

Effectiveness of Electronic Learning Module in Implementing Ventilator-Associated Pneumonia Prevention Measures of Intensive Care Unit Nurses

Taghreed Hamza Hawsawi^{1*}, Elham Al-Naghshabandi², Samah Mahmoud Sofar³

¹Master of Nursing Medical Surgical Department KAU, JDH, Saudi Arabia.

²Associate Professor, Medical Surgical Nursing KAU, JDH, Saudi Arabia.

³Lecturer, Medical Surgical Nursing Department, Faculty of Nursing, Alexandria University, Egypt.

*Correspondence:

Taghreed Hamza Hawsawi, Master of Nursing Medical Surgical Department KAU, JDH, Saudi Arabia, E-mail: taghreed.edu@hotmail.com.

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ABSTRACT

Background: One of the vital principles for preventing ventilator associated pneumonia (VAP) in the hospital is equipping healthcare worker by adequate knowledge regarding VAP prevention measures. Integration of electronic education into nursing education flowing growing awareness all-over the world help ICU nurses to incorporate evidence-based practice into daily care for critical ill patient.

Study Aimed to evaluate the effectiveness of electronic learning module in implementation of ventilator-associated-pneumonia prevention measures of intensive care unit nurses.

Methodology: this study was quasi experimental design used two tools; knowledge assessment tool and VAP bundle checklist. Convenience sample of 109 ICU nurses was recruited from Al-Noor specialist hospital in Makkah.

Result: It was founded that nurses' knowledge before they were exposed to educational module was graded as average 72.66% while scores were improved after the exposure to learning module to be high 96.2% meaning that their knowledge has been noticeably improved. However, differences in ICU nurses knowledge in pre and post test was highly significant ($P < 0.005$). ICU nurses poor practice was apparent before exposure to module (61.73%), while ICU nurses practice showed tremendous improvement ($> 99\%$) in the last observation. The difference between pre- and post test observation was highly significant ($P > 0.005$).

Conclusion: The study revealed that e-learning module in educating ICU nurses about VAP prevention were considerably effective. This was highlighted by high mean scores for VAP knowledge and practice after exposure to module.

Recommendation: Integrate orientation program for VAP prevention measures to new staff and continues professional development program for senior staff.

Introduction

Ventilator-associated pneumonia (VAP) is one of the most common hospital-acquired infections world-wide. It's the second most common nosocomial infection in ICUs and the first most common in patients receiving mechanical ventilation for longer than 48 hours. (Villar et al. 2016) Furthermore a study conducted in American Association of Critical-Care Nurses reported that VAP rates in USA range from 1 to 4 cases per 1000 ventilator days in

industrialized countries and up to 13 cases per 1000 ventilator days in developing countries. Despite advances in preventive strategies and treatment modalities, ventilator-associated pneumonia (VAP) remains the most common infectious complication of patients admitted to intensive care units (ICUs). It results in high morbidity and mortality rate, prolonged hospital lengths, and increased cost of hospitalization as well as affected patient safety (Ali Khan et al. 2016).

Lack of knowledge on preventive measures of the nursing staff and their competency deficiency is considered as an obstacle to effectively exercising CDC VAP prevention guidelines (Ha et al. 2016). The preventive measures to combat against VAP must be given utmost importance in the critical care practice. The internationally recognized Stepwise approach in clinical best practice guidelines has been identified five elements if VAP care bundle. Which included head-of-bed elevation, daily sedation vacation, readiness-to-wean assessment, peptic ulcer disease prophylaxis and deep vein thrombosis prophylaxis as the basis for VAP prevention. It is incorporated as ventilator care bundle (VCP) which achieves best care for ICU-ventilated patients [1].

Staff knowledge is considered as the first step on the ladder of guideline implementation and adherence, so that, staff education intervention should be applied in the multimodal policy (Labeau et al. 2009).

The progressive development in information and communication technology (ICT) enables the capability to virtually touch every aspect of life including teaching and learning [2]. Primarily, it was reported that computer-based learning of the ICU nursing employees prompted higher results compared to those receiving conventional learning [3]. E-learning is considered as a by-product of such development and application of the new techniques of teaching and learning on the clinical field of nursing [4]. Button et al. indicated that, nurses' background of the modern technology has a great deal of influence on the integration and incorporation of e-learning in the teaching process. The healthcare practitioner faces strenuous challenges in clinical practice. These challenges are represented in a shortage of resources, the escalation of patient illness severity in ICU patients for instance, and a high turnover of responsible staff.

To overcome such challenges and met the needs required, the healthcare educators, as well as the nurses are in need of developing innovative tools which provide efficient methods for successful educational outcome, which helping in the advancement and improvement of the clinical nurse skills [5]. Integration of nursing education about VAP prevention measures with proper implementation of VAP bundle, provide a significant reduction of VAP incidence of intensive care unit patient and marked improvement of staff nurses knowledge and awareness of VAP prevention measures.

Significance of the Study

Teaching and learning are no longer confined to the classroom or the school day. There are many technologies that can offer a great deal of flexibility in when, where, and how education is delivered. Accordingly the researcher believe that ICU nurses electronic training for VAP prevention measure training will have major affect rather than traditional training. A reduction of VAP in ICU should be done through an active guideline implementation strategy and measuring the baseline level of knowledge provides to identify the specific educational needs of a target group and to tailor educational interventions to the group's exact requirements

(Labeau et al. 2009).

