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Assessment of nurses' knowledge and compliance to evidence based guidelines regarding bundle of ventilator associated pneumonia in a military hospital

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Abstract

Ventilator-associated pneumonia is the most common hospital-acquired infection among patients receiving mechanical ventilation in an intensive care unit. Different evidence based guidelines for the prevention of ventilator-associated pneumonia have been developed and recommended. Intensive Care Units' nurses have been found to be in the best position to put knowledge into practice as they are at the patient's bedside 24 hours daily providing nursing care and therefore play an important role in the prevention of VAP. This study focuses on enhancing nurses' knowledge and compliance regarding ventilator-associated pneumonia (VAP) bundle for prevention of ventilator-associated pneumonia (VAP) in intensive care units in a Military Hospital.

Objectives: To assess the critical care nurses' knowledge of and compliance with the preventive care bundle of ventilator associated pneumonia.

All head and staff nurses (N=80) working in different intensive care units (N=9) in a Military Hospital were included. The study tools included a self-administered questionnaire designed to test nurse's knowledge and an observational checklist to test nurses' compliance with ventilator associated pneumonia bundle.

Results: The total mean score of nurses' compliance (70.6%) was more than the total mean score of nurses' knowledge (52.4 %) of evidence based guidelines regarding ventilator associated pneumonia bundle. Nurses' knowledge levels were excellent in 16% of the studied nurses, very good in 7.2%, good in 17.6%, fair in 14.9% & poor in 44.3% of the studied nurses. Nurses' compliance levels were excellent in 56.4%, very good in 3.5%, good in 2%, fair in 24.5% & Poor in 13.43% of the studied nurses.

In **conclusion**: The knowledge of VAP bundle components in the study group was considerably lower than the compliance levels, which indicates that training educational programs directed towards infection prevention and control of device-associated infections should stress on explaining the principle behind the procedure, and manuals, information booklets and self-instruction modules should be implemented to guide healthcare personnel in areas of prevention of VAP.

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1. Introduction

The use of mechanical ventilation (MV) in the Intensive Care Unit is frequent and exposes patients to the risk of acquiring ventilator-associated pneumonia (VAP) [1] which is a type of Healthcare Associated Infection. VAP is usually acquired in hospital settings approximately 48–72 hours after the start of mechanical ventilation [2]. Ventilator-associated pneumonia is associated with delayed extubation, prolonged stay in the ICU, increased mortality and morbidity, and increased utilization of healthcare resources. That is why, prevention of VAP is considered an essential objective of health care delivery in ICUs [3].

The use of evidence-based practice EBP and guidelines improves the quality of patient care and closes the gap between research outcomes and practice [4, 5]. Evidence based practice is the use of current research evidence combined with clinical expertise as well as patient clinical and laboratory values to formulate sound interventions that ultimately improve the quality of patient care [6]. The use of evidence based practice can improve the processes, outcomes and costs of clinical care [7].

The Institute of Health Improvement (IHI) has developed a preventive ventilator care bundle that incorporates several strategies to prevent morbidity associated with the use of ventilators [8]. Adherence to and implementation of the adopted VAP prevention guidelines have been variable and were affected by lack of training, lack of an adequate infection prevention and control program, and lack of knowledge among healthcare providers of such guidelines. Although knowledge of the guidelines does not guarantee implementation and adherence, lack of knowledge may be a barrier to adherence to and implementation of VAP prevention guidelines [9, 10].

Aim of the study

The study aimed to enhance nurses' knowledge and compliance regarding ventilator-associated pneumonia (VAP) bundle to prevent ventilator-associated pneumonia (VAP) in intensive care units in a Military Hospital.

Study Objectives

- To assess nurses' knowledge of evidence-based guidelines regarding VAP preventive bundle in intensive care units.
- To identify the level of nurses' compliance with the VAP preventive bundle in intensive care units.

2. Material and methods

2.1. Technical Design

- Study Design: A descriptive cross-sectional analytic design was used in the study.
- Study Setting: The study was carried out in intensive care units in a Military Hospital.
- Sample size: The sample for this study consisted of all head and staff nurses (male and female) (No= 80) who worked in different intensive care units (No= 9). The units involved comprised Cardiothoracic ICU, Medical ICU, Neurology ICU, Neurosurgery ICU, General Surgical ICU, Gastroenterology ICU, Cardiology ICU, Vascular Surgical ICU, Urology and Transplantation Surgical ICU. Staff enrolled were the ones who accepted to participate in the research and met the inclusion criteria.

2.1.1. Inclusion Criteria

Head and staff nurses who have been working in an intensive care unit for more than six months and have accepted to participate in the research and are on duty during the study period.

2.1.2. Exclusion criteria

- Head and staff nurses have been working in an intensive care unit for a duration less than six months.
- Head and staff nurses who declined participation in this study.

2.2. Data Collection Tools

Self-administered questionnaire: It was designed to include socio-demographic data as well as knowledge of the latest evidence-based guidelines regarding VAP preventive bundle in the intensive care unit.

2.2.1. The Scoring system for the questionnaire was as follows

- The correct answer was given the score of "ONE"
- The wrong answer was given the score of "ZERO".

All items related to a certain dimension “e.g. Definition of VAP” were summed up and a mean score was calculated:

Mean % Score= (Mean Score/No. of Items) * 100

VAP bundle compliance checklist: Based on CDC updated guidelines, a checklist was constructed to identify ICU nurses’ compliance levels with the VAP bundle [11, 12], to which few items adopted from a previously designed and implemented checklist developed by Ali, 2013 [13] were added, to identify the level of intensive care nurses’ compliance with the VAP bundle in intensive care units.

2.2.2. The Scoring system for the developed observational checklist had two responses

- 'Comply' response was given the score of "ONE"
- 'Does not comply’ response was given the score of "ZERO".

