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ORIGINAL ARTICLE

Implementation of Ventilator-Associated Pneumonia Prevention Bundle among ICU Nurses in Salmaniya Medical Complex, Bahrain: A Quasi-Experimental Study

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ABSTRACT

Objective: To evaluate the effectiveness of an educational intervention to improve the knowledge regarding ventilator-associated pneumonia (VAP) and practices of VAP prevention bundle among the intensive care unit (ICU) nurses in Salmaniya Medical Complex in Bahrain.

Methods: A quasi- experimental study was conducted in the main ICU of Salmaniya Medical Complex in Bahrain from October 2021 to January 2022. A convenience sampling technique was used, and 58 ICU staff nurses were enrolled in the study. Tools used for data collection were a self-administered questionnaire to assess ICU nurses knowledge and an observational checklist to assess the adherence of ICU nurses to the VAP prevention bundle.

Results: Of 58 total study subjects, almost three-quarters of the ICU nurses 42 (72%) had poor knowledge of VAP prior to the educational intervention. However, after the implementation, the proportion increased with 46 (79%) of the nurses acquiring good knowledge about the VAP and 56 (97%) of the ICU nurses acquiring good knowledge of the VAP prevention bundle. Overall, there was a significant improvement in the median score of adherences to the VAP prevention bundle elements before and after the intervention (p-value ≤ 0.05).

Conclusion: This study concluded that the levels of knowledge about VAP and practices of the VAP prevention bundle can be improved by implementing a relevant educational program for ICU nurses. The findings of this study also provide evidence of the importance of a continuous training program for ICU nurses to ensure quality patient care in the critical care units.

Keywords: Adherence, Care Bundles, Intensive Care Units, Nurses, Ventilator Associated Pneumonia.

Clinical Trial Registry #: NCT05517759

INTRODUCTION

Ventilator-associated pneumonia (VAP) is a common healthcare-associated infection in lung parenchyma that occurs in patients who received invasive mechanical ventilation for more than 2 consecutive days before the day of the event.[1] According to the national statistics of the ministry of Bahrain in 2019, it was reported that 12 death cases in Salmaniya Medical Complex (SMC) were diagnosed with lung disease, which developed 48 hours after being put on mechanical ventilation. A six years surveillance study from 2008 to 2013, conducted in three Arabian Gulf countries including Bahrain, Oman, and Saudi Arabia reported 368 cases of VAP during the study period.[2] Similarly, the developed countries have recorded 22.8% incidents of VAP; especially in intensive care units (ICU).[3] The University Clinical Center of Kosovo recorded 72.7% cases of VAP and labelled it as the predominant type of infection in the ICU.[4]

VAP can lead to very negative effects that range from increasing the overall healthcare cost by delaying the extubation period and increasing the length of stay in the hospital, to increasing the possibility of antimicrobial resistance, mortality and morbidity rates.[5] Therefore, a series of interventions have been recommended by the Institute of Health Improvements (IHI), recognized as the VAP prevention bundle.[5] These interventions are: elevating the head end of the bed 30°-45°, daily sedation interruption, oral care with chlorhexidine, peptic ulcer disease (PUD) prophylaxis, and deep vein thrombosis (DVT) prophylaxis.[6]

Nurses in critical care play an important role in disease management and prevention; therefore, the nursing practice must be based on a strong body of scientific knowledge. Although the optimal approach for

reducing VAP is still unclear, many studies conveyed that educating nurses who are giving care to patients on mechanical ventilators can play a consequential role in reducing the rates of VAP.[7, 8] Furthermore, evidence also suggests that the cases of VAP in ICU settings can be significantly reduced, following an educational intervention of the VAP bundle.[7,8] Alternatively, a lack of knowledge and sub-optimal practice of VAP prevention bundle by the nurses can dramatically increase the rates of VAP.[8,9]

Nurses who are working in ICUs are required to deliver high-quality care by incorporating evidence-based practices regarding VAP prevention. Keeping in view the role of nurses in VAP prevention and owing to the lack of information regarding nurses' knowledge of VAP and practices of VAP prevention bundle in Bahrain, the current study has taken up the objective to assess the effectiveness of an educational intervention to improve the knowledge and practices of ICU nurses regarding VAP and VAP prevention bundle.

