International Journal of General Medicine

Dovepress
open access to scientific and medical research

Open Access Full Text Article

ORIGINAL RESEARCH

Performance Assessment of Medical Professionals in Prevention of Ventilator Associated Pneumonia in Intensive Care Units

Sahbanathul Missiriya Jalal[1], Ahmed Mansour Alrajeh[2], Jumanah Abdullah Ali Al-Abdulwahed[1]

[1]Department of Nursing, College of Applied Medical Sciences, King Faisal University, Al-Ahsa, 31982, Saudi Arabia; [2]Department of Respiratory Therapy, College of Applied Medical Sciences, King Faisal University, Al-Ahsa, 31982, Saudi Arabia

Correspondence: Sahbanathul Missiriya Jalal, Department of Nursing, College of Applied Medical Sciences, King Faisal University, Al-Ahsa, 31982, Saudi Arabia, Tel +966564070973, Email sjalal@kfu.edu.sa

Purpose: Ventilator-associated pneumonia (VAP) is one of the most common infections in intensive care units (ICU) with a 6–52% incidence. The VAP mortality rate is 50% to 70%. Medical professionals (MPs) working in the ICU are expected to follow the guidelines to prevent VAP. The study aimed to assess the performance of MPs in preventing VAP and to associate the performance with the baseline information.

Methods: An observational cross-sectional study was conducted in the ICUs of selected hospitals in eastern Saudi Arabia. A total of 152 MPs were selected by random sampling. A structured questionnaire including baseline information, knowledge and performance-related questions was used to collect the data. Frequency, mean, and chi-square tests were used for analysis.

Results: Out of 152 MPs, 40.8% had adequate and 7.9% had inadequate knowledge. A high mean score of 12.9 ± 2.2 was obtained by physicians, followed by 11.3 ± 1.6 by nurses, 9.8 ± 2.2 by RTs, and 8.6 ± 2.1 by interns. Overall, 52.6% had satisfactory performance. Approximately 57.9% and 67.8% of MPs cleaned their hands before touching the patient and the ventilator, respectively. Many (79.6%) MPs used personal protective equipment in the ICU. Some (47.4%) of the MPs changed the patient's position regularly. About 77.6% of MPs followed the sterile technique when suctioning the airway. There was a significant association found between the performance of MPs on the prevention of VAP with age ($p < 0.001$), designation ($p < 0.05$), professional experience ($p < 0.05$), managing chronic obstructive pulmonary disease conditions ($p < 0.05$) and training attended ($p < 0.001$).

Conclusion: Although some of the MPs had satisfactory performance regarding VAP prevention in the ICU, more attention should be paid to training them on clinical guidelines to improve health care quality and reduce the rate of VAP.

Keywords: ventilator-associated pneumonia, intensive care units, medical professionals, infection

Introduction

Critically ill patients are at risk of different complications[1] such as acute respiratory distress syndrome (ARDS) and chronic obstructive pulmonary disease (COPD), which can be treated with mechanical ventilation procedures[2] and respiratory care[3] in the Intensive Care Unit (ICU).[4] Ventilator-associated pneumonia (VAP)[5] is a lung infection occurring more than 48 hours after the initiation of endotracheal intubation[6] and mechanical ventilation and is one of the most common infections in ICUs with 6–52% incidence.[7] VAP mortality rate is 70% in high-risk patients globally.[8] The incidence ranges from 2 to 16 episodes per 1000 ventilator-days in the United States.[9] The estimated risk of VAP is 1.5% per day and decreases to less than 0.5% per day after the 14th day of mechanical ventilation.[10,11] In the Kingdom of Saudi Arabia, the overall VAP rate was 2.97 per 1000 ventilator-days in Ministry of health hospitals.[12]

The primary factor for developing pneumonia in the ICU is mechanical ventilation.[13] Endotracheal tube intubation, nasogastric tube feeding, malnutrition, and inadequate flow of saliva, which lead to oropharyngeal colonization in patients are other predisposing factors.[14] VAP increases oxygen demand, production of sputum, alveolar collapse, and impaired gas exchange.[15] Further consequences of VAP include prolonging the duration of hospitalization and increasing

Received: 21 February 2022
Accepted: 29 March 2022
Published: 7 April 2022

the length of stay in the ICU, increasing the cost of treatment, more usage of healthcare resources, and longer duration of mechanical ventilation, thereby causing high morbidity and mortality rates.[16–20]

Medical professionals (MPs) working in the ICU are expected to play an important role in the prevention of VAP by following protocols.[21] Awareness of this protocol by healthcare providers are effective in the prevention of VAP and could reduce its incidence significantly.[22–24] Some researchers showed the importance of nurses' level of knowledge regarding specific preventive measures of VAP.[25] The application of this knowledge to practice is essential in healthcare settings. Few studies have analysed the compliance of nurses on preventive aspects of VAP,[26] in which the questionnaires may not be reliable to measure compliance to reflect performance.[27] However, the study related to direct observation of practices on VAP prevention in the ICU is lacking. Hence, considering the high functionality of following the guidelines for the prevention of VAP and the lack of evidence-based research, researchers were prompted to assess the performance of MPs in the prevention of VAP in ICUs. The primary objective of the study was to assess the knowledge and performance of MPs in the prevention of VAP in ICU and to associate the performance of MPs in the prevention of VAP with the selected demographic variables.