All items related to a certain dimension “e.g. Infection Control Measures” were summed up and a mean score was calculated:

Mean % Score= Mean Score/No. of Items*100

Knowledge and Compliance Levels were calculated as follow:

Mean % score was converted to levels of knowledge and compliance as seen in table 1. [13]

Table 1 Knowledge and Compliance Evaluation Score Conversion

Percentage of correct answers/ compliance incidents	Level
0% - 59.9%	Poor
60% - 64.9%	Fair
65%-74.9%	Good
75% - 84.9%	Very Good
85% -100%	Excellent

Validity Test: For the content validity purpose, the modified knowledge questionnaire was translated into Arabic and back translated into English by a language specialist to increase the validity and reliability of the instruments. Then, the developed questionnaires and VAP bundle compliance checklist were submitted to five experts in infection prevention and control, critical care medicine and critical care nursing, in order to evaluate content language clarity (for Arabic-speaking nurses), relevance, readability, ease of understanding, sequence, and expected completion time. After that, the modified translated questionnaire and VAP bundle compliance checklist were edited according to experts’ suggestions. Finally, the tools were endorsed by the experts and authorized for use.

2.2.3. Administrative Design and Ethical Considerations

An official permission to conduct the study in a military hospital was obtained from the Director of the hospital. Total confidentiality of any obtained information was ensured, with no untoward consequences for any of the study findings.

2.2.4. Data Collection Procedure

Screening of nursing staff for inclusion and exclusion criteria was done by the research team.

Data were collected two days a week by the research team. Nurses included in the study were observed while performing the basic VAP bundle practices using the compliance observational checklist.

2.3. Statistical design

2.3.1. Data Management and Analysis

The collected data was revised, coded, and tabulated using statistical package (SPSS 25 for windows; © SPSS Inc., Chicago, IL, 2017). Data was presented and suitable analysis was done according to the type of data obtained for each parameter.

Descriptive Statistics

- Mean, Standard deviation (+ SD) and range for parametric numerical data
- Frequency and percentage of non-numerical data.

Analytical Statistics:

Chi square test was used to examine the relationship between two qualitative variables but when the expected count was less than 5 in more than 20% of the cells; Fisher's Exact Test was used.

P-value: Level of significance:

- P>0.05: Non-significant (NS)
- P<0.05: Significant (S)
- P<0.01: Highly significant (HS).

3. Results

3.1. Demographic characteristics of the studied nurses

Table (2) shows that 45.0% of the studied nurses aged 20-24 years old, 90.0% of nurses were females, 55% of nurses were graduates from the technical nursing school, and 55.0% of nurses had work experience in the ICU ranging from 6 months to 4 years.

Table 2 Demographic characteristics of the studied Military Nurses (n=80)

	Age	**No.**	**%**	**Mean ± SD**	**x2**	**P-value**
Age	20-24 Years	36	45.0	26.93 ± 5.90	6.100	0.047*
	25-30 Years	26	32.5			
	More than 30 Years	18	22.5			
Sex	Male	8	10.0		51.200	0.000**
	Female	72	90.0			
Education	Technical Nursing Diploma	44	55.0		20.575	0.000**
	Technical Institute of Nursing	25	31.2			
	bachelor's degree (B.SC.N)	11	13.8			
Experience in ICU	6 Months – 4 Years	44	55.0	7.48 ± 6.15	17.200	0.000**
	5-10 Years	16	20.0			
	More than 10 Years	20	25.0			

(*) Statistically Significant at P<0.05 (**) Highly Significant at P<0.01

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3.2. Assessment of nurses' knowledge of evidence based guidelines regarding bundle of ventilator associated pneumonia

Table (3) shows that 100% of the nurses gave a correct answer regarding the item "Route of infection in ventilator associated pneumonia (VAP)"; and 47.5% of nurses gave an incorrect answer to the question "What is the pathogenesis of VAP?"; the overall mean and standard deviation was 64.4 ± 17.7.

Table 3 Assessment of Nurses' General Knowledge of VAP

General Knowledge of (VAP)	Correct		Incorrect	
	No.	%	No.	%
Definition of Ventilator associated Pneumonia (VAP)	51	63.8	29	36.3
Ventilator associated pneumonia (VAP) develops in an intubated patient after hours or more of mechanical ventilation support.	60	75.0	20	25.0
Route of infection in ventilator associated pneumonia (VAP)	80	100.0	0	0.0
Anatomic areas that represent the primary route for ventilator-associated pneumonia (VAP)	61	76.3	19	23.8
What is the pathogenesis of VAP?	42	52.5	38	47.5
Signs of VAP	47	58.8	33	41.3
Positive sputum culture indicates the likelihood of (VAP).	60	75.0	20	25.0

Table 4 Assessment of Nurses' Knowledge as regard Ventilator associated Pneumonia Risk Factors

Risk factors	Correct		Incorrect	
	No.	%	No.	%
Risk factors of VAP related to the host	30	37.5	50	62.5
Risk factors of VAP related to the hospital	28	35.0	52	65.0
Risk factors of VAP related to instrumentation	22	27.5	58	72.5
Type of Endotracheal tube that decrease Risk of VAP	52	65.0	28	35.0

Table (4) shows that 65.0% of the nurses gave a correct answer regarding the item "Type of Endotracheal that decrease risk of VAP"; and 72.5% of nurses gave an incorrect answer regarding the item "the Risk factors of VAP related to instrumentation"; the overall mean and standard deviation was 41.2 ± 29.2.

Table 5 Assessment of Nurses' Knowledge of evidence based guidelines regarding strategies used to reduce the rates of VAP

Ventilator associated pneumonia bundle	Correct		Incorrect	
	No.	%	No.	%
Best Practice to prevent VAP	32	40.0	48	60.0
Components of ventilator associated pneumonia (VAP) care bundle	28	35.0	52	65.0
Prevention strategies (VAP bundle) that prevent (VAP)	26	32.5	54	67.5
Strategies which reduce VAP rate by preventing the pathogens from entering the lungs	68	85.0	12	15.0

Table (5) shows that 85.0% of the nurses gave a correct answer regarding the item "Strategies which reduce VAP rate by preventing the pathogens from entering the lungs"; 67.5% of nurses gave an incorrect answer regarding the item "Prevention strategies (VAP bundle) that prevent (VAP)"; the overall mean and standard deviation was 48.1 ± 26.0.