Bangert & Easterby [6], stated that, the problem is lack of sufficient evidence supporting the use of ICT in the teaching and learning processes of the nursing staff. Moreover, there is a great deal of conflict between the advantages of using the e-learning and its associated disadvantages [7].

Material and Method

Study aim

This study aimed to evaluate the effectiveness of electronic learning module in implementation of ventilator-associated-pneumonia prevention measures of intensive care unit nurses.

Study Design

Quantitative quasi experimental design was used to conduct this study.

Study Setting

The current study was conducted in intensive care unit of Al Noor Specialist Hospital in Makkah. Total bed capacity of the hospital is 500 beds and 24 ICU beds.

Sample size

The total number of ICU nurses (150) The estimated sample size was 109 nurses by using Epi-info software (version 7), at the assumption of 95% confidence interval, 5% margins of error and 50% prevalence of adequate nursing knowledge [8].

Study Sample

Convenience sample of nurses working in ICU were involved in the study according to following criteria.

Inclusion criteria

Nurses have at least three-month experience in ICU.

Study Tools

Two tools were used in the study.

Tool I: VAP knowledge assessment

This tool was developed by the researcher in English language; it aimed to assess the ICU nurses sociodemographic characteristic and knowledge regarding VAP prevention measures. It consisted of two parts.

Part I: Socio-demographic characteristic

This part aimed to assess Socio-demographic characteristic for ICU nurses, includes age, sex, marital status, level of education, working experience and attending training courses related to VAP.

Part II: Nurses VAP prevention knowledge questionnaire

This part aimed to assess ICU nurse's knowledge regarding VAP prevention measures. It was developed according to mainly tharra literatures as [9-12]. Consisted of 32 multiple choice questions which are covered VAP definition (1), risk factors (4), pathophysiology (2), clinical manifestation (3), classification

and causes (2), bundle prevention element (12) and nursing management to prevent VAP (8). Likert scale from 0-2 was used in which 0 indicated wrong answer, 1 indicated I don't know, while 2 indicated correct answer.

Scoring system

The tool consisted of 32 questions each question 5% scoring with total of 100% by the use of the following equation: accredited result of the nurse $\times 10 \div 32$ (total questions number)

Tool II: VAP bundle observational check-list

Constructed by the researcher in English language according to reviewing relevant literatures related to VAP prevention measures, based on (CDC 2015) guideline for VAP bundle [8]. It aimed to assess nurses practice before and after E-learning module of VAP prevention measures, which included preparing equipment, positioning, ability of spontaneous breathing, hand washing, mouth care, DVT and PUD prophylaxis's finally documentation.

Scoring system

This tool was consisting of 10 items, in which each item counted by 10%. Item 2 consist of 6 sub-items each one counted by 1.67%, Item 3 consist of 5 sub-item each one counted by 2% and item 5 consist of 4 sub-item each one counted by 2.5% while item 6 consist of 3 sub-item each one counted by 3.34%.

Regarding follow-up observation result the researcher was sum the total of the follow-up and divided by 3 to get the main of the total.

Data collection process

The researcher was initiated data collection process by conduct meeting with head nurse working in intensive care units to explain the purpose of the study and process of work in order to facilitate the work procedures. The researcher was met 6 nurses each day to conduct the pre-test and observation checklist for period of one month to complete the target sample 109, in which each shift includes 25-27 nurses. Collecting post-test was consumed 3 month in which the researcher met the participated nurses at different shift due to nurse's rote changes. Data collection includes four phases.

Phase I: Observation phase

The researcher observed 6 nurses daily prior exposing to module by the use of tool II to collect baseline data for nurse's practice. Direct observation for the 6 nurses was started at the beginning of each shift. Each nurse consumes at least 10-15 min during VAP bundle technique implementation.

Phase II: Introductory phase

- The researcher was gathered observed nurses in the conference room for period of one hour in ordered to introduce the module, explain an instructional guideline and answer the questions relevant to module usage.
- Nurses was started by entering demographic data-using tool I part I.
- After that nurses performed pre-test for VAP prevention knowledge by using tool I part II which was consumed 10-15

min for each one of them.

- The researcher developed VAP E-learning module in English language based on ADDIE module which consisted of five stages: analysis, design, development, implementation and evaluation. The module includes illustrated images, video and algorithm. It aimed to deliver the knowledge of VAP prevention measures to ICU nurses. It's consisted of 8 items, definition of VAP, pathophysiology of disease, five clinical manifestations, categorize, risk factors according to host related factors and finally VAP prevention measures. The nurses read the E-learning module which demonstrated in nursing lap of education center in the hospital each nurse use a separated computer, in which each nurse expend 25-30 min maxim in this part.
- The nurses after exposing to E-learning module in computer moved to immediate post-test which was similar structure to pre-test using tool I part II.

Phase III: Post observation phase

The researcher replicated observation checklist to observe nurses practice post exposure to module using tool II.

Phase IV: Follow-up phase

Follow up of nurse's practice was implemented by repeating observation checklist three times for sequence three days. Two weeks after immediate post-test the researcher conducted post-test 1 by using tool I part II to assess the nurse's knowledge retention. followed by 2nd post-test 2 week after 1st post-test.

Reliability

The reliability of the developed tools was tested by using Cronbach's alpha test Reliability coefficient value was 0.82 for knowledge assessment tool and 0.71 for observation checklist.