Materials and Methods

Study Design

An observational cross-sectional study under quantitative design was conducted among MPs to achieve the objectives of the study in the year 2021. The study was carried out according to the guidelines of Helsinki[28] and was ethically approved by the Research Ethics Committee, Deanship of Scientific Research, King Faisal University, Al-Ahsa, Saudi Arabia (HAPO-05-HS-003). The research protocol was also approved by the King Fahad Hospital Hofuf, Institutional Review Board (H-05-HS-065) with RCA Number 39-45-2021. Informed consent was obtained from all the MPs involved in the study before data collection and ensured confidentiality, no risk, anonymity, and voluntary participation.

Study Setting and Participants

The research setting included the selected hospitals in the eastern region of the Kingdom of Saudi Arabia. In this research, the study participants were MPs, including physicians, nurses, respiratory therapists (RTs), and interns, by using stratified random sampling. The study participants were selected based on the inclusion criteria, such as the MPs who were interested in participating in the study, including males, females, Saudis, and non-Saudis, with a minimum of six months of experience in the ICU.

Study Sampling

Considering the variables and outcome of the study, assuming the expected 50% of the study population had good practice in following the hospital guidelines to prevent VAP in ICU, with an allowable margin error of 5% at a 95% confidence interval, and accounting for the finite population of 297 MPs, a minimum sample size of 168 was calculated. However, finally, after the stratified randomization sampling,[29] a total of 152 MPs from various fields were included in the data collection.

Data Collection

A structured questionnaire with an observational tool was used to collect the data. This questionnaire is an originality tool, and it was evaluated by a panel of experts to validate the tool. A pilot study was conducted to improve the tool.

The structured questionnaires consisted of three parts: The first part of the questionnaire included baseline information, and the second part included the knowledge questionnaire about the prevention of VAP and the third part of the tool about the performance of MPs to prevent VAP.

Baseline Information

The participating professional's baseline information, such as age, gender, the highest educational qualification, designation, professional experience, working sector, unit, managing patients with COPD, and information about training taken on prevention of VAP were included in the first part of the tool.

Knowledge on the Prevention of VAP

The second part of the tool included 16 multiple choice questions regarding the aspects of the prevention of VAP. Each question had four options, of which three were incorrect and one was correct. The structured knowledge questionnaire was validated by medical experts and scored as either one point for a correct response or zero point for an incorrect response. The total knowledge score was summed up and computed for analysis. The score interpretations were counted from 75% to 100% (12 to 16) as adequate knowledge, from 50% to 74% (8 to 11) as moderately adequate knowledge, and below 50% (less than 8) as inadequate knowledge.

Practice on Prevention of VAP

The third part of the tool had 16 structured questions related to the prevention of VAP. The investigators observed the performance of MPs directly, whether they complied or not, and filled in the questionnaire. If the practice achieved by MPs at 75% and above was considered satisfactory performance, and anything below that score was considered unsatisfactory performance. The overall practice was calculated and interpreted by using the frequency distribution table in the results section given below.

The questionnaire was piloted among 15 MPs, and they were excluded from the final analysis. The reliability of the questionnaire was tested (r = 0.962) using Cronbach's alpha. The time to fill in the questionnaire ranged from 15 to 20 minutes. Information was included in the tool with an introduction, explaining the objectives of the study and ensuring privacy and confidentiality before distribution. Participation in the study was voluntary. Informed consent was obtained from all the participants before the data collection.

Data Analysis

All statistical analyses were performed with the Statistical Package for Social Sciences (SPSS) for Windows, version 21.0, International Business Machines (IBM) Corporation, Armonk, New York, USA. Results were reported in accordance with STROBE guidelines. The researchers used descriptive statistics such as frequency and percentages for categorical variables and mean and standard deviation (SD) for continuous variables. In inferential statistics, Chi-square tests were used to evaluate associations between performance and baseline information and to identify *p*-value. Statistical significance is defined as a *p*-value of less than 0.05.

Results

Baseline Information of the MPs

Table 1 displays the baseline information of the MPs, which included age in years, gender, highest educational qualification, designation, professional experience, working sector, and type of work unit. A total number of 152 MPs were included in the analysis most of them 61 (40.1%) were in the age of 31–40 years, and many of the participants, 113 (74.3%) were females. The overall mean score of the age was 37.3 ± 8.98. About the educational status of them, 52 (34.2%) studied diplomas, 74 (48.7%) had bachelor's degrees and 22 (14.5%) had master's degrees as their highest level of qualification. Few MPs, 4 (2.6%), were doctorates. Regarding the designation of the MPs, 39 (25.7%) were physicians, 71 (46.7%) were nurses, and 16 (10.5%) were RTs. Furthermore, 71 (46.7%) MPs had 1 to 3 years of experience, 28 (18.4%) had 4 to 6 years of experience and 15 (9.9%) had 6 to 9 years of experience. Concerning the working sector, most of the participants, 105 (69.1%), worked in a government hospital and 78 (51.3%) were in medical ICU, 32 (21.1%) in surgical ICU and the remaining 42 (27.6%) in CCU (critical care unit). The training on VAP prevention and infection control attended by MPs within 2 years were shown in Figure 1. Among them, 12 (7.9%) physicians, 24 (15.8%) nurses, 5 (3.3%) RTs and 2 (1.3%) interns were undergone training.