Table (6) shows that the highest mean and standard deviation were for the item 'head-of-bed elevation' (71.2 ± 21.3), 'daily sedative interruption and daily assessment of readiness to extubate' (69.5 ± 25.0), and the lowest for the item 'peptic ulcer disease (PUD) prophylaxis' (35.0 ± 47.9). In addition, the total mean and standard deviation of 'Nurses' knowledge of evidence based guidelines regarding bundle of ventilator associated pneumonia' were 52.4 + 12.5. (results are shown in figure 1)

Table 6 Mean & Standard Deviation for knowledge items of evidence based guidelines regarding bundle of ventilator associated pneumonia

Items	Mean+ SD
General Knowledge of (VAP)	64.4+ 17.7
Risk factors	41.2+ 29.2
Physical strategies	38.6 + 16.5
ventilator associated pneumonia bundle	48.1 + 26.0
Head-of-Bed Elevation	71.2 + 21.3
Daily sedative interruption and daily assessment of readiness to extubate	69.5 + 25.0
Peptic ulcer disease (PUD) prophylaxis	35.0 + 47.9
Deep venous thrombosis (DVT) prophylaxis	38.7 + 49.0
Oral Care with Chlorhexidine Gluconate (CHG)	39.5 + 27.6
The Total Mean and Standard Deviation	52.4 + 12.5

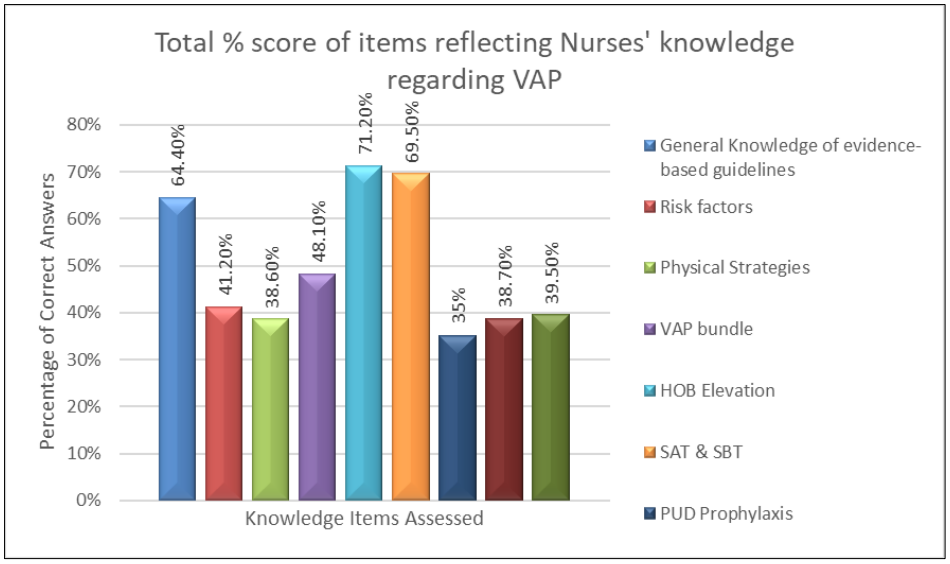

Figure 1 Assessment of Nurses' Knowledge of evidence based guidelines regarding bundle of ventilator associated pneumonia

3.3. Assessment of Nurses' Knowledge Levels to Evidence Based Guidelines Regarding Bundle of Ventilator Associated Pneumonia

Table (7) shows that 44.3% gave a poor level of knowledge, while only 16% of the nurses gave an excellent level regarding ventilator associated pneumonia bundle.

Table 71 Assessment of Nurses' Knowledge Levels as regards Ventilator associated Pneumonia Bundle (n=80)

		Nurses' Knowledge Levels to Evidence Based Guidelines Regarding Bundle					Total	x2	p-value
		Excellent	Very Good	Good	Fair	poor			
General Knowledge of (VAP)	No.	16	0	29	20	15	80	6.100	0.000**
	%	20%	0.0%	36.3%	25.0%	18%	100.0%		
Risk factors	No.	3	0	21	16	40	80	35.300	0.000**
	%	3.8%	0.0%	26.3%	20%	50%	100.0%		
Physical strategies	No.	0	0	2	17	61	80	70.525	0.600
	%	0.0%	0.0%	2.5%	21.3%	76.3%	100.0%		
VAP bundle	No.	3	0	23	27	27	80	19.800	0.600
	%	3.8%	0.0%	28.8%	33.8%	33.8%	100.0%		
Head-of-Bed Elevation	No.	14	21	28	11	6	80	18.625	0.000**
	%	17.5%	26.3%	35.0%	13.8%	7.5%	100.0%		
Daily sedative interruption and daily assessment of readiness to extubate	No.	16	31	0	16	17	80	8.100	0.600
	%	20%	38.8%	0.0%	20.0%	21.3%	100.0%		
Peptic ulcer disease prophylaxis	No.	28	0	0	0	52	80	7.200	1.600
	%	35%	0.0%	0.0%	0.0%	65%	100.0%		
Deep venous thrombosis prophylaxis	No.	31	0	0	0	49	80	4.050	1.600
	%	38.8%	0.0%	0.0%	0.0%	61.3%	100.0%		
Oral Care with CHG	No.	4	0	24	0	52	80	43.600	0.600
	%	5%	0.0%	30%	0.0%	65%	100.0%		
Total	No.	115	52	127	107	319	720	30.400	0.000**
	%	16%	7.2%	17.6%	14.9%	44.3%	100%		

(*) Statistically Significant at P<0.05 (**) Highly Significant at P<0.01

Table 82 Assessment of Nurses' Compliance to Infection Control Measures

Infection control measures	Comply		Not Comply	
	No.	%	No.	%
Wash hands before and after patient contact	74	92.5	6	7.5
Wash hands between patients	79	98.8	1	1.3
Change gloves between patients	79	98.8	1	1.3
Use sterile Ambu bag	79	98.8	1	1.3
Disinfect Ambu bag before use	79	98.8	1	1.3
Change Ambu bag between patients	73	91.3	7	8.8

Table (8) shows that the majority of the studied nurses (98.8%) were compliant with standards that reflect infection control measures; the overall mean and standard deviation were 96.4 $\pm$ 12.6.