Validity

The content of the constructed tools was revised by a jury of 5 experts in the field of Medical Surgical Department Faculty of Nursing at King Abdul Aziz University to test content validity, completeness, and clarity of items. Comments and suggestion of jury was considered and the tool was modified accordingly.

Pilot Study

A pilot study was conducted on 10% (20 nurses) to test clarity, feasibility, and applicability of the study. Necessary modifications were done, nurses included in the pilot study was excluded from the main sample study.

Ethical Consideration

Ethical approval was obtained from Makkah region ministry of health Institutional Review Board department. The researcher was also assured the administration of the study sitting that conducting of the study will not affect the work at the study setting. Witten consent was obtained from the nurses with clear explanation for the right of refusing and withdrawing from the participation. The digital data was not included name or identifying personal data.

Results

Table 1: Show the frequency distribution of sociodemographic data of ICU nurses for VAP prevention measures.

Variable	Nurses participant (n=109)	
	Frequency	Percent %
Age		
25-29 years old	62	56.9%
30-34 years old	25	22.9%
35-49 years old	17	15.6%
50-60 years old	5	4.6%
Marital status		
Single	47	43.1%
Married	60	55.0%
Divorced	2	1.8%
Level of education		
Diploma	6	5.5%
high diploma	7	6.4%
BSN	94	86.2%
MSN	2	1.8%
Critical care experience		
3-11 month	4	3.7%
1-3 years	27	24.8%
more than 3 years	78	71.6%
Attending of VAP lecture		
E-learning	17	15.6%
traditional course	12	11.0%
in service education	34	31.2%
not attended	46	42.2%
Time of last attended to VAP lecture		
Not Attended	36	33.0%
less than 6 months	43	39.4%
6 months ago	13	11.9%
1 year ago	9	8.3%
more than 1 year	8	7.3%

*BSN: Bachelor in nursing *MSN: Master in nursing *N: number of ICU nurses

Table 1: Show the frequency distribution of sociodemographic data of ICU nurses for VAP prevention measures.

It was illustrated that more than half 56.9% of the ICU nurses were in the age group from (25-29) year old, while only 4.6% in the age group from (50-60) year old. Concerning to marital statuses it was observed that more than half 55% of the ICU nurses were married, while only 1.8% was divorced. ICU nurses level of education showed, that majority 86.2% of nurses were BSN while only 1.8% were MSN. Concerning critical care experience more than third 71.6% of the ICU nurses had a critical care experience of more than three year, while only 3.7% of ICU nurses had 3-11-month experience. Moreover, it was found that nearly half 42.2% of ICU nurses were not attending VAP lectures at all, while 11% of ICU nurses attend traditional courses of VAP. In relation to time of attending VAP lecture, it was noticed that 39.4% of the ICU nurses attended VAP lecture from less than 6 month ago.

Table 2: frequency distribution of pre/posttest of ICU nurses for VAP prevention measures

Knowledge question	Before exposure to module						After exposure to module						T-test	P-value						
	Pretest frequency			Immediate 1 st post frequency			2 nd & 3 rd post frequency													
	Correct	Don't Know	Wrong	Correct	Don't Know	Wrong	Correct	Don't Know	Wrong	Correct	Don't Know	Wrong								
Definition of VAP(Q1)	81.4	88	2.5	2.7	7.5	8.2	108	100	0	0	0	0	108	100	0	0	0	3.53	0.001	
Pathophysiology of VAP, Q (2-3)	82.5	75.6	7	2.7	39	35.7	108	100	0	0	0	0	108	100	0	0	0	7.9	.000	
Risk factors of VAP, Q (4-7)	71.7	65.8	5	6.4	32.2	29.5	108	100	0	0	0	0	107	99.7	1	0.92	2.5	0.22	32.7	.000
VAP prevention measure Q (7.9,10,12,13,14, 24,25,26,27,30,31)	79	72.4	9	8.25	21.8	20	56	51.4	4	3.66	48.9	44.8	49.7	86.9	2.08	1.92	3.08	2.8	20.8	.000
Classification & Causes of VAP, Q (8,11)	51.5	47.2	5.5	5.04	52	47.7	54.5	50	1	0.91	53.5	49	108	100	0	0	0	8.8	.000	
Clinical manifestation of VAP, Q (18,19,20)	57.6	52.9	11	10	40.3	37	12	11	17.6	16.2	79.3	72.7	48.3	44.3	24.3	22.3	36.3	33.3	14.1	.000
Nursing care for VAP patients, Q (15,16,21,22, 23,28,29,32)	96.3	88.4	4.6	2.24	8	7.3	56.2	51.6	2.73	2.75	50	46.2	93.5	85.7	4.37	4	11	10.2	20	.000

*Q = Question, **2nd & 3rd posttest = Here combined in one table were both test result identical, all question was allocated in the knowledge assessment tool *F-test = Paired Samples Test *P-Value 0.005 = Test of Sig

Table 2: Show the frequency distribution of pre/posttest of ICU nurses for VAP prevention measures before and after exposure to VAP prevention module.