Knowledge on Prevention of VAP

The overall knowledge level of MPs regarding the prevention of VAP is shown in Table 2, in that 62 (40.8%) had adequate knowledge, 78 (51.3%) had moderately adequate knowledge, and 12 (7.9%) had inadequate knowledge. The overall mean score was 11.1 ± 2.4. A high mean score of 12.9 ± 2.2 was obtained by physicians, followed by 11.3 ± 1.6 by nurses, 9.8 ± 2.2 by RTs, and 8.6 ± 2.1 by interns.

Table 1 Baseline Information of the MPs. (n=152)

Characteristic	Category	N (%)
Age (years)	20–30 years	39 (25.7)
	31–40 years	61 (40.1)
	41–50 years	43 (28.3)
	More than 50 years	9 (5.9)
Gender	Male	39 (25.7)
	Female	113 (74.3)
Educational qualification (highest)	Diploma	52 (34.2)
	Bachelor	74 (48.7)
	Master	22 (14.5)
	Doctorate	4 (2.6)
Designation	Physicians	39 (25.7)
	Nurses	71 (46.7)
	RTs	16 (10.5)
	Interns	26 (17.1)
Professional experience	< 1 year	34 (22.4)
	1–3 years	71 (46.7)
	4–6 years	28 (18.4)
	6–9 years	15 (9.9)
	10 and above years	4 (2.6)
Working sector	Public hospital	105 (69.1)
	Private hospital	47 (30.9)
Working unit	Medical ICU	78 (51.3)
	Surgical ICU	32 (21.1)
	CCU	42 (27.6)
Managing COPD patients	Yes	37 (24.3)
	No	115 (75.7)

Abbreviations: N, number; %, percentage.

Performance on Prevention of VAP

The practice compliance of MPs regarding the prevention of VAP in ICU is reported in Table 3. Regarding hand hygiene, 88 (57.9%) and 103 (67.8%) MPs regularly cleaned their hands with soap and water or an alcohol-based rub before touching the patient and before touching the ventilator, respectively. Most of the MPs 121 (79.6%) complied by wearing personal protective equipment (PPE) strictly while caring for patients and handling ventilators. Approximately 109 (71.7%) MPs either verified or did the oral hygiene of the patient using chlorhexidine twice daily at regular intervals by every 12 hours. Most of the MPs 137 (90.1%) recommended elevating the head of the bed by 30 to 45 degrees to reduce VAP occurrences. Some of the MPs 72 (47.4%) changed the body position of the patient to clear the secretions every 2 hours once regularly and advised suctioning of the patient to clear the

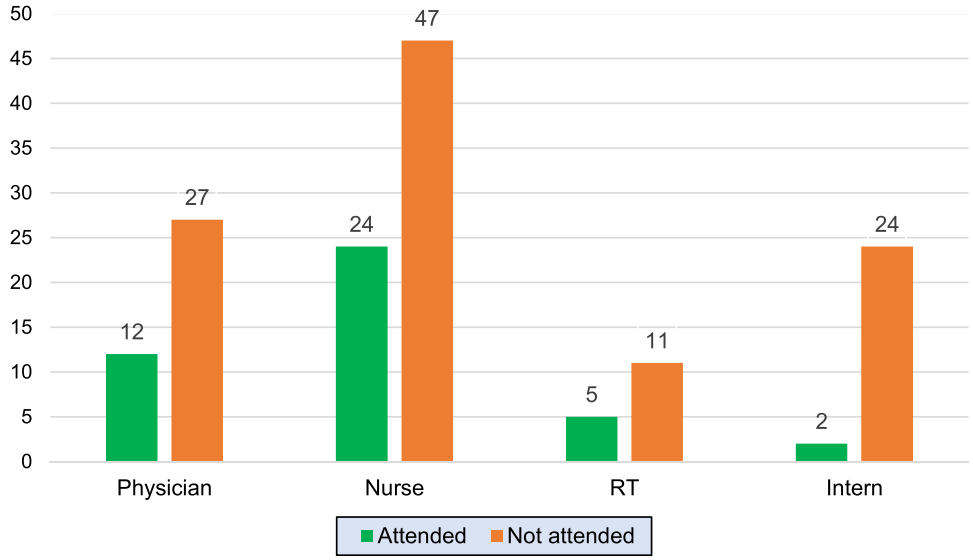

Figure 1 Training attended by MPs on VAP prevention guidelines. (n=152).