METHODS

A quantitative quasi-experimental interventional design has been used to assess the effectiveness of an educational intervention to improve the knowledge and practice of ICU nurses related to the prevention of VAP. This study was conducted at the selected ICU of Salmaniya Medical Complex, the main tertiary setting in Bahrain, from October 2021 to January 2022. To comply with the ethical guidelines for ethical research, ethical approval was taken from the Institutional Review Board of the Committee for higher studies at the University of Bahrain. This study was also approved by the Ethics Committee of the Ministry of Health, the Secondary Health Care Research committee in Salmaniya Medical Complex and the Scientific Research and Publication committee at the College of Health and Sport Science. Informed consent was sought from the eligible ICU nurses.

Nurses were recruited by using a non-probability convenience sampling method from the main ICU of Salmaniya Medical Complex. As per Centers for Disease Control and Prevention (CDC) guidelines,[1] each patient connected to a mechanical ventilator must receive the bundle of care to prevent VAP; therefore, all nurses in the ICU were invited to participate in this study. A total of 110 nurses worked in permanent positions at the ICU. The sample size was calculated to be 87 by using 95% confidence interval, 5% margin of error and total population of nurses i.e., 110. However, 20 nurses were shifted temporarily to work in the COVID center, and 9 nurses did not complete all of the intervention phase. Thus, the final sample size came out to be 58.

A demographic data questionnaire was utilized to record information on age, sex, years of experience, educational level and marital status. This study consisted of three phases. During the pre-interventional phase of the study nurses' knowledge regarding VAP and VAP prevention bundle was assessed by using a knowledge-based questionnaire that was adopted from Lin et al[9] consisting of twelve multiple-choice questions (MCQs) related to VAP and VAP prevention bundle. The level of knowledge was classified by using bloom's cut-off points (80%-100% for good knowledge, 60%-79% for moderate knowledge and ≤60% for poor knowledge). Each correct answer counted as one, while a wrong answer was taken as a zero on the scale. The score was calculated for each participant and the summated result of each participant was reported out of a total of 100 before and after the intervention.

Nurses were given 7-10 minutes to choose the answers. Once the participants completed the questionnaire, their adherence to the VAP bundle was evaluated by using an observational checklist obtained from IHI[10] to assess nurses' practices regarding the VAP prevention bundle. It included five interventions to reduce VAP. These interventions were: elevation of the head of the bed (HOB) (30-45) degree, daily sedation vacation and assessment of weaning and extubating, usage of prophylaxis for PUD, Usage of prophylaxis of DVT, oral care daily with chlorhexidine. This tool was also completed by the researcher through direct observations.

The adherence to the VAP prevention bundle was recorded daily for each bundle element; if the bundle elements were performed it was recorded as "yes", whereas if it was missing it was recorded as "no". The application of all five elements of the VAP bundle was evaluated, and the data collection time for each patient did not exceed 10 minutes. The PUD and DVT prophylaxis prescriptions are clinical practice guidelines and standard protocols followed in Salmaniya Medical Complex for all in-patients, prescribed by doctors and administered by nurses according to the National Health Regulatory Authority guidelines.

In the implementation phase of this study, the researcher provided educational sessions related to the VAP prevention bundle. All nurses were divided into groups of six to seven nurses. A schedule of teaching sessions was organized with ICU nursing supervisors to avoid disturbing the daily work of the nursing staff. The

sessions were delivered face-to-face, as group discussions, brainstorming and smart card activities. The educational package covered all aspects of knowledge regarding VAP such as definitions, risk factors, causes, manifestation, diagnostic criteria, and nursing care to prevent VAP. A PowerPoint display screen and information pamphlet was used to display the relevant information.

During the post-intervention phase, the researcher reassessed the nurses' knowledge by using the same knowledge-based questionnaire (used in the pre-intervention phase) and nurses' compliance was reassessed by using the IHI VAP prevention checklist during respective work shifts (morning, evening and night).