Second and third post-test combined in one table because both test result were identical. Clustering of question were done according to the VAP prevention knowledge module content: VAP definition, VAP pathophysiology, risk factors of VAP, VAP prevention measures, classification and causes of VAP, clinical manifestation of VAP and nursing care of VAP. Concerning VAP prevention measures definition, the majority (88%) of the ICU nurses answered it correctly in pre-test, while all (100%) of ICU nurses answered it correctly in 2nd & 3rd post- test. Regarding Pathophysiology questions it was observed that three quarter (75%) of ICU nurses answered question correctly in the pre-test, while all (100%) of ICU nurses answered question correctly in immediate posttest, 2nd & 3rd posttest. Concerning risk factors of VAP, pre-test score showed that more than half (65.8%) of the ICU nurses answered the question correctly, while in immediate post-test all (100%) of ICU nurses answered question correctly as well as almost (99%) of the ICU nurses answered question correctly in the 2nd & 3rd post-test. Concerning VAP prevention measures, pre-test result showed that more than two third (72.4%) of the ICU nurses answered the question correctly, while immediate post-test more than half (51.60%) of ICU nurses answered question correctly, in which 2nd & 3rd post-test showed the majority (86.9%) of the ICU nurses answered question correctly. Concerning classification and causes of VAP, pre-test result showed that nearly half (47.24%) of the ICU nurses answered question correctly, while half (50%) of the ICU nurses answered question correct in immediate post-test, regarding 2nd & 3rd post-test it was noticed that all (100%) ICU nurses answered question correctly.

Concerning nursing care intervention questions, the majority (88.41%) of ICU nurses answered question correctly in pre-test, while more than half (51.6%) of the ICU nurses answered question correctly, as well as 2nd & 3rd post-test the majority (85.7%) of the ICU nurses. As it's comes to clinical manifestation of VAP prevention measures, pre-test result showed that more than half (52.9%) of the ICU nurses answered question correctly, while in immediate post-test only (11%) of the ICU nurses answered the questions correctly, in which 2nd & 3rd post-test result showed less than half (44.34%) of the ICU nurses answered question correctly. Finally it was noticeable, that there is statistically significant difference regarding all items of VAP prevention measures between pre-test and post-test of ICU nurses (P-value =.000*).

Table 3: Shows Knowledge assessment of pre/posttest of ICU nurses for VAP prevention measures before and after exposure to VAP prevention module.

Knowledge	Before exposure to VAP prevention module		After exposure to VAP prevention module		Chi square	P-value
	Pre-test	Post-test	Immediate Post-test	Post-test 2 nd & 3 rd		
Mean ± S.D	72.66 ±12.096	96.2 ±2.15	91.32 ±2.86	109	.000*	

* Test of Sig. = P-value *2nd & 3rd posttest = Here combined in one table were both test result identical.

Table 3: Shows Knowledge assessment of pre/posttest of ICU nurses for

VAP prevention measures before and after exposure to VAP prevention module.

There was statistically significant difference between pre-test knowledge and immediate post-test, 2nd & 3rd (P-value $\leq .000^*$). However, it was observed that, ICU nurses knowledge mean score (72.66 ± 12), while it's improved after module to be in the high level (96.2 ± 2.15), meaning that nurses knowledge has been noticeably improved. A slight drop being noticed in ICU nurse's knowledge in 2nd & 3rd post-test to reach (91.32 ± 2.8).

Table 4.4) Shows frequency distribution for level of knowledge of ICU nurse's for VAP prevention measures before and after exposure to VAP prevention module.

Scour of level of Knowledge	Before exposure to module		After exposure to module				X2	P-Value 0.05
	Pretest		Posttest 1 st	Posttest 2 nd & 3 rd				
	N	%	N	%	N	%		
High (90%-100%)	13	11.9%	103	94%	82	74.3%	264.38	.000*
Moderate (80%-89%)	17	15.6%	6	5.5%	27	25 %		
Average (70%-79%)	36	33%	0	0	0	0		
Poor (less than 70%)	43	39.81%	0	0	0	0		

* Test of Sig. = P-Value 0.005 * χ^2 = chi square test * 2nd&3rd posttest = Were combined in one table were both test result identical. * 2 weeks after immediate pretest posttest I conducted, 2 weeks after posttest I posttest II conducted

Table 4.4: Shows frequency distribution for level of knowledge of ICU nurse's for VAP prevention measures before and after exposure to VAP prevention module.

It was observed that less than half 40.4% of the ICU nurses had poor level of knowledge in the pre-test, while nearly three quarter 74.3% of the ICU nurses had high level of knowledge in the 2nd & 3rd post-test. Almost 93% of the ICU nurses had high level of knowledge in immediate post-test. There was highly statistical significant difference regarding level of knowledge between pre-test and post-test of ICU nurses for VAP prevention measures (P-value=.000*).

