (mean=113.57, SD =1.388). (One-way ANOVA was conducted p value =0.048) (see Table 4.12).

Table 4.12: Compliance score means between Age groups

Age	Mean	Std. Error	P value
Between 20 to 25 years	105.222	3.240	0.048
Between 26 to 30 years	113.921	1.577	
Greater than 30 years	113.571	1.388	

4.13 Compliance score means between Years of Experience:

To assess the differences in the compliance based on years of experience. One-way ANOVA was conducted. The result showed that: There was no significant statistical difference between years of experience less than one year (mean =113.250, SD =4.876, from "1-5 years of experience" (mean =108.143, SD=2.128), "6-10 years of experience" (mean=114.6, SD=1.698) and "more than ten years" (mean=114.00, SD =1.582). (One-way ANOVA was conducted p value =0.093) (see Table 4.13)

Table 4.13: Compliance score means between Years of Experience

Years of Experience	Mean	Std. Error	P value
Less than one year	113.250	4.876	0.093
From 1 to 5 years	108.143	2.128	
From 6 to 10 years	114.697	1.698	
More than 10 years	114.000	1.582	

4.14 Compliance score means between Education Qualification:

To assess the differences in the compliance based on educational qualification, One-way ANOVA was conducted. The result showed that: There was no significant statistical difference in the mean compliance score about ventilation associated pneumonia prevention between education qualification of "diploma" (mean =112.882, SD =2.435, "BSN degree" (mean =112.865, SD=1.167), "master degree" (mean=114, SD =4.489). (One-way ANOVA was conducted p value =0.970) (see Table 4.14)

Table 4.14: Compliance score means between Education Qualification

Education Qualification	Mean	Std. Error	P value
Diploma	112.882	2.435	**0.970**
Baccalaureate (BSN) Degree	112.865	1.167	
Master's Degree	114.000	4.489	

4.15 Compliance score means between Marital status:

To assess the differences in the Compliance based on marital status, One-way ANOVA was conducted. The result showed that: There was no significant statistical difference in the mean compliance score about ventilation associated pneumonia prevention between marital status "Married" participants (mean 114.603, SD =1.288, "single" (mean =109.857, SD=1.657)," divorced" (mean=117, SD =6.934) and "widow" (mean=115.00, SD =9.806). (One-way ANOVA was conducted p value =0.146) (see Table 4.15).

Table 4.15: Compliance score means between Marital status

Marital status	Mean	Std. Error	P value
Married	114.603	1.288	0.146
Single	109.857	1.657	
Divorced	117.000	6.934	
Widow	115.000	9.806	

The level of knowledge about VAP prevention among ICU nurses was almost good as there were about 57.3% (n=55) of the nurse participants had a good and adequate information (see Table 4.16).

Table 4.16: Level of Knowledge

		N	N%
Level of Knowledge	Excellent	2	2.1
	Good	55	57.3
	Average	35	36.5
	Poor	4	4.2
	Total	**96**	**100.0**

5. DISCUSSION

The reported level of knowledge regarding VAP prevention was good among 57.3% (n-55) of the nurses. This score is within the mean scores ever reported in various studies, ranging from 41.2% among nurses during the annual congress of the Flemish Society for Critical Care Nurses in November 2005 to 78.1% in the USA. Poor knowledge related to VAP prevention has also been reported in Iran, Yemen (Oliveira *et al*., 2014) and Taiwan (Schober, *et al*., 2018) in Asia, and Egypt (Ali *et al*., 2013). The differences in knowledge scores may be explained by the differences in models of healthcare delivery in ICUs and lack or differences in specific guidelines and policies regarding training and

practicing VAP prevention in ICUs. The knowledge in the current study depends on the education qualification, there was significant statistical difference in the mean knowledge score about ventilation associated pneumonia prevention between education qualification (P value = 0.006). Similarly, in previous study, Nurses who deliver care to ventilator patients should be expert and qualified to provide best care for such patients. However, effective teaching program for nursing staff will improve the efficiency of nursing care (Mohamed *et al*., 2019). That sport the importance of postgraduate degree to enhance the knowledge among nurses.

According to the findings of a recent study, 60% of staff nurses have adequate knowledge of how to use VAP bundles. This percentage suggested that the majority of critical care nurses were knowledgeable about the ventilator care bundle (Redho *et al*., 2021). Surprisingly, about 91.7% (n=88) of the participants in this study showed a good knowledge about using protocol of care for mechanically ventilated patients and this was above what is reported in the related study. In this study, the ICU nurses indicated that they have a good knowledge through their answers of several step and procedure to prevent the VAP as well as good compliance about the care of patients under mechanical ventilation. According to previous studies, the main barriers to the implementation of evidence-based guidelines for VAP prevention were lack of skills (96.6%), lack of staff (95.5%), and lack of knowledge (79.3%) (Bankanie *et al*., 2021). Lack of knowledge and skills may be attributed to the inability to transform research into practice (which reflects poor perception of the importance of evidence-based practice), and poor information sharing among nurses (Bankanie *et al*., 2021). The knowledge application regarding critical patient care is an essential element for professional nursing practice. Many non-pharmacological protocol strategies are used in order to prevent VAP. Such protocols are considered an immediate responsibility of assigned nurse in critical care unit and can be easily set up at minimum costs (Hassan & Wahsheh, 2017). Ventilator-Associate Pneumonia is a cause of infections that progresses forty-eight hours after beginning of mechanical ventilation support (Osman *et al*., 2020). It increases the morbidity and mortality rate among intubated patients. Also, prolonged hospitalization and increased health care cost are associated with VAP. Many studies are done focused on pneumonia preventive measures and different methods were suggested (Rawal *et al*., 2018).