Data entry and analysis were done using Statistical Package for Social Sciences (SPSS) version 20.0. Median (IQR) was computed for quantitative variables like age, and pre- and post-intervention VAP knowledge scores, while frequency and percentages were computed for categorical variables, including gender, marital status, level of education, and experience.

Inferential statistics were explored using the Wilcoxon Signed Ranks test to compare pre- and post-intervention knowledge scores with the demographic characteristics of the nurses. Moreover, the Spearman's correlation test was used to determine the relationship between the knowledge score and the adherence score. The p-value of ≤ 0.05 was considered statistically significant.

RESULTS

Of the 58 total study subjects, there were 47 (81%) females and 11 (19.0%) males. The majority of the participants 55 (94.8%) were married and were between 30-39 years of age 30 (51.7%). Most of the participants were bachelor's degree holders 39 (67.2%) followed by associate degree 12 (20.7%), and diploma-level education 7 (12.1%). Almost 22 (38%) of the participants had less than 10 years of experience working in the ICU, while the rest of the participants had more than 10 years of working experience at the ICU.

Table 1 represents the different knowledge levels of ICU nurses and their improvement before and after intervention. In regard to the knowledge about VAP, it was clear from the table that almost three quarters of ICU nurses were occupying the highest proportion 42 (72.4%) in having poor knowledge about the disease (VAP) before the education program and 9 (15.5%) had moderate knowledge and 7 (12.1%) had good knowledge about the disease and only 21 (36.2%) of them had a good knowledge about the bundle elements. However, after the implementation the proportion increased in which 46 (79.3%) of the nurses have a good knowledge about the VAP and 56 (96.6%) of the ICU nurses had a good knowledge about VAP bundle.

Table 2 describes the data of improvements that nurses had in the level of adherence to apply the VAP bundle elements according to the demographic characteristics. Overall, it was clear from the table that there was a significant difference in the median score of adherences to the VAP elements before and after the education program. In regard to the gender both female and male showed statistically significant results in the level of adherence (p-value 0.003) and (p-value <0.001) respectively. The age group showed a statistically significant results also (p-value ≤0.05), except for the age group 20 - 29 in which their level of adherence to VAP bundle elements were low compared to the other age groups. In terms of the duration of working at the ICU, adherence to VAP bundle elements increased significantly post-intervention (p-value ≤ 0.05) in all groups with varying levels of experience working at the ICU.

We did not find any significant correlation between the pre- and post- intervention phase knowledge and adherence scores of the participants (Table 3). The proportion of nurses who implement HOB elevation, as per the researcher's direct observation, improved significantly post-intervention 49 (84.5%). Moreover, oral care with chlorhexidine also increased from 15 (26%) in the pre-intervention phase to 50 (86%) post-intervention. The percentage of the participants performing daily sedation vacation also improved from 31 (53%) pre-intervention to 36 (62%) following the educational intervention. The DVT and PUD prophylaxis percentage almost remained constant (Figure 1).

DISCUSSION

Our study found that an educational training program for ICU nurses can be an effective strategy to improve the knowledge of ventilator-associated pneumonia and can ensure adherence to the VAP prevention bundle activities amongst critical care nurses.

This current study found an insufficient level of knowledge and sub-optimal practices of VAP and VAP prevention bundle among the ICU nurses during the pre-intervention phase of the study. This finding is supported by previous literature that reported that a majority of nurses lack knowledge of VAP prevention in critical care settings.[11-13] A previous study, conducted in

Table 1: Comparison of nurses' knowledge about VAP prevention bundle before and after the training program (n = 58)

	Before			After		
	Poor	Moderate	Good	Poor	Moderate	Good
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
VAP Knowledge Score	42 (72.4)	9 (15.5)	7 (12.1)	2 (3.4)	10 (17.2)	46 (79.3)
VAP Bundle Knowledge Score	20 (34.5)	17 (29.3)	21 (36.2)	0 (0)	2 (3.4)	56 (96.6)
Overall Knowledge Score	31 (53.4)	26 (44.8)	1 (1.7)	0 (0)	3 (5.2)	55 (94.8)

-VAP: Ventilator-Associated Pneumonia
All data presented as number (%)