Table 9 Assessment of Nurses' Compliance to Evidence Based Guidelines Regarding Bundle of Ventilator Associated Pneumonia

Items	**Mean+ sd**
Infection prevention and control measures	96.4 + 12.6
Ventilator Care Measures	48.5 + 16.1
Endotracheal Suctioning Care	55.0 + 15.8
Head-of-Bed Elevation	96.2 + 19.1
Daily —sedative interruption and daily assessment of readiness to extubate	85.0+ 24.3
Peptic Ulcer Prophylaxis	50.6 + 23.1
DVT Prophylaxis	95.6 + 14.2
Oral Care Measures	94.3 + 17.7
The Total Mean and Standard Deviation	70.6 + 9.3

Table (9) shows that the highest mean and standard deviation was for infection control measures 96.4 ± 12.6, patient positioning 96.2 ± 19.1, and the lowest for the item ventilator care measures 48.5 ± 16.1. In addition, the total mean and standard deviation of Nurses' Compliance to Evidence Based Guidelines Regarding Bundle of Ventilator Associated Pneumonia was 70.6 ± 9.3.

Table 10 Assessment of Nurses' Compliance Levels as regard Ventilator associated Pneumonia Bundle (n=80)

		Nurses' Compliance Levels to Evidence Based Guidelines Regarding Bundle					**Total**	**x2**	**p-value**
		Excellent	**Very Good**	**Good**	**Fair**	**Poor**			
Infection Prevention & Control Measures	No.	69	9	1	0	1	80	162.200	0.600
	%	86.3%	11.3%	1.3%	0.0%	1.3%	100.0%		
Ventilator Care Measures	No.	0	8	0	24	48	80	30.400	0.600
	%	0.0%	10%	0.0%	30%	60%	100.0%		
Endo-Tracheal Suctioning Care	No.	4	6	12	34	24	80	40.500	0.000**
	%	5%	7.5%	15%	42%	30%	100.0%		
Head-of-Bed Elevation	No.	77	0	0	0	3	80	68.450	1.600
	%	96.3%	0.0%	0.0%	0.0%	3.8%	100.0%		
Daily sedative interruption and daily assessment of readiness to extubate	No.	57	0	0	22	1	80	60.025	0.600
	%	71.3%	0.0%	0.0%	27.5%	1.3%	100.0%		
Peptic ulcer disease prophylaxis	No.	9	0	0	63	8	80	74.275	0.600
	%	11.3%	0.0%	0.0%	78.8%	10%	100.0%		
Deep venous thrombosis prophylaxis	No.	73	0	0	7	0	80	54.450	1.600
	%	91.3%	0.0%	0.0%	8.8%	0.0%	100.0%		
Oral Care with CHG	No.	72	0	0	7	1	80	116.275	0.600
	%	90%	0.0%	0.0%	8.8%	1.3%	100.0%		
Total	No.	361	23	13	157	86	640	42.125	0.000**
	%	56.4%	3.5%	2%	24.5%	13.43%	100%		

(*) Statistically Significant at P<0.05 (**) Highly Significant at P<0.01

Table (10) shows that the highest percentage of nurses (56.4%) was excellent and only 13.43% of the nurses were poor regarding Nurses' Compliance Levels to Evidence Based Guidelines Regarding Ventilator Associated Pneumonia Bundle.

3.4. Correlation between Nurses' Knowledge and compliance as regarding to VAP bundle

Table (11) shows that the total percentage score of nurses' compliance (83%) was higher than the total percentage score of nurses' knowledge (60.4%) regarding evidence-based guidelines of ventilator associated pneumonia bundle (5 dimensions of (VAP) bundle). In addition, there was no statistically significant correlation between nurses' knowledge and compliance scores (P>0.05) as regard all VAP bundle dimensions.

Table 11 Correlation between Nurses' Knowledge and compliance Mean Scores as regard the five dimensions of VAP bundle

5 dimensions of (VAP) bundle	Nurses' Knowledge (Mean ± SD)	Nurses' Compliance (Mean ± SD)	Pearson Correlation Coefficient "r"	P-value
Patient Positioning	71.2 ± 21.3	96.2 ± 19.1	0.049	0.664
Extubation and Weaning Trials	69.5 ± 25.0	85.0 ± 24.3	0.096	0.395
Peptic ulcer prophylaxis	35.0 ± 47.9	50.6 ± 23.1	0.076	0.504
DVT Prophylaxis	38.7 ± 49.0	95.6 ± 14.2	0.130	0.251
Oral Care	39.5 ± 27.6	94.3 ± 17.7	0.035	0.755
Total Mean ± SD	60.4 ±16.8	83.0 ± 11.7	0.193	0.087

(*) Statistically Significant at P<0.05 (**) Highly Significant at P<0.01

Table 12 Comparison between Nurses' Knowledge and compliance levels as regard VAP bundle

Levels	Nurses' Knowledge		Nurses' Compliance	
	No.	%	No.	%
Excellent	115	16	361	56.4
Very good	52	7.2	23	3.5
good	127	17.6	13	2
fair	107	14.9	157	24.5
poor	319	44.3	86	13.43

Table (12) shows that the Nurses' Compliance levels were Excellent among 56.4% of nurses, and the Nurses' knowledge levels were poor among 44.3%.

3.5. Relationship between Nurses' Knowledge of Evidence Based Guidelines Regarding Bundle of VAP and their Socio-demographic Characteristics

Table (13) shows that there is no statistically significant relationship between Nurses' Knowledge about VAP and their Age and Gender (P>0.05).