subglottic secretions. Approximately 118 (77.6%) MPs followed the sterile technique when suctioning the airway. Around 136 (89.5%) MPs changed the disposable ventilator circuit weekly once regularly, and 84 (55.3%) MPs controlled and maintained cuff pressure properly. Additionally, 52 (34.2%) MPs repositioned the endo tracheal tube (ETT) and 53 (34.9%) MPs controlled and maintained cuff pressure regularly. While 97 (63.8%) MPs used the spontaneous breathing trial regularly, 55 (36.2%) used it rarely. Nearly half of the MPs 78 (51.3%) did chest wall percussion, regularly. Many of the MPs 83 (54.6%) lightened the sedation at regular intervals, to assess for neurological readiness to wean the patient from ventilation. Mostly 141 (92.8%) MPs complied to conservative fluid management for every 24 hours once and 137 (90.1%) MPs administered short course of systemic antibiotics to prevent infection to their patients. Additionally, 93 (61.2%) MPs used some devices, such as the intermittent pneumatic compression (IPC) device, to prevent deep vein thrombosis (DVT). Maximum number 143 (94.1%) of MPs instructed or performed timely evacuation of water container of ventilator circuit. The overall results showed that 80 (52.6%) had satisfactory performance and the remaining 72 (47.4%) needed to improve their performance as they had been unsatisfactory in their practices. There was a significant association found (Table 4) between the performance of MPs on the prevention of VAP with age ($p < 0.001$), designation ($p < 0.05$), professional experience ($p < 0.05$), managing patients with COPD ($p < 0.05$) and training attended within 2 years on VAP prevention guidelines ($p < 0.001$).

Discussion

Among hospital-acquired infections, VAP is one of the serious health problems that result in a higher mortality and morbidity rate.[30,31] The findings of the present study showed that 62 (40.8%) had adequate knowledge regarding the VAP

Table 2 Frequency Distribution of Level of Knowledge Regarding Prevention of VAP. (n=152)

Level of Knowledge	Adequate Knowledge	Moderately Adequate Knowledge	Inadequate Knowledge	Mean ± SD
	N (%)	N (%)	N (%)	
Physician (n=39)	28 (18.4)	10 (6.6)	1 (0.7)	12.9 ± 2.2
Nurse (n=71)	29 (19.1)	40 (26.3)	2 (1.3)	11.3 ± 1.6
RT (n=16)	3 (2)	10 (6.6)	3 (2)	9.8 ± 2.2
Intern (n=26)	2 (1.3)	18 (11.8)	6 (3.9)	8.6 ± 2.1
Overall	62 (40.8%)	78 (51.3%)	12 (7.9%)	11.1 ± 2.4

Table 3 Frequency Distribution of MP's Performance Regarding Prevention of VAP in ICU. (n=152)

Performances to Prevent VAP	Compliance N (%)	Non-Compliance N (%)
Hand hygiene with soap and water or an alcohol-based rub before and after touching the patient.	88 (57.9)	64 (42.1)
Hand hygiene with soap and water or an alcohol-based rub before touching the ventilator.	103 (67.8)	49 (32.2)
PPE usage strictly while caring the patients and handling ventilator.	121 (79.6)	31 (20.4)
Oral hygiene of the patient using chlorhexidine at regular intervals.	109 (71.7)	43 (28.3)
Head elevation of bed to 30 to 45 degrees.	137 (90.1)	15 (9.9)
Suctioning of the patient to clear the subglottic secretions.	72 (47.4)	80 (52.6)
Use sterile technique when suctioning the airway.	118 (77.6)	34 (22.4)
Use of disposable ventilator circuit and change regularly.	136 (89.5)	16 (10.5)
Control and maintain cuff pressure.	84 (55.3)	68 (44.7)
Use spontaneous breathing trial.	97 (63.8)	55 (36.2)
Do chest wall percussion	107 (70.4)	45 (29.6)
Lighten sedation at regular intervals, to assess for neurological readiness to wean the patient from ventilation.	83 (54.6)	69 (45.4)
Conservative fluid management.	141 (92.8)	11 (7.2)
Administer short course of systemic antibiotics.	137 (90.1)	15 (9.9)
Use devices to prevent DVT	93 (61.2)	59 (38.8)
Timely evacuation of water container of ventilator circuit.	143 (94.1)	9 (5.9)

Abbreviations: N, number; %, percentage.

prevention guidelines. The overall mean score of knowledge level was 11.1 ± 2.4. A high mean score of 12.9 ± 2.2 was obtained by physicians, followed by 11.3 ± 1.6 by nurses, 9.8 ± 2.2 by RTs, and 8.6 ± 2.1 by interns. A similar study was conducted on the impact of education on VAP in the ICU, in which the nurse's knowledge as reflected in their test mean score was 63.17 ± 9.34.[32] A cross-sectional study, involving ICU nurses in major hospitals in Tanzania demonstrated that 79.3% of nurses had a mean knowledge score of 3.86 ± 1.56, based on ten questions.[33] Another study showed that the median value of total points scored by nurses on the questionnaire was 4.00 ± 2.00,[34] and 15·91 ± 2·68.[35]

The current study indicated that 57.9% of MPs regularly cleaned their hands, which was supported by similar research in which 57% adhered to hand hygiene.[36] In our study, 79.6% of the MPs complied with the protocol by wearing PPE strictly. This finding was supported by a study on compliance with the standards for the prevention of VAP by nurses in the ICU, in which the use of PPE was 80.3%.[37] In the present study, 71.7% adhered to the oral hygiene of the patient using chlorhexidine. The adherence rate was 45.6% in a multi-centre study done by Eom et al,[38] and 87.5% in another study.[37] In this study, 90.1% of MPs recommended elevating the head of the bed by 30 to 45 degrees to reduce VAP occurrences. Similarly, the compliance rate was 98% in the study conducted on adherence to the VAP bundle and the incidence of VAP in the surgical ICU.[39] However, the adherence rate was evidenced at 65.9% in the research[38] which was low. There was 80% adherence in one study,[40] and 96.6% in another study.[37]