Evidence-based practice suggests that preventing VAP can be accomplished by implementing a VAP preventive treatment bundle (Osman *et al*., 2020). VAP is a serious illness, and nurses can help prevent it by performing a basic function such as using. non-pharmacological protection. This study recognized some of non-pharmacological process that can help to prevent the VAP. Examples of these non-pharmacological interventions include elevated head of patient's bed, routinely oral care as a part of the bundle of care along with early weaning. In the meantime, it was found that nurses lack compliance with VAP prevention standards due to a lack of understanding and job stress (Jam *et al*., 2017). In this study, the majority of nurses showed their compliance as they had a very good response and that compatible with their level of knowledge.

Endotracheal aspiration (Aspiration through the endotracheal tube) is the most common invasive non-pharmacologic process management applied by nurses in critical care units for patients on mechanical ventilator to promote and maintain optimal level of oxygen supply, gas exchange, alveolar ventilation, avoid lung conjugation and atelectasis, and decrease the risk of VAP and other pulmonary complications. If the endotracheal aspiration procedure is not properly done, the patient may develop dangerous complications like cardiac arrhythmia or arrest, lower respiratory tract infection, bronchospasm, atelectasis, VAP, anxiety and shortness of breath (Bozan & Güven, 2020). The ICU nurses in this study showed their compliance regarding caring of patient under mechanical ventilation evidenced by their agreement of statement such as: two nurses perform suctioning, sedation protocol, sterility of suction catheter while inserted inside the airways, and using formal infection control program. A bundle of care is a collection of standardized therapies derived from related information and designed to improve patient outcomes by boosting patient care and encouraging adherence to recommendations. It focuses on pneumonia etiology and pathophysiology as well as the method and duration of mechanical ventilation and the provision of consistent preventative measurements. Implementing bundles of care as a medical practice for patients on mechanical ventilators has been linked to a lower risk of VAP (Osti *et al*., 2017). Multidisciplinary individuals such as nurses, doctors, pharmacists, and respiratory therapists must, nevertheless, be included in the VAP plan of care for greater efficiency levels. Supervisors in ICUs must ensure that practical documents relevant to VAP prevention are available in the units, such as a policies, procedures, or standard care plans (Osti *et al*., 2017). The majority of the participants in this study 91.7% (n=88) showed their excellent response regarding the VCB (ventilator care bundle) and they mentioned that they use a checklist used as a protocol of care for mechanically ventilated patients.

There are easy management interventions that can improve ventilator patient safety, according to the Centers for Disease Control and Prevention (CDC) (Say, 2020). These interventions include: reducing the amount of time the patient is on mechanical ventilation, daily assessment of the patients' ability to breathe on their own, meticulous hygiene, hand washing before and after contact with the patient or ventilator or use of alcohol sanitizer in the absence of a hand washing area, 30-45 degree elevation of the head of bed, regular oral care, and

washing or changing the endotracheal tube according to company protocols or instructions from the manufacturing company (Say, 2020). In this study, 86.5% (83%) of the ICU nurses showed their adequate knowledge regarding early weaning so they reflected that it's important to reduce the VAP risk. In addition, they showed their compliance about several procedure and behaviors to prevent the VAP such as chest physiotherapy, adequate hand hygiene, doing suction in a proper way and using sterile equipment.

Providing treatment for critically ill patients is challenging. It usually entails various devices that can lead to difficulties, such as protective lung techniques. To avoid ventilator- related problems, protective lung techniques are employed. Unfortunately, nurses lack the necessary knowledge to maximize the efficiency of protective lung techniques (Asmar *et al*., 2020). Meanwhile, as part of their responsibilities and in order to avoid VAP, nurses must have appropriate knowledge about ventilator habits, positive air pressure, daily weaning procedures, aspiration avoidance, and appropriate head of the bed elevation level (Zeb, 2018). ICU nurses in this study have a good knowledge concerning protective lung techniques, about 79.2% (n=76) had a correct answer about the recommended position that help patient on mechanical ventilator to not get VAP. Moreover, they have a very good compliance to maintain an adequate pressure in endotracheal tube cuff.

This study showed the significant difference in knowledge score between participants based on the education level and that reflect the role of the highest education in improving the level of knowledge. Moreover, this study indicated that there was significant statistical difference in the mean compliance score about ventilation associated pneumonia prevention among gender, the females were more compliance than males and also the non-Saudi participants had more compliance than Saudi. Additionally, the participants whom between age group 26-30 years old were had more compliance than others.

6. CONCLUSION

Ventilation associated pneumonia represents a substantial public health concern. Insufficient nursing knowledge and compliance about VAP assessment and prevention is a serious safety concern in all healthcare settings. The study highlighted those ICU nurses who showed moderate good and compliance towards VAP prevention.

7. RECOMMENDATION

It is recommended to take a decision of establishing a scientific club in each critical care center to enhance information interaction and provide guidance mainly for nurses to teach them how to cope with patients under Mechanical ventilators. Moreover, provide a hand on training to increase the skills and confidence level among critical care nurses who interact with patients on mechanical ventilation. A ventilation bundle checklist needs to be created in every critical care unit to support the nurse's supervisors to tack the compliance of their team (including nurses).

Implications

Increased knowledge and compliance about the prevention of VAP may result in the nurse being the first healthcare professional to identify a patient at risk for VAP. Maintaining maximum patient care is highly important in healthcare. To increase the care for patients under mechanical ventilation, nurses across all critical departments must become more knowledgeable about equipment, tools, and procedures that help to prevent VAP. They have to be competent and confident in their abilities to care for patients with VAP. Further, they need to understand key components to maintaining healthy lungs and thus maintain VAP prevention.

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