Table 13 Relationship between Nurses' Knowledge about VAP and their Age & Gender

Age & Gender			Nurses' Knowledge about VAP					Total	x2	p-value
			Excellent	Very Good	Good	Fair	poor			
Age	20-24 Y	No.	0	0	3	22	11	36	6.453	0.168
		%	0.0%	0.0%	8.3%	61.1%	30.6%	100.0%		
	25-30 Y	No.	0	0	5	16	5	26		
		%	0.0%	0.0%	19.2%	61.5%	19.2%	100.0%		
	> 30 years	No.	0	0	0	10	8	18		
		%	0.0%	0.0%	0.0%	55.6%	44.4%	100.0%		
Gender	Male	No.	0	0	1	5	2	8	0.139	0.933
		%	0.0%	0.0%	12.5%	62.5%	25.0%	100.0%		
	Female	No.	0	0	7	43	22	72		
		%	0.0%	0.0%	9.7%	59.7%	30.6%	100.0%		

(*) Statistically Significant at P<0.05 (**) Highly Significant at P<0.01

Table 14 Relationship between Nurses' Knowledge about VAP and their education level and work experience

Education Level & Work Experience			Nurses' Knowledge about VAP					Total	x2	p-value
			Excellent	Very Good	Good	Fair	poor			
Education Level	Technical Nursing Diploma	No.	0	0	2	27	15	44	5.550	0.235
		%	0.0%	0.0%	4.5%	61.4%	34.1%	100.0%		
	Technical Institute of Nursing	No.	0	0	3	15	7	25		
		%	0.0%	0.0%	12.0%	60.0%	28.0%	100.0%		
	bachelor's degree (BSC.N)	No.	0	0	3	6	2	11		
		%	0.0%	0.0%	27.3%	54.5%	18.2%	100.0%		
Years of Work Experience in ICU	6 months - 4 Years	No.	0	0	6	26	12	44	1.843	0.765
		%	0.0%	0.0%	13.6%	59.1%	27.3%	100.0%		
	5 -10 Years	No.	0	0	1	9	6	16		
		%	0.0%	0.0%	6.2%	56.2%	37.5%	100.0%		
	More than 10 Years	No.	0	0	1	13	6	20		
		%	0.0%	0.0%	5.0%	65.0%	30.0%	100.0%		

(*) Statistically Significant at P<0.05 (**) Highly Significant at P<0.01

Table (14) shows that there is no statistically significant relationship between Nurses' Knowledge about VAP and their Education and Experience in ICU (P>0.05).

3.6. Relationship between Nurses' Compliance Levels to Evidence Based Guidelines Regarding Bundle of VAP and their Socio-demographic Characteristics

Table (15) shows that there is no statistically significant relationship between Nurses' Compliance Levels to Evidence Based Guidelines Regarding Bundle of VAP and their Age and Gender (P>0.05).

Table 15 Relationship between Nurses' Compliance Levels to Evidence Based Guidelines Regarding Bundle of VAP and their Age & gender

Age & Gender			Nurses' Compliance Levels					Total	x2	p-value
			Excellent	Very Good	Good	Fair	poor			
Age	20-24 Y	No.	3	6	17	9	1	36	7.731	0.460
		%	8.3%	16.7%	47.2%	25.0%	2.8%	100.0%		
	25-30 Y	No.	0	9	10	7	0	26		
		%	0.0%	34.6%	38.5%	26.9%	0.0%	100.0%		
	> 30 years	No.	3	4	7	4	0	18		
		%	16.7%	22.2%	38.9%	22.2%	0.0%	100.0%		
Gender	Male	No.	1	1	5	1	0	8	2.273	0.686
		%	12.5%	12.5%	62.5%	12.5%	0.0%	100.0%		
	Female	No.	5	18	29	19	1	72		
		%	6.9%	25.0%	40.3%	26.4%	1.4%	100.0%		

(*) Statistically Significant at P<0.05 (**) Highly Significant at P<0.01

Table 16 Relationship between Nurses' Compliance Levels to Evidence Based Guidelines Regarding Bundle of VAP and their Education Level and Work Experience

Education Level and Work Experience			Nurses' Compliance Levels to Evidence Based Guidelines Regarding Bundle					Total	x2	p-value
			Excellent	Very Good	Good	Fair	poor			
Education Level	Technical Nursing Diploma	No.	3	13	14	14	0	44	8.132	0.421
		%	6.8%	29.5%	31.8%	31.8%	0.0%	100.0%		
	Technical Institute of Nursing	No.	2	4	4	14	1	25		
		%	8.0%	16.0%	16.0%	56.0%	4.0%	100.0%		
	bachelor's degree (BSC.N)	No.	1	2	2	6	0	11		
		%	9.1%	18.2%	18.2%	54.5%	0.0%	100.0%		
Years of Work Experience in ICU	6 months - 4 Years	No.	2	8	21	12	1	44	6.312	0.612
		%	4.5%	18.2%	47.7%	27.3%	2.3%	100.0%		
	5 -10 Years	No.	2	3	7	4	0	16		
		%	12.5%	18.8%	43.8%	25.0%	0.0%	100.0%		
	More than 10 Years	No.	2	8	6	4	0	20		
		%	10.0%	40.0%	30.0%	20.0%	0.0%	100.0%		

(*) Statistically Significant at P<0.05 (**) Highly Significant at P<0.01

Table (16) shows that there is no statistically significant relationship between nurses' compliance levels to evidence based guidelines regarding bundle of VAP and their Education and Experience in ICU (P>0.05).

4. Discussion

ICU nurses have been found to be in the best position to put knowledge into practice as they are at the patient's bedside 24 hours daily providing nursing care and therefore play an important role in the prevention of VAP. Nevertheless nurses need to have an awareness of the problem as well as knowledge so as to adhere to such practices. Various measures to prevent VAP have been reported in the literature [14].

The prevention and control of VAP in ICU are dependent on the education and sensitization of ICU staff members towards the problem and on the availability of equipment necessary for controlling cross infection between environment, health provider and patients [14].

This study aimed to evaluate nurses' knowledge and compliance regarding ventilator-associated pneumonia (VAP) bundle to prevent ventilator-associated pneumonia (VAP) in intensive care units in a Military Hospital. Our objectives were to assess intensive care nurses' knowledge of evidence-based guidelines regarding ventilator bundle and to identify the level of intensive care nurses' compliance with the ventilator bundle in Intensive Care Units.