A semi-upright position in ventilated patients is recommended to prevent VAP and is an essential component of the ventilator bundle.[35,41] Because, the aspiration of oropharyngeal secretions and gastric contents containing bacteria leading the pathogenesis of VAP in supine position than in patients in a 45° position.[42,43] In our study, 47.4% MPs changed the body position of the patient every two hours, once regularly to clear the secretions and suctioning to clear the

Table 4 Association Between the MP's Performance Regarding Prevention of VAP and Baseline Informations. (n=152)

Characteristic	Category	Satisfactory Performance	Unsatisfactory Performance	Chi-Square Test
Age (years)	20–30 years	31	8	X^2 = 18.9565 P = 0.000279***
	31–40 years	22	39	
	41–50 years	21	22	
	More than 50 years	6	3	
Gender	Male	22	17	X^2 = 0.3005 P = 0.5836 NS
	Female	58	55	
Educational qualification (highest)	Diploma	23	29	X^2 = 3.4075 P = 0.332965 NS
	Bachelor	45	29	
	Master	12	10	
	Doctorate	2	2	
Designation	Physician	21	18	X^2 = 8.3692 P = 0.038967*
	Nurse	39	32	
	RT	12	4	
	Interns	8	18	
Professional experience	< 1 year	10	24	X^2 = 10.6169 P = 0.031224*
	1–3 years	36	35	
	4–6 years	16	12	
	6–9 years	11	4	
	10 and above years	3	1	
Working sector	Public hospital	56	49	X^2 = 0.0671 P = 0.795642 NS
	Private hospital	24	23	
Working unit	Medical ICU	39	39	X^2 = 4.4366 P = 0.108794 NS
	Surgical ICU	23	9	
	CCU	23	19	
Managing COPD	Yes	13	24	X^2 = 6.4752 P = 0.010939*
	No	68	47	
Training attended	Yes	31	12	X^2 = 22.1207 P = 0.00001***
	No	33	76	

Notes: *Significance at $p < 0.05$; ***Significance at $p < 0.001$.

Abbreviations: ARDS, acute respiratory distress syndrome; CCU, critical care unit; CDC, centers for disease control and prevention; COPD, chronic obstructive pulmonary disease; DVT, deep vein thrombosis; ETT, endo tracheal tube; IBM, International Business Machines; ICU, intensive care unit; IPC, intermittent pneumatic compression; MPs, medical professionals; PPE, personal protective equipment; RTs, respiratory therapists; SD, standard deviation; SPSS, statistical package for social sciences; STROBE, strengthening the reporting of observational studies in epidemiology; USA, United States of America; VAP, ventilator associated pneumonia; WHO, World Health Organization; NS, non-significant.

subglottic secretions, that was supported by Tabaeian et al.[37] A study proved the effects of 45° semi-upright position improves ventilation and oxygenation in mechanically ventilated intensive care patients, in which peripheral oxygen saturation (SpO_2) and end-tidal carbon dioxide ($ETCO_2$) improved significantly for the 45° position compared with <10° position.[44]

The sterile technique when suctioning the airway was followed by 77.6%. But the use of sterile techniques for airway suctioning through the open method by nurses was shown in a study ($p = 0.175$).[37] The effect of ventilator circuit changes on ventilator-associated pneumonia was proved by many researchers.[45] In this research, 89.5% of MPs changed the disposable ventilator circuit regularly, and 55.3% of MPs controlled and maintained cuff pressure properly. There was 34.2% compliance in repositioning the ETT and 34.9% in controlling and maintaining the cuff pressure regularly. Additionally, a matched case-control study conducted among mechanically ventilated patients admitted to the ICU reported that patients who had a history of ETT repositioning were twice as likely to develop VAP as patients who had no history of ETT.[46]

Spontaneous breathing trials can be performed on low levels of pressure support, and continuous positive airway pressure.[47] This current study finding reported that 63.8% of MPs used the spontaneous breathing trial regularly, which was consistent with a study.[48] Nearly, half of the MPs (51.3%) were done with chest wall percussion. This was not indicated in another study. However, the effect was proved.[49] More than half of the MPs 54.6% have lightened the sedation at regular intervals, to assess for neurological readiness to wean the patient from ventilation. But, in another study, the least adherence to the management of sedation and analgesia.[50] About the conservative fluid management[51] and administration of a short course of systemic antibiotics,[52] 92.8% and 90.1% MPs complied to prevent infection to their patients respectively. IPC device[53] was used to prevent by 61.2% of MPs. Most of them (94.1%) performed timely evacuation of the water container of the ventilator circuit. These findings were compared with another study.[37]