Table 2: Comparison of nurses' adherence score about VAP prevention bundle before and after training program according to demographical characteristics (n= 58)

	Total	Adherence Score		p-value
		Before Median (IQR)	After Median (IQR)	
Age (Years)				
20 - 29	6	65.0 (56.1 – 83.3)	80.0 (77.5 – 92.5)	0.168
30 - 39	30	63.3 (50.0 – 70.0)	90.0 (80.0 – 90.0)	<0.001*
≥40	22	60.0 (50.0 – 70.0)	90.0 (8.0 – 100.0)	<0.001*
Gender				
Male	11	70.0 (60.0 – 70.0)	90.0 (80.0 – 100.0)	< 0.001*
Female	47	60.0 (50.0 – 70.0)	90.0 (80.0 – 90.0)	0.003*
Level of Education				
Associate degree	12	66.6 (51.38 – 73.7)	85.0 (80.0 – 100.0)	0.003*
Diploma	7	55.5 (30.0 – 66.0)	80.0 (80.0 – 90.0)	0.027*
Bachelor's degree	39	60.0 (50.0 – 70.0)	90.0 (80.0 – 90.0)	<0.001*
Being an ICU Nurse (Years)				
< 5	7	66.6 (60.0 – 77.7)	80.0 (80.0 – 90.0)	0.018*
5-10	22	60.0 (50.0 – 71.2)	85.0 (80.0 – 90.0)	<0.001*
11-15	13	58.3 (50.0 – 66.6)	70.0 (45.0 – 75.0)	0.003*
>15	16	90.0 (75.0 – 90.0)	90.0 (90.0 – 100.0)	<0.001*

-VAP: Ventilator-Associated Pneumonia
Wilcoxon Signed Ranks test applied, *p-value ≤ 0.05

318 ICUs in Europe reported that out of various domains of intensive care, the performance of ICU nurses was the lowest in the mechanical ventilation domain.[14] Multiple factors may contribute to the inadequacy in the knowledge and practices regarding VAP and VAP prevention bundle among ICU nurses.[15] This may range from the level of academic qualification to the degree of professional experience of working in an intensive care environment.[16,17] However, disease-specific education and practical training can effectively fill-in this gap, as evident in this current study. Moreover, a continuous medical education program for periodic reinforcement of best practices in VAP prevention strategies may be more efficacious than sporadic or occasional teaching initiatives.[18]

This study found that the knowledge and practices of VAP and VAP prevention bundle significantly improved post-intervention, among all ICU nurses, irrespective of their years of experience working in the intensive care environment. This is contradictory to the findings of Rafiq et al., who found that the mean knowledge score of experienced nurses was significantly better than less experienced nurses.[19] The plausible reason for this discrepancy could be the fact that there is insufficiency in the current nursing training program in critical areas in Bahrain, along with a lack of on-job training on various domains of ventilator mechanics, therefore, the duration of work experience may not affect the level of knowledge or practices of VAP or VAP prevention bundle among ICU nurses with varying levels of experience.

Table 3: Correlation between knowledge and adherence score of nurses about VAP prevention bundle (n=58)

		Pre-Phase Adherence Score	Post-Phase Adherence Score
Pre-phase Knowledge Score	Spearman's correlation	-0.196	0.087
	p-value	0.140	0.514
Post-phase Knowledge Score	Spearman's correlation	0.068	0.071
	p-value	0.612	0.598