The result of the present study revealed that the participants who met the inclusion criteria were 80 nurses working in 9 different intensive care units, 90% were females and 10% were males. Forty five percent (45%) of the studied military nurses were between the ages of 20-24 years, 32.5% of nurses were between 25-30 years and 22.5% aged more than 30 years. The qualification of 55% of studied nurses was a degree from technical nursing school, 31.2% were graduates from technical institute of nursing and 13.8% were graduates from faculty of nursing. The mean value of years of experience of all participants in ICU was 7.48 ± 6.15 years.

This study showed that nurses' general knowledge of ventilator associated pneumonia was high. This can be explained that the knowledge about causative organism and mode of transmission were of interest and constituted a basic information level in the curriculum of study and in all training courses, but their knowledge regarding the definition of ventilator associated pneumonia (63.8%) was fair, and poor regarding signs of VAP (58.8%) and pathogenesis of VAP (52.5%), respectively. In addition, the nurses' knowledge about VAP risk factors was poor. This can be explained by the fact that the knowledge about VAP needed more education to increase awareness and was not previously included in the basic nursing education. This finding is in close agreement with *Yaseen et al. (2015)* who found that 70.2% of nurses enrolled in their study knew the definition of Ventilator Associated Pneumonia (VAP) correctly, while it differs in another aspect as only 5.8% of nurses in that same study knew the pathogenesis of VAP [3].

The present study revealed that nurses' knowledge about physical strategies of VAP was poor, as the mean standard was (38.6 ± 16.5). This study also showed that 50% of the studied military nurses knew that oral route for endotracheal intubation is recommended. This result is close to the results shown by *Bagheri-Nesami et al. (2013)* who revealed that only (34.6%) answered correctly about oral intubation [15]. Other studies by *Yaseen et al. (2015)* and *Korhan et al. (2013)* showed that 77.9% and 79% of nurses, respectively, knew the oral route is preferred for endotracheal intubation [3, 16]. Also, a study by *Gomes (2010)* found that 69.88% of the nurses recommended oral intubation. This result revealed that there is a lack of knowledge about the recent guidelines and recommendations for the route of intubation taken to prevent VAP [6].

The current study showed that the nurses' knowledge about VAP preventive bundle was generally poor with the mean standard being 48.1 ± 26.0, as the highly incorrect answers were for "Best Practice to prevent VAP" (60%), "Components of ventilator associated pneumonia care bundle" (65%), "Prevention strategies that prevent VAP" (67.5%). The only correct answer was for "Strategies which reduce VAP rate by preventing the pathogens from entering the lungs" (85%). This is because nurses' care of respiratory diseases is included in basic nursing education.

This study revealed that nurses knowledge about Head-of-Bed Elevation was excellent regarding the following information: bed position that helps to reduce the risk of VAP (92.3%), head of bed elevation (30° - 45°) to prevent aspiration from the stomach into the airways (91.3%), patient positioning that help to reduce the risk of ventilator associated pneumonia (VAP) (85%), while knowledge was good regarding the impact of the use of Kinetic beds on prevention of ventilator associated pneumonia (65%). And knowledge was poor regarding the following information: "Interventions which help lower pulmonary aspiration of gastric contents" (47.5%), "Contraindication to the appropriate elevation of head of bed" (46.3%), but generally the mean standard was good (71.2 ± 21.3). This result is in agreement with *Bagheri-Nesami et al. (2013)* who found that 82.7% of nurses recommended semi-recumbent position and 90.4% of them used kinetic beds [15]. Also, a study by *Yaseen et al. (2015)* revealed that 78.8% of nurses agreed with the use of kinetic beds to reduce the risk of VAP and 86.5% of them knew that semi-recumbent positioning is

recommended [3]. In addition, a study by *Gomes, (2010)* who found that 68.67% of nurses knew that semi-recumbent positioning is recommended, and 55.42% knew that kinetic beds reduce the risk for VAP [6]. Also, *Korhan et al. (2013)* reported that 54.3% of nurses believed that kinetic standard beds reduced the risk of VAP [16]. And finally a study by *Al-Sayaghi (2014)* found that most nurses knew that it is recommended to keep patients in the semi-recumbent position, and kinetic beds in reducing the risk of VAP was known by minority of nurses [17]. As previously mentioned, nurses' care of respiratory diseases was in their basic nursing education, and it is a commonly recommended measure for bed ridden patient.

The current evidence based guidelines mentioned in VAP bundle by *O'Grady et al. (2014)* state that daily assessment of readiness to wean (SBT) and daily sedation interruption (SAT) are recommended simultaneously to reduce the length of mechanical ventilation, thereby reducing the risk for developing VAP [18].

Our study shows that 85.0% of nurses know the "Benefit of performing Spontaneous Awakening Trial & Spontaneous Breathing Trial" and 86.3% of the nurses know correctly that "Sedation vacation and weaning protocol" can be performed with the use 'Spontaneous Awaking and Spontaneous Breathing Trials", which is considered an excellent score, while only 46.3% of nurses knew the contraindications for attempting the "Spontaneous Awakening and Breathing Trials", which is considered a poor score. The mean standard was (69.5 $\pm$ 25.0).

These results are almost consistent with the studies done by *Al-Sayaghi (2014)* who found that 62.8% of nurses know that daily sedation interruption and assessment of readiness for weaning decrease the risk of VAP, *Luetz et al. (2012)* who recommend that weaning should be considered as early as possible, a daily screening for readiness to wean should be implemented, and a weaning protocol including a SBT should be used, and by *Blackwood et al. (2011)* who showed that weaning protocol was associated with significant reduction for duration of mechanical ventilation, length of weaning, and length of stay in the ICU [17, 19, 20]. The explanation for this result is that the physician is the only one who is responsible for initiation of weaning trials and interruption in sedation utilizing a sedation scale. The ICU physicians help the nurses to know and understand the importance of weaning trials and interruption in sedation utilizing the sedation scale (this is done as per physician's instruction in hospitals enrolled in our study).

In this study, only 35.0% of nurses knew that "Peptic ulcer disease prophylaxis" is one of the VAP bundle which recommended by *IHI (2012)*. Critically ill patients requiring mechanical ventilation are at an increased risk of developing stress ulcers and gastrointestinal bleeding. Also, bacterial colonization of the stomach can lead to respiratory tract colonization and infection through aspiration of stomach secretions [21].