There was a significant association found between the performance of MPs on the prevention of VAP with age ($p < 0.001$), designation ($p < 0.05$), professional experience ($p < 0.05$), managing patients with COPD[54] ($p < 0.05$) and training attended within 2 years on VAP prevention guidelines ($p < 0.001$). Nevertheless, it should also be noted that, in the present study, 16 preventive measures were included. The strength of the present study was the method used for data collection, which was conducted by direct observation of the MPs' performances, without causing any reaction or change in their behavior, and therefore, the results demonstrated their real performance of them. In the previous study[55] a total of 12 preventive measures were included through direct observation of the nurses, and the rate of compliance was low. In addition to that, this is the first study to assess the performance of MPs, including physicians, nurses, RTs, and interns. Overall, the findings of this study showed satisfactory performance of the MPs. The weakness of the current study was the parameters in compliance of MPs for a given patient or unit observed by using a "yes" or "no" checklist rather than a rating scale. In addition, to measure sustained compliance, longer follow-up was needed, which was the limitation. However, considering the prevalence of VAP[56] and its various complications, it is necessary to expand the study with larger samples. The factors causing the low or unsatisfactory performance of MPs will be further studied in the future. Also, it is recommended that a preventive clinical guide for VAP need to be circulated to all MPs.

Conclusion

The findings of the study evidenced that, approximately half of the study participants had adequate knowledge and satisfactory performance regarding VAP prevention in ICU. However, more attention should be paid to planning and providing appropriate and regular training programs for all MPs to update the information and follow the clinical guidelines and necessary facilities must be provided with high-quality services in the ICU to improve health care quality, and by the way to reduce the rate of VAP.

Acknowledgments

The authors extend their appreciation to the Deanship of Scientific Research at King Faisal University, Al-Ahsa, Kingdom of Saudi Arabia for its financial support through Nasher track with reference to the research grant number NA00099.

Disclosure

The authors report no conflicts of interest in this work.