Statement	Before exposure to module		Nurses practice of ICU nurses after exposure to module					
	Baseline nurses practice		1 st Observation		2 nd Observation		3 rd Observation	
	Done N \ %	Not done N \ %	Done N \ %	Not done N \ %	Done N \ %	Not done N \ %	Done N \ %	Not done N \ %
1-Had washing	109(100%)	0	109(100%)	0	109(100%)	0	109(100%)	0
2- Preparing the equipment								
Bag - valve - mask	109(100%)	0	109(100%)	0	109(100%)	0	109(100%)	0
Sterile Gloves	109(100%)	0	109(100%)	0	109(100%)	0	109(100%)	0
Stethoscope	109(100%)	0	109(100%)	0	109(100%)	0	109(100%)	0
Chlorhexidine	109(100%)	0	109(100%)	0	109(100%)	0	109(100%)	0
Tooth brushing	109(100%)	0	109(100%)	0	109(100%)	0	109(100%)	0
3- Patient positioning	109(100%)	0	109(100%)	0	109(100%)	0	109(100%)	0
4- physical assessment of the respiratory tract								
Inspection	5 (4.6%)	104(95%)	107(99%)	2 (1.8)	107(99%)	2(1.8%)	107(99%)	2(1.8%)
Percussion	7 (6.4%)	102(93.5%)	103(95.4%)	6 (5.5)	103(95.4%)	6(5.5%)	103(96.5%)	6(5.5%)
Auscultation	11 (9.25%)	98(90.7%)	108(100%)	1 (0.9)	107(100%)	2(1.8%)	108(100%)	1(0.9%)
5- Wean from ventilator								
Central venous line	0	109 (100%)	102(93.5%)	7(6.4%)	103(94.5%)	6(5.5%)	103(94.5%)	6(5.5%)
oxygenation status	107(99%)	2 (1.8%)	109(100%)	0	109(100%)	0	109(100%)	0
discontinues sedation	109(100%)	0	109(100%)	0	109(100%)	0	109(100%)	0
Vital signs	109(100%)	0	109(100%)	0	109(100%)	0	109(100%)	0
6- Performing subglottal suctioning								
109(100%)	0	109(100%)	0	109(100%)	0	109(100%)	0	
7- Moth cleaning								
mouth rinse	45(41.3%)	64(58.33%)	109(100%)	0	109(100%)	0	109(100%)	0
Tooth brushing	43(40.4%)	66(60.1%)	109(100%)	0	109(100%)	0	109(100%)	0
Oral suctioning	106(98.2%)	3(1.85%)	109(100%)	0	109(100%)	0	109(100%)	0
8- Peptic ulcer prophylaxis's	109(100%)	0	109(100%)	0	109(100%)	0	109(100%)	0
9- DVT prophylaxis's	109(100%)	0	109(100%)	0	109(100%)	0	109(100%)	0
10- Documentation	109(100%)	0	109(100%)	0	109(100%)	0	109(100%)	0

Table 4.5: Shows frequency distribution of practice assessment of ICU nurses for VAP prevention measures.

It was observed that all 100% of ICU nurses performed hand washing, preparing the required equipment and proper positioning before and after exposure to VAP prevention module. Regarding physical assessment of respiratory tract, it was founded that majority of ICU nurses did not perform inspection, percussion and auscultation (95%), (93%) and (90%) respectively. While after exposure to module the highest majority of nurses performed inspection, percussion and auscultation (99%), (95.4%) and (100%) respectively.

All 100% of ICU nurses assessing patient prior weaning from ventilator by checking oxygen status, discontinued sedation and measuring vital signs before and after exposure to VAP prevention module, while all 100% of ICU nurses did not measure central venue line before exposure to VAP prevention module while, there was improvement after exposure to module, in which highest percentage of ICU nurses (93.5%), (94.5%) and (94.5%) measure central venue line during 1st, 2nd and 3rd observation respectively.

Regarding mouth cleaning before exposure to module (58.33%), (60.1%) of the ICU nurses did not performed mouth rinse, tooth brushing, while almost 98% of ICU nurses performed oral suctioning. In addition, after exposure to module all 100% of ICU nurses performed mouth cleaning items. Finally, All 100% of ICU nurses performed peptic ulcer prophylaxis, DVT prophylaxis and documentation items.

Table 4.6: Shows distribution of Practice assessment of ICU nurses before and after exposure to VAP prevention module

Practice	Before exposure to VAP prevention module	After exposure to VAP prevention module			Chi square	P-value
	Baseline observation	1 st observation	2 nd & 3 rd Observation			
Mean \pm Std. D	61.73 \pm 5.97	99.4 \pm 2.3	99.52 \pm 100		216	.000*

* Test of Sig. = P-value * 2nd&3rd posttest = Were combined in one table were both test result identical.

Table 4.6: Shows distribution of Practice assessment of ICU nurses before and after exposure to VAP prevention module.

It was observed that, there was statically significant difference between ICU nurses practice before and after exposure to VAP prevention module with (P-value $\leq .000^*$). While it observed that, ICU nurses practice improved from 61.73 ± 5.97 before exposure to VAP prevention module to 99.52 ± 100 after exposure to VAP prevention module.

Table 7): Show level of practice of ICU nurse's for VAP prevention measures.

Score of level of practice	Baseline		1st observation		2 nd & 3 rd observation		X ²	Test of Sig.
	N	%	N	%	N	%		
High (90%-100%)	0	0	107	99.1	109	100	216.6	.000*
Moderate (80%-89%)	3	2.8	2	0.92	0	0		
Average (70%-79%)	3	2.8	0	0	0	0		
Poor (less than 70%)	103	94.5	0	0	0	0		
Total	0	0	0	0	0	0		

* Test of Sig. = P-Value 0.005 * χ^2 (2) = chi square test with * 2nd&3rd posttest = Were combined in one table were both test result identical.

Table 4.7: Show level of practice of ICU nurse's for VAP prevention

measures.

It was observed that majority 94.5% of ICU nurses had poor practice regarding VAP prevention measures before exposure to module, while almost 99.1% of the ICU nurses had high level of practice after exposure to VAP prevention module in 1st observation. Moreover, all 100% of ICU nurses had high level of practice in the 2nd & 3rd observation after exposure to VAP prevention module. Finally, there was statistically significance difference between baseline practice before exposure to module and 1st, 2nd and 3rd observation after exposure to VAP prevention module for ICU nurses levels of practice, (P.value ≤ 0.000*).