Only 38.8% of nurses knew that "deep venous thrombosis (DVT) prophylaxis" is one of the VAP bundle. *IHI (2012)* stated that mechanically ventilated patients are at high risk for DVT. Although there is no evidence to suggest DVT prophylaxis reduces VAP risk, it is appropriate to include it in a bundle that supports care of mechanically ventilated patients due to their high risk for DVT. The interpretation for these results is that the prophylactic medications are prescribed by the physician; they is not among nurse's responsibilities [21].

The nurses knowledge related to oral care using chlorhexidine 0.12% solution was fair regarding the benefit of performing oral care (57.5%), and poor regarding "How often should oral care alone be performed" (37.5%), and "How often should oral care with CHG be performed" (23.8%). With the mean standard (39.5 $\pm$ 27.6), which is poor. This result contradicts with results provided by *Yaseen et al. (2015)* who revealed that 85.6% of nurses knew that Chlorhexidine 0.12% is recommended solution for oral care, and 52.9% of them knew the frequency of oral care. Another study by *Jansson et al. (2013)* reported that 95.0% of nurses knew that 0.12% chlorhexidine gluconate antiseptic oral rinses reduce the risk of VAP. The study found that nurses knew oral care as a routine work from their experiences or their past education and they did not know the new recommendation for oral care [3, 22].

The result of assessment nurses' knowledge revealed that all critical care nurses with different educational levels, irrespective of their years of experience, had unsatisfactory knowledge levels about ventilator associated pneumonia and VAP bundle preventive measures. The study showed that the total mean percentage score reflecting Nurses' knowledge of evidence-based guidelines regarding ventilator associated pneumonia bundle was 52.4 % which is considered poor. The nurses' knowledge levels were excellent among 16% of the nurses and very good among 7.5% of the nurses, 17.6% were good, 14.9% were fair, and 44.3% were poor. In addition, there was no statistically significant relationship between nurses' knowledge about VAP and their age, gender, education and years of experience in the ICU.

These results are consistent with *Gomes (2010),* who found low awareness of nurses about VAP guidelines. The average score in the results of Gomes' study was 21.6%, *Korhan et al. (2013)* and *Lin et al. (2014)*, who found that critical care nurses' knowledge about ventilator-associated pneumonia prevention is poor, *Bagheri-Nesami et al. (2013)* who found

that the knowledge of Iranian nurses seemed inadequate and the average level of the nurses' knowledge was 51.92% which was low [6, 16, 15]. Also, *Jansson et al. (2013)* revealed that Critical care nurses' mean score in the knowledge test was 59.9% which was low [22]. In addition, a study by *Said (2012)* reported adequate ICU nurses' knowledge on VAP preventive strategies, and no significant association found between ICU training, level of education, years of working experience and knowledge [14]. Furthermore, in a study by *Labeau et al.(2007)*, the average score among European nurses was 45.1% [23]. And finally, the study by *Al-Sayaghi (2014)* showed that knowledge of evidence-based strategies for preventing VAP is low among the majority of nurses working in Yemen ICUs (47.3%) [17].

It has been suggested by this study that Majority of the nurses acquired their knowledge of taking care of critically ill patients from their basic educational programs, and most of them tend to apply measures automatically by simply following instructions given by physicians or colleagues without being fully aware of what and why they actually do.

Although an infection control measure is not a component of ventilator bundle practices, it plays an important role in reducing the risk of ventilator associated pneumonia. Our study shows that the mean standard score of nurses' compliance to infection control measure was 96.4 $\pm$ 12.6 which is excellent.

According to the evidence based guidelines (EBG's) on prevention of VAP, semi- recumbent positioning is recommended to prevent VAP amongst all participants of nurses in all ICU. In the current study; the majority of the studied nurses (96.3%) showed compliance to maintaining head of bed elevation, which consider excellent. These results are consistent with the following researcher as *Juneja et al. (2011)* who reported that 98.4% of nurses' compliance with head of the bed elevation to reduce the VAP, *Conway et al. (2011)* and *Al-Harthy et al. (2014)* who found that compliance with head-of-bed elevation was 95%, *Bagheri-Nesami et al. (2015)* who reported that 76.8% of nurses implement Semi-recumbent position for their patient, and finally *Mohamed (2013) and Eom et al. (2014)* who recorded 76% and 65.9% nurses' compliance with the head of the bed at 30^{o} or more [24, 25, 26, 15, 27, 28]. This could be explained by the fact that it is a commonly recommended measure for bed ridden patient in the intensive care units.

The nurses' compliance to "Standards of Extubation and Weaning Trials" was excellent with mean standard of 85.0 $\pm$ 24.3. A score of 75.0% compliance to "Interruption in sedation utilizing sedation scale", and 95.0% Perform daily assessments of readiness to wean and extubate. In the same line a study by *Conway et al. (2011)* found that compliance with "wake and wean" element was 70%. Also, a study by *Al-Harthy et al. (2014)* reported that compliance with "Sedation vacation and assessment of readiness of extubation" was about 66%. Finally *Jiménez et al. (2009*) reported that Sedation vacation compliance was noticed to be 67% pre- education and 72% post education [25, 26, 29]. The possible explanation for adherence to these guidelines is that nurses in most critical care units follow the physician's instructions and they never initiate weaning trials on their own, and the physician is the only one who is responsible for initiation of weaning trials and interruption in sedation utilizing sedation scale. It is not a nurse's decision.

Another recommended care for prophylaxis of VAP is checking the gastric residual volume (GRV) every 4 to 6 hours; administering intermittent rather than continuous enteral feeding and performing routine acidification of gastric feeding. In the current study, Nurses' Compliance to Peptic Ulcer Prophylaxis was poor with the mean standard being 50.6 $\pm$ 23.1. While 88.8% of the nurses did not comply and follow what is recommended in evidence based guidelines regarding checking GRV every 4 – 6 hours or intermittent enteral feeding, 90% of them complied with performing routine acidification of gastric feeding. Another study by *Jiménez et al. (2009*) documented that PUD prophylaxis was (93%). Also, a study by *Eom et al. (2014)* reported that compliance with peptic ulcer disease prophylaxis was high (83%). The lowest compliance reported by *Juneja et al. (2011)* who found only 22.2% compliance score with patient use of selective decontamination of the digestive tract (SDD). The possible explanation for this finding is that the acidification of the gastric feeding occurs by using certain drugs which are prescribed by a physician [22, 27, 24].