References

1. Burtin C, Clerckx B, Robbeets C, et al. Early exercise in critically ill patients enhances short-term functional recovery. *Crit Care Med*. 2009;37(9):2499–2505. doi:10.1097/CCM.0b013e3181a38937
2. Pham T, Brochard LJ, Slutsky AS. Mechanical ventilation: state of the art. *Mayo Clin Proc*. 2017;92(9):1382–1400. doi:10.1016/j.mayocp.2017.05.004
3. Jolley SE, Moss M, Needham DM, et al. Point prevalence study of mobilization practices for acute respiratory failure patients in the United States. *Crit Care Med*. 2017;45(2):205–215. doi:10.1097/CCM.0000000000002058
4. Kalanuria AA, Zai W, Mirski M. Ventilator-associated pneumonia in the ICU. *Crit Care*. 2014;18(2):208. doi:10.1186/cc13775
5. Papazian L, Klompas M, Luyt CE. Ventilator-associated pneumonia in adults: a narrative review. *Intensive Care Med*. 2020;46(5):888–906. doi:10.1007/s00134-020-05980-0
6. Tikka T, Hilmi OJ. Upper airway tract complications of endotracheal intubation. *Br J Hosp Med*. 2019;80(8):441–447. doi:10.12968/hmed.2019.80.8.441
7. Rebmann T, Greene LR. Preventing ventilator-associated pneumonia: an executive summary of the association for professionals in infection control and epidemiology, inc, elimination guide. *Am J Infect Control*. 2010;38(8):647–649. doi:10.1016/j.ajic.2010.08.004
8. Ban KO. The effectiveness of an evidence-based nursing care program to reduce ventilator-associated pneumonia in a Korean ICU. *Intensive Crit Care Nurs*. 2011;27(4):226–232. doi:10.1016/j.iccn.2011.04.001
9. Martin-Loeches I, Rodriguez AH, Torres A. New guidelines for hospital-acquired pneumonia/ventilator-associated pneumonia: USA vs. *Europe Curr Opin Crit Care*. 2018;24(5):347–352. doi:10.1097/MCC.0000000000000535
10. Bouadma L, Sonneville R, Garrouste-Orgeas M, et al. Ventilator-associated events: prevalence, outcome, and relationship with ventilator-associated pneumonia. *Crit Care Med*. 2015;43(9):1798–1806. doi:10.1097/CCM.0000000000001091
11. Teng G, Wang N, Nie X, et al. Analysis of risk factors for early-onset ventilator-associated pneumonia in a neurosurgical intensive care unit. *BMC Infect Dis*. 2022;22:66. doi:10.1186/s12879-022-07053-7
12. Humayun T, Alshanbari N, Alanazi A, et al. Rates of ventilator associated pneumonia in Saudi ministry of health hospitals; A two-year multi-center study. *Am J Infect Dis Micro*. 2021;9:25–31. doi:10.12691/ajidm-9-1-6
13. Micik S, Besic N, Johnson N, et al. Reducing risk for ventilator associated pneumonia through nursing sensitive interventions. *Intensive Crit Care Nurs*. 2013;29:261–265. doi:10.1016/j.iccn.2013.04.005
14. Wu D, Wu C, Zhang S, et al. Risk factors of ventilator-associated pneumonia in critically III patients. *Front Pharmacol*. 2019;10:482. doi:10.3389/fphar.2019.00482
15. Ruffell A, Adamcova L. Ventilator-associated pneumonia: prevention is better than cure. *Nurs Crit Care*. 2008;13(1):44–53. doi:10.1111/j.1478-5153.2007.00248.x
16. Hawe CS, Ellis KS, Cairns CJ, et al. Reduction of ventilator-associated pneumonia: active versus passive guideline implementation. *Intensive Care Med*. 2009;35(7):1180–1186. doi:10.1007/s00134-009-1461-0
17. Rello J, Chastre J, Cornaglia G, et al. A European care bundle for management of ventilator-associated pneumonia. *J Crit Care*. 2011;26(1):3–10. doi:10.1016/j.jcrc.2010.04.001
18. Sundar KM, Nielsen D, Sperry P. Comparison of ventilator-associated pneumonia (VAP) rates between different ICUs. *J Crit Care*. 2012;27(1):26–32. doi:10.1016/j.jcrc.2011.05.019
19. Chow MC, Kwok SM, Luk HW, et al. Effect of continuous oral suctioning on the development of ventilator-associated pneumonia: a pilot randomized controlled trial. *Int J Nurs Stud*. 2012;49(11):1333–1341. doi:10.1016/j.ijnurstu.2012.06.003
20. Craven DE, Lei Y, Ruthazer R, et al. Incidence and outcomes of ventilator-associated tracheobronchitis and pneumonia. *Am J Med*. 2013;126(6):542–549. doi:10.1016/j.amjmed.2012.12.012
21. Lavrinenko A, Sheck E, Kolesnichenko S, et al. Antibiotic resistance and genotypes of nosocomial strains of *Acinetobacter baumannii* in Kazakhstan. *Antibiotics*. 2021;10(4):382. doi:10.3390/antibiotics10040382
22. Aloush SM. Nurse's implementation of ventilator-associated pneumonia prevention guidelines: an observational study in Jordan. *Nurs Crit Care*. 2018;23(3):147–151. doi:10.1111/nicc.12323
23. Alkubati SA, Saghir SAM, Al-Sayaghi KM, et al. Healthcare worker's knowledge of evidence-based guidelines for prevention of ventilator-associated pneumonia in Hodeida, Yemen. *J Basic Clin Physiol Pharmacol*. 2021. doi:10.1515/jbcpp-2020-0388
24. Branco A, Lourencone EMS, Monteiro AB, et al. Education to prevent ventilator-associated pneumonia in intensive care unit. *Rev Bras Enferm*. 2020;73:e20190477. doi:10.1590/0034-7167-2019-0477
25. Hassan ZM, Wahsheh MA. Knowledge level of nurses in Jordan on ventilator-associated pneumonia and preventive measures. *Nurs Crit Care*. 2017;22(3):125–132. doi:10.1111/nicc.12273
26. Al-Sayaghi KM. Critical care nurse's compliance and barriers toward ventilator-associated pneumonia prevention guidelines: cross-sectional survey. *J Taibah Univ Med Sci*. 2020;16:274–282. doi:10.1016/j.jtumed.2020.12.001
27. Aloush SM, Al-Rawajfa OM. Prevention of ventilator-associated pneumonia in intensive care units: barriers and compliance. *Int J Nurs Pract*. 2020;26(5):e12838. doi:10.1111/ijn.12838
28. World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. *JAMA*. 2013;310(20):2191–2194. doi:10.1001/jama.2013.281053
29. Howell CR, Su W, Nassel AF, et al. Area based stratified random sampling using geospatial technology in a community-based survey. *BMC Pub Health*. 2020;20(1):1678. doi:10.1186/s12889-020-09793-0
30. Divatia JV, Pulinilkunnathil JG, Myatra SN. Nosocomial infections and ventilator-associated pneumonia in cancer patients. *Onco Crit Care*. 2019;1419–1439. doi:10.1007/978-3-319-74588-6_125
31. Giuliano KK, Baker D, Quinn B. The epidemiology of non-ventilator hospital-acquired pneumonia in the United States. *Am J Infect Control*. 2018;46(3):322–327. doi:10.1016/j.ajic.2017.09.005
32. Subramanian P, Choy KL, Gobal SV, et al. Impact of education on ventilator-associated pneumonia in the intensive care unit. *Singapore Med J*. 2013;54(5):281–284. doi:10.11622/smedj.2013109