Table (8): Shows relation between sociodemographic data of ICU nurse and VAP prevention measures pre/post-test knowledge

Sociodemographic	Knowledge of ICU nurses before exposure to VAP prevention module			Knowledge of ICU nurses after exposure to VAP prevention module		
	Mean ±SD	F	Sig.	Mean ±SD	F	Sig.
Age						
25-29	72.25±10.7	0.120	0.887	93±1.9	1.14	0.33
30-34	72.47±13.49			92±2.1		
35-49	71.91±13.91			93±2.1		
50-60	83.72±12.18			91±1.3		
Marital status						
Single	73.93±9.18	0.453	0.637	93.4±2	0.37	0.77
Married	71.67±14.13			92.6±2		
Divorce	72.6±12.09			90±0.00		
Educational Level						
Diploma	65.24±12.18	1.12	0.345	92±1.8	3.002	0.05
High diploma	75.12±17.8			92±0.00		
BSN	73.1±11.65			92±2.1		
MSN	65±4.41			93.6±1.7		
Year of clinical experience						
3-11 months	69.9±3.4	0.15	0.85	92.1±1.04	0.67	0.51
1-3 years	72.1±8.4			93.2±2.1		
> 3 years	72.9±13.41			92.8±2.09		
Type of training program						
e-learning	73.86±8.7	0.520	0.721	92±2.1	0.75	0.5
Traditional course	72.2±12.2			93±2		
In service Education	76.6±12.79			92±2.3		
Not attended	69±11.97			92±1.8		
Last time attend training program						
Not attended	69.3±11.9	0.637	0.637	92.7±1.8	0.43	0.78
< 6 months	78.3±10.81			93.2±2.3		
6 months ago	73.2±9.9.08			92.5±1.8		
1 year ago	71.02±13.18			93.1±2.3		
>1 year ago	65.74±12.09			93±2.3		

* Mean = S.D = mean & stander deviation * F-test = difference test * P-value= test of significant

Table 4.8: Shows relation between sociodemographic data of ICU nurse and VAP prevention measures pre-test knowledge.

It was noticed that, there was statically difference between ICU nurse's knowledge after exposure to module and level of education (P-value ≤ 0.05*). In which ICU nurses with MSN nurses level of education had the lowest (65 ± 4.41) mean score before exposure to VAP prevention module, while after exposure to VAP prevention module ICU nurses with MSN nurses level of education had the highest (93.6 ± 1.7) mean score. However, it was observed that, there were no statically significant differences between other sociodemographic data of ICU nurse knowledge before and after exposure to VAP prevention module.

It was observed that, there was statically significant difference between ICU nurses age and practice before \after exposure to VAP prevention module for age group from (35-49) \ (50-60) (P-value ≤ 0.02*) and (P-value ≤ 0.00*) respectively. However, ICU nurses age group from (35-49) had the highest (62.09 ± 5.4) mean score practice before exposure to VAP prevention module.

In addition, after exposure to VAP prevention module ICU nurses age group from (35-49) and (50-60) had highest (100 ± zero) mean score practice.

Table (4.9): Relationship between sociodemographic data and knowledge of VAP prevention measures of ICU nurse.

Sociodemographic	Baseline before exposure to VAP prevention module			After exposure to VAP prevention module		
	Mean ±SD	F	Sig.	Mean ±SD	F	Sig.
Age						
25-29 (n=62)	61.67±6.06	0.73	* 0.02	99.77±1.34	3.428	* 0.00
30-34 (n=25)	62.09±5.4			98.34±3.7		
35-49 (n=17)	62.46±6.7			100±zero		
50-60 (n=5)	58.09±5.97			100±zero		
Marital status						
Single (n=47)	61.09±5.19	1.81	0.536	99.69±1.53	0.508	0.603
Married (n=60)	61.9±6.12			99.3±2.5		
Divorce (n=2)	69.047±16.83			100±zero		
Educational Level						
Diploma (n=6)	61±5.2	0.6	0.57	98.4±3.88	0.052	0.984
High diploma (n=7)	59±4.6			98.64±3.6		
BSN (n=94)	61±6.1			99.61±1.84		
MSN (n=2)	57±6			100±zero		
Year of clinical experience						
3-11 months (n=4)	58.33±2.38	2.57	0.081	97.62±4.76	1.82	0.167
1-3 years (n=27)	59.96±4.98			99.76±0.95		
> 3 years (n=78)	62.51±6.25			99.49±2.2		
Type of training program						
e-learning (n=17)	63.02±6.63	0.503	0.681	99.43±2.31	0.26	0.854
Traditional course (n=12)	62.69±4.9			100±zero		
In service Education (n=34)	61.2±6.21			99.39±2.47		
Not attended (n=46)	61.39±5.87			99.45±2.07		
Last time attend training program						
Not attended (n=46)	61.39±5.87	2.0	0.1	99.45±2.07	0.398	0.809
< 6 months (n=37)	61.65±5.7			99.44±2.37		
6 months ago (n=10)	58.57±4.5			100±zero		
1 year ago (n=9)	65.6±7.8			98.94±3.17		
>1 year ago	63.94±5.39			100±zero		

* Mean ± SD = mean & stander deviation * F-test = difference test * P-value= test of significant

Table 4.9: Relationship between sociodemographic data and practice observation before and after exposure to e-learning module of VAP prevention measures of ICU nurse.