-VAP: Ventilator-Associated Pneumonia

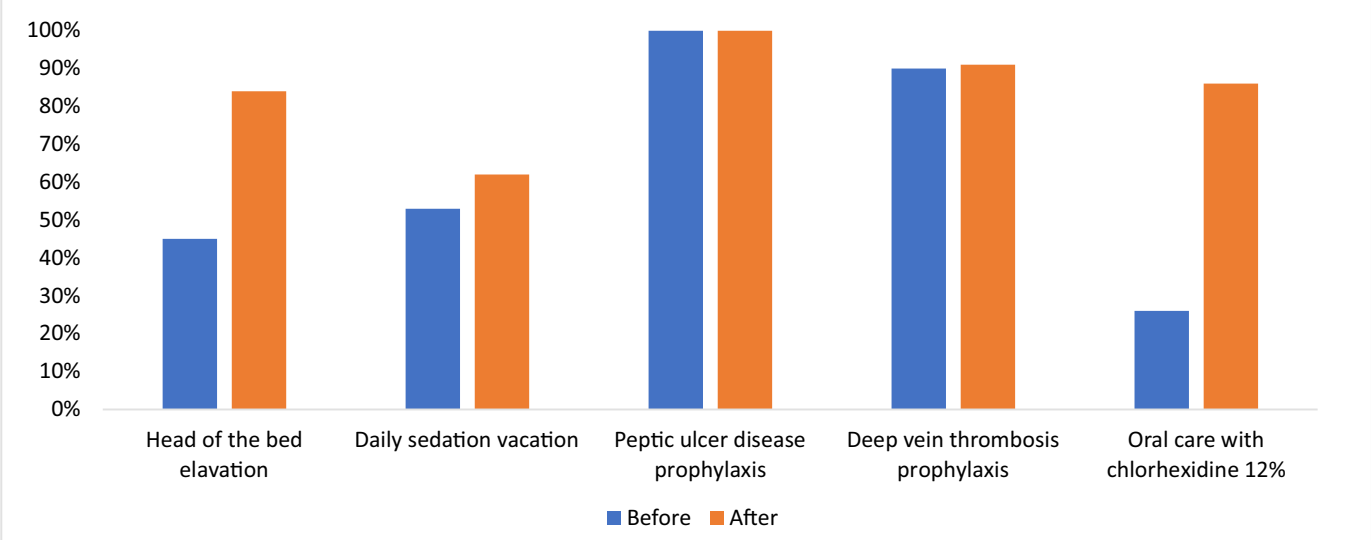

Figure 1: Comparison of nurses' adherence to evidence-based VAP prevention bundle (n=58)

Among the five elements of the VAP prevention bundle, oral care with chlorhexidine was found to be the least applied element by the ICU nurses, followed by the HOB elevation during the pre-intervention phase. However, these were also the elements that dramatically improved following the educational intervention, highlighting the importance of a well-designed and practical training program in improving the competencies and practices of ICU nurses.

Despite an improvement in the level of knowledge of the VAP and adherence to VAP prevention bundle, we did not find a significant correlation between the knowledge and adherence scores following the intervention. This finding is in agreement with the study of Kalyan et.al, in which they reported no association between the knowledge of VAP or adherence to the VAP prevention bundle.[20]

To the best of our knowledge, this present study was the first to assess the effectiveness of an educational intervention in improving the knowledge and practices regarding the VAP and VAP prevention bundle, among the ICU nurses in Bahrain. We acknowledge some limitations of this study. Firstly, due to the COVID-19 pandemic, a considerable number of the nursing staff was shifted to COVID-19 facilities and the main ICU faced nursing staff shortages. This challenged our study sample size. Secondly, this was an institutional-based study, which limits the generalizability of this study. Moreover, the period of our direct observation of VAP prevention bundle practices was limited. Despite these limitations, this work tried to fill the gap in our knowledge regarding the effectiveness of an educational intervention in improving the knowledge regarding VAP and practices of VAP prevention bundle among the nurses in intensive care settings in Bahrain.

CONCLUSION

This study concluded that the levels of knowledge about VAP and practices of the VAP prevention bundle can be improved by implementing a relevant educational program for ICU nurses. The findings of this study also provide evidence of the importance of a continuous training program for intensive care nurses to ensure quality patient care in the critical care units.

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ETHICAL APPROVAL: The Ethics approval was taken from the Institutional Review Board of the Committee for higher studies at the University of Bahrain. This study was also approved by the Ethics Committee of the Ministry of Health, the Secondary Health Care Research Committee in Salmaniya Medical Complex and the Scientific Research and Publication Committee at the College of Health and Sport Science Bahrain.

AUTHORS' CONTRIBUTIONS: ZMA: Has conceived and planned the experiments and data collection also wrote the manuscript.
BMM: Supervised the project and performed the analytic calculations with performed the numerical analysis. Approval of the final version of the manuscript.

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