The results of this study in relation to DVT prophylaxis by nurses in the form of Applying anti-embolic stockings or sequential compression showed that (98.8%) of the studied nurses were compliant with "Apply anti-embolic stockings or sequential compression", and 92.5% compliant with "Administrate of anticoagulant", with the mean standard (95.6 $\pm$ 14.2) which is excellent. This finding coincides with the finding of *Jiménez et al. (2009*) who found that 87% of nurses showed compliance to DVT prophylaxis. Finally the lowest compliance was from a study by *Eom et al. (2014)* who found 65.6% of nurses compliant with deep venous thrombosis prophylaxis. The possible explanation for this finding is that nurses apply these measures as it is one of the ICU policies for all critically ill patients and commonly recommended measures for bed ridden patients [29, 27].

The most of the nurses (96.3%) used topical antimicrobial agents for oral decontamination regularly and 92.5% performed oral hygiene with antiseptic mouth wash (chlorhexidine gluconate), with mean standard (94.3 $\pm$ 17.7) which is excellent. The current study result is agree with a study by *Conway et al. (2011)* who revealed that compliance with

chlorhexidine gel usage was 100%. Also, A study by *Al-Harthy et al. (2014)* reported that mouthwash with chlorhexidine gluconate for intubated patients was a part of the daily nursing care in our ICU, resulting in a compliance percentage of 100%. Another study by *Juneja et al. (2011)* sated that (83.3%) of nurses use chlorhexidine in mouth care. And finally a study by *Eom et al. (2014)* found that compliance with oral decontamination using chlorhexidine 0.12% was low (45.6%). the researchers explain that as oral care is one of ICU policies in the hospital, all nurses provide oral care for the patient every shift or more if indicated [25, 26, 24, 27].

Our study demonstrated that the findings of nurses' compliance with VAP bundle practices indicate that a large percentage of critical care nurses implemented preventive measures for VAP (the total mean percentage score 70.6 % is good. While, the nurses' compliance levels were Excellent among 56.4% of the nurses and very good among (3.5%) of the nurses, (2%) were good, (24.5%) was fair and 13.43% were poor. In addition; there is no statistically significant relationship between nurses' compliance levels to evidence based guidelines regarding bundle of VAP and their age, gender, education and years of experience in ICU ($P>0.05$).

The results were almost agreed with *Mohamed (2013)* who found that the total VAP bundle compliance rate was (63%). Also, a study by *Eom et al. (2014)* reported that Overall compliance with the VAP bundle, except continuous aspiration of subglottic secretions (CASS), was (41.1%). Another study by *Juneja et al. (2011)* who revealed that most of the intensivists (96.8%), reported using VAP bundles in their ICUs [28, 27, 24]. Also, a study by *Jiménez et al. (2009)* reported that Ventilator bundle compliance pre-educational was (6%). The ventilator bundle was followed adequately in (59%) of the cases post-educational [29].

The findings of this study highlight that nurses working in the ICUs had low level of knowledge (poor) (60.4%) regarding 5 dimension of VAP bundle but they had good level of practice (83%). In addition, there was no statistical significant correlation between nurses' knowledge and compliance score ($P>0.05$) as regard all VAP bundle dimensions.

As suggested, nurses are not prepared or knowledgeable enough to provide evidence based or specialty care. That is due to that the curriculum of the basic nursing education does not have any courses related to VAP bundle. No nurse has a special certification in ICU nursing or, there are inadequate courses before working in the intensive care units. There is no continuous education or training for nurses related to VAP bundle. There aren't proper periodical evaluations or assessment of educational needs and training for the nursing stuff in intensive care unit.

Shortage of staff one of the causes led to lack of knowledge that because of workload they are very exhausted they don't have time to improve their knowledge by self-study. There is no chance for them to read or learn.

The absence of consistent policies and procedures is another important explanation for this knowledge deficiency. Nurses do not have manuals, information booklets and self-instruction module about recent EBGs for prevention of VAP in the area of work. There is an infection control department this explain a good knowledge and practice of infection control items but there are no updating training programs for nurses about patient on ventilator.

5. Conclusion

Although compliance was quite acceptable among the nursing staff of the different ICUs, their base-line knowledge of the reason behind their practices was much lower. This points to the defect in the current educational programs given to nurses both in their educational institutes and their working facilities, while their discipline and obedience to given orders and copycat practices following the footsteps of their chief nurses and older comrades can be a contributing factor to the observable higher compliance levels.

This means further research and modification of nurses' training education programs are needed to keep the nurses updated as regards the evidence-based guidelines and infection prevention and control policies and procedures with focus on their scientific justification.

Recommendations

Based upon the result of the current study, the following recommendations are suggested:-

- The need for in-service education and integration of evidence-based guidelines regarding prevention of ventilator associated pneumonia.
- The need for developing a unified protocol for VAP prevention based upon current evidence based guidelines.
- The need for establishing a system to ensure that VAP prevention protocol will be implemented consistently in

all ICUs.

- The ICUs should review and update their policies and procedures (as needed) to include the current EBGs for VAP prevention.
- Development of an information booklet and self-instruction module in areas of prevention of VAP.
- New nursing staff must be distributed in the hospital according to their professional interests.
- Orientation of new ICU staff should include education on strategies for prevention of VAP.
- The need for periodic evaluation of the newly hired nurses, as well as currently working staff
- For nursing schools and colleges, the curriculum of the basic nursing programs should be modified to include the most recent EBGs for VAP prevention.
- The need to raise nursing student's interest in research so as to keep them updated with current practice.

Compliance with ethical standards

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Disclosure of conflict of interest

There is no conflict of interest.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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