33. Bankanie V, Outwater AH, Wan L, et al. Assessment of knowledge and compliance to evidence-based guidelines for VAP prevention among ICU nurses in Tanzania. *BMC Nurs*. 2021;20(1):209. doi:10.1186/s12912-021-00735-8
34. Akin Korhan E, Hakverdioglu Yont G, Parlar Kilic S, Uzelli D. Knowledge levels of intensive care nurses on prevention of ventilator-associated pneumonia. *Nurs Crit Care*. 2014;19(1):26–33. doi:10.1111/nicc.12038
35. Jam Gatell MR, Sante Roig M, Hernandez Vian O, et al. Assessment of a training programme for the prevention of ventilator-associated pneumonia. *Nurs Crit Care*. 2012;17(6):285–292. doi:10.1111/j.1478-5153.2012.00526.x
36. Lambert ML, Palomar M, Agodi A, et al. Prevention of ventilator-associated pneumonia in intensive care units: an international online survey. *Antimicrob Resist Infect Control*. 2013;2(1):9. doi:10.1186/2047-2994-2-9
37. Tabaeian SM, Yazdannik A, Abbasi S. Compliance with the standards for prevention of ventilator-associated pneumonia by nurses in the intensive care units. *Iran J Nurs Midwifery Res*. 2017;22(1):31–36. doi:10.4103/1735-9066.202073
38. Eom JS, Lee MS, Chun H, et al. The impact of a ventilator bundle on preventing ventilator-associated pneumonia: a multicenter study. *Am J Infect Control*. 2014;42(1):34–37. doi:10.1016/j.ajic.2013.06.023
39. Bird D, Zambuto A, O Donnell C, et al. Adherence to ventilator-associated pneumonia bundle and incidence of ventilator-associated pneumonia in the surgical intensive care unit. *Arch Surg*. 2010;145(5):465–470. doi:10.1001/archsurg.2010.69
40. Kiyoshi-Teo H, Cabana MD, Froelicher ES, et al. Prevention guidelines adherence to institution-specific ventilator-associated pneumonia. *Am J Crit Care*. 2014;23(3):201–214. doi:10.4037/ajcc2014837
41. Niel-Weise BS, Gastmeier P, Kola A, et al. Bed Head Elevation Study Group. An evidence-based recommendation on bed head elevation for mechanically ventilated patients. *Crit Care*. 2011;15(2):R111. doi:10.1186/cc10135
42. Orozco-Levi M, Torres A, Ferrer M, et al. Semi-recumbent position protects from pulmonary aspiration but not completely from gastroesophageal reflux in mechanically ventilated patients. *Am J Respir Crit Care Med*. 1995;152(4):1387–1390. doi:10.1164/ajrccm.152.4.7551400
43. Alexiou VG, Ierodiakonou V, Dimopoulos G, et al. Impact of patient position on the incidence of ventilator-associated pneumonia: a meta-analysis of randomized controlled trials. *J Crit Care*. 2009;24(4):515–522. doi:10.1016/j.jcrc.2008.09.003
44. Van Beers F, Vos P. Semi-upright position improves ventilation and oxygenation in mechanically ventilated intensive care patients. *Crit Care*. 2014;18(Suppl 1):P258. doi:10.1186/cc13448
45. Park S, Kim WY, Baek MS. Risk factors for mortality among mechanically ventilated patients requiring pleural drainage. *Int J Gen Med*. 2022;15:1637–1646. doi:10.2147/IJGM.S349249
46. Ismaeil T, Alfunaysan L, Alotaibi N, et al. Repositioning of endotracheal tube and risk of ventilator-associated pneumonia among adult patients: a matched case-control study. *Ann Thorac Med*. 2019;14(4):264–268. doi:10.4103/atm.ATM_26_19
47. Penuelas O, Thille AW, Esteban A. Discontinuation of ventilatory support: new solutions to old dilemmas. *Curr Opin Crit Care*. 2015;21(1):74–81. doi:10.1097/MCC.0000000000000169
48. Khan RM, Al-Juaid M, Al-Mutairi H, et al. Implementing the comprehensive unit-based safety program model to improve the management of mechanically ventilated patients in Saudi Arabia. *Am J Infect Control*. 2019;47(1):51–58. doi:10.1016/j.ajic.2018.06.022
49. Spapen HD, De Regt J, Honore PM. Chest physiotherapy in mechanically ventilated patients without pneumonia-a narrative review. *J Thorac Dis*. 2017;9(1):E44–E49. doi:10.21037/jtd.2017.01.32
50. Jansson MM, Syrjala HP, Talman K, et al. Critical care nurse's knowledge of, adherence to, and barriers toward institution-specific ventilator bundle. *Am J Infect Control*. 2018;46(9):1051–1056. doi:10.1016/j.ajic.2018.02.004
51. Blackwood B, Alderdice F, Burns K, et al. Use of weaning protocols for reducing duration of mechanical ventilation in critically ill adult patients: Cochrane systematic review and meta-analysis. *BMJ*. 2011;342:c7237. doi:10.1136/bmj.c7237
52. Grissom CK, Hirshberg EL, Dickerson JB, et al. National heart lung and blood institute acute respiratory distress syndrome clinical trials network. Fluid management with a simplified conservative protocol for the acute respiratory distress syndrome*. *Crit Care Med*. 2015;43(2):288–295. doi:10.1097/CCM.0000000000000715
53. Righy C, Do Brasil PEA, Valles J, et al. Systemic antibiotics for preventing ventilator-associated pneumonia in comatose patients: a systematic review and meta-analysis. *Ann Intensive Care*. 2017;7(1):67. doi:10.1186/s13613-017-0291-4
54. Cook DJ, Crowther MA. Thromboprophylaxis in the intensive care unit: focus on medical-surgical patients. *Crit Care Med*. 2010;38:S76–S82. doi:10.1097/CCM.0b013e3181c9e344
55. Koulenti D, Blot S, Dulhunty JM, et al. COPD patients with ventilator-associated pneumonia: implications for management. *Eur J Clin Microbiol Infect Dis*. 2015;34(12):2403–2411. doi:10.1007/s10096-015-2495-6
56. Righi E, Aggazzotti G, Ferrari E, et al. Trends in ventilator-associated pneumonia: impact of a ventilator care bundle in an Italian tertiary care hospital intensive care unit. *Am J Infect Control*. 2014;42(12):1312–1316. doi:10.1016/j.ajic.2014.08.009