Discussion

VAP is one of the major side effects for the patients on ventilator, all over the world VAP costs burden of billions on the healthcare system in both developing and developed world. It consider as a leading cause of morbidity and mortality in ICU. Therefor the study aimed to evaluate the effectiveness of electronic learning module in implementation of ventilator-associated-pneumonia prevention measures of intensive care unit nurses.

Sociodemographic characteristic of ICU nurse's for VAP prevention measures

All ICU nurses were female like the study of Hart et al., (2008) who stated that 90.9% of the participant were female. The present study elaborated that, more than half of the ICU nurses were in the age group from (25-29) year old this result was in congruent with Kapucu et al., [13] who emphasized that nearly half of the participant for preventing VAP were 25-29 years old. Regarding level of education present study showed that, majority of ICU nurses were BSN while only few were MSN. Tolentino et al. [14] mentioned that nearly half of nurse's participant in VAP prevention had baccalaureate degrees in nursing. As well as Tabacian et al., [15] evaluated the nurses compliance with the standards for

prevention of VAP in the intensive care units they found that 98.3% of nurses had a bachelor's degree and only 1.7% had a master's degree. Moreover Tubaishat, conducted a nurses study in Jordan he funded that, a majority of the nurses had a bachelor's degree in nursing.

Concerning critical care experience of present study, two third of the ICU nurses had a critical care experience of more than three year. This study in line with El Nabawy & Abosamra [16] showed that, the highest percent of studied nurses in critical area ICU had less than 5 years of experience in the intensive care unit. These findings emphasize the importance of nurses experience to perform critical care tasks. The present study showed that nearly half of the ICU nurses did not attend lecture for VAP prevention measures. This result is congregant with El Nabawy & Abosamra [16], who stated that 79.6% of nurses didn't take any previous training about guidelines of VAP prevention measures. As well as, the result is contradicted with Kapucu et al., [13] who founded that 58.3% of nurses had received training on prevention of hospital infections included VAP.

Knowledge of ICU nurse's for VAP prevention measures

The present study showed that there was statistically significant difference regarding ICU nurses knowledge of VAP definition, pathophysiology, risk factors, prevention measures, classification, clinical manifestation and nursing care of VAP between pre-test and post-test of ICU nurses. The result reflects the effect of E-learning module of ICU nurses after exposure to VAP prevention module. This result compatible with Subramanian et al., [17] who conduct a study for the impact of education on ventilator-associated pneumonia in the intensive care unit, revealed that the nurses educational intervention had a significant effect on the nurses' knowledge of VAP. Another study conducted by Meherali et al., [18] mentioned that The 5-hour training module significantly enhanced nurses' knowledge towards evidence based guidelines for the prevention of VAP.

In addition ICU nurses' knowledge means score was improved after implementation of VAP prevention module. A slight drop being noticed in ICU nurse's knowledge in 2nd & 3rd post-test. This result in line with Blot et al., [19] who revealed that an educational initiative increased the average level of knowledge from 53% in a pretest to 77% following an educational course in post test. Moreover present study results is congruent with a result of Meherali et al., [18] who found that there was a difference in mean score from baseline (7.8) to post-test 1 mean score (10.8) and finally in post-test 2 mean score (9.8) who show a slight drop in knowledge level during 2nd and 3rd post-test as it's appear in the current study. Ahmed & Abosamra [20] stated that a principle being identified that knowledge retention generally falls to 75-89% of its original level after a relatively short 2-3 weeks' time.

Moreover the current study reported that, less than half of the ICU nurses had poor level of knowledge in the pre-test, while nearly three quarter of the ICU nurses had high level of knowledge in the 2nd & 3rd post-test. Almost of the ICU nurses had high level of

knowledge in immediate post-test. This result is in congregant with Meherali et al., [18] who revealed that, knowledge scores of nurses increased significantly after the educational intervention in the first post-test; however, there was a decline in the score in second post-test. Under the light of previous studies with integration of currant one, we can say that ICU nurses needed for such education module with appropriate and content approach to gain their knowledge and improve the practice regarding VAP prevention measures.

Practice of ICU nurse's for VAP prevention measures

The current study showed that all ICU nurses performed hand washing and proper positioning before and after exposure to VAP prevention module. A similar study conducted by Saber [21], who stated that, ICU nurses practice for hand washing and elevation head of bed showed significant improvement from 12% to 28% and 60% to 80% after implementation of care bundle education respectively.

Regarding physical assessment of respiratory tract, the present study revealed that majority of ICU nurses did not perform inspection, percussion and auscultation. While after exposure to module the highest majority of nurses performed all assessment appropriately. in this regards Abbasinia et al., [22] conducted a study about the effect of a designed respiratory care program on the incidence of ventilator associated pneumonia, and concluded that a designed upper respiratory cares program can reduce the incidence of VAP.

The current study revealed that, all ICU nurses assessing patient prior weaning from ventilator by checking oxygen status, discontinued sedation and measuring vital signs before and after exposure to VAP prevention module, while all ICU nurses did not assess hemodynamic status before exposure to VAP prevention module. This may be related to ICU nurses believed that assessing hemodynamic status is not nurses responsibility and it's a doctors or respiratory therapist job. However after the researcher introduced VAP prevention measures module, ICU nurse's practice regarding all aspect of assessing patient prior weaning from ventilator was improved including hemodynamic status. This result is in line with Bird et al., [23] who conducted a study about adherence to ventilator associated pneumonia bundle in ICU, revealed that practice of ICU nurses with sedation break, and assessment for extubating were excellent before implementing program and remained higher than 92% after implementing the program. Additionally Mclean et al., [24] who conducted a study about improving adherence to mechanical ventilation weaning protocol for critically ill adults stated that, there was improvement in critical area regarding assessing patient readiness to wean from mechanical ventilator from 1.2 before intervention to 3.78 after the intervention with noticeable significant statically difference before and after the intervention.

Regarding mouth cleaning before exposure to module the present study revealed that, more than half of the ICU nurses did not perform mouth rinse and tooth brushing. This behavior was attributed to nurse's reliance that night shift staff will perform

and night shift are relied on morning staff, while almost all ICU nurses performed oral suctioning appropriately. Surprisingly, after exposure to module all ICU nurses performed mouth cleaning items appropriately. This result is similar to Hui Qing et al., [25] who mentioned that less than half percent of the registered nurses not used the oral cleaning or decontaminant for the mechanically ventilated patients before intervention while ninety-seven percent of the RNs used an oral cleaning after the intervention.

Moreover, the current study emphasized that, all ICU nurses administered peptic ulcer disease (PUD) and deep vein thrombosis (DVT) prophylaxis before and after exposure to VAP prevention module, in which the commitment to those prophylaxis is due to routinely including them in the medication sheet. This result is congruent with Lance-smith & Nardi, [26] who stated that ICU nurses responses at the first month after education of staff members, showed 100% compliance for PUD prophylaxis and DVT prophylaxis, while the practice rate remained greater than 98% for several months. In addition this result is in line with Subramanian et al., [17] who concluded that, ICU nurses' practice regarding PUD and DVT prophylaxis was 81.8% before interduce the intervention, while 100% of the ICU nurses implement PUD and DVT prophylaxis after intervention.

Moreover the present study concluded that all ICU nurses practice improved after introducing of VAP prevention measures module, in which the percentage improved from 0% at the baseline to 100% at the final observation. These scores increased to 100% in three subsequent observations after exposure to module. Notably, the above-mentioned result was related to the effects of the facilitator of education programs in developing suitable protocols to address the use of VAP prevention approaches. Moreover, this education module increased the nurses confidence about their ability and skills as well as improved practices toward utilization of VAP prevention mechanisms in intensive care unit. This result is in line with Subramanian et al., [17] who revealed that nurses educational intervention had a significant effect on the nurses practice regarding Ventilator care bundle, as reflected in their test scores preintervention was 63.17 and post intervention was 95.

Relationship between Knowledge and sociodemographic data

The present study showed that there was statically significant difference between ICU nurse's knowledge after exposure to VAP prevention module and level of education. In which ICU nurses level of education with master nursing certificate improved after exposure to VAP prevention module. This result is in line with van de Steeg, et al. [27] who revealed that, there was more improvement after E-Learning in the nurses who already had a master degree with high statistically significant difference. Additionally this result is in line with Akin Korhan, et al. [28] who stated that the differences between nurses' educational levels regarding VAP prevention knowledge was found to be statistically significant.

However, it was observed that, there were no statistically significant difference between other sociodemographic data of ICU nurse and knowledge before and after exposure to VAP prevention module.

This result disagreed with Ahmed & Abosamra [20] who stated that there is strong relationship between years of experiences and previous training and knowledge of nurses for prevention of VAP.

Relationship between practice and sociodemographic data

The current study revealed that, there was statistically significant difference between ICU nurses age with practice before and after exposure to VAP prevention module. The study result contradicted with Albaqawi, et al. [29] who stated that no significant difference between nurses age and holistic nursing care. On other hand Feldman et al., stated that middle age was positively related to productivity measures of job practice. Furthermore a study conducted by Choi & Cho revealed that there were significance differences regarding nurses practice with age, marital status, total number of years in the career and the length of employment in the present department.

Moreover, the present study manifested that, there were no statistically significant difference between other sociodemographic data of ICU nurse and practice before and after exposure to VAP prevention module. The result of this study is in line with Said, [30] who conducted a similar study about knowledge and practice of intensive care nurses on prevention of ventilator associated pneumonia, and found that there is no statistically significant difference in ICU nurses practice with demographic characteristic. Moreover this result of the study is in line with Albaqawi et al., [29] in Saudi Arabia who reported that there were no significant differences between holistic care and ICU nurse practice when demographic variables were taken as test factor.

Conclusion

The study concluded that, there is statistically significant difference regarding ICU nurses knowledge between pre-test and immediate post-test, 2nd & 3rd. Furthermore, it was observed that less than half of the ICU nurses had poor level of knowledge in the pre-test, while nearly three quarter of the ICU nurses had high level of knowledge in the 2nd & 3rd post-test. Although almost of the ICU nurses had high level of knowledge in immediate post-test. Regarding ICU nurses practice it was concluded that, there is statistically significant difference between ICU nurses practice before and after exposure to VAP prevention module. Moreover majority of ICU nurses had poor practice for VAP prevention bundle before exposure to VAP module, while after exposure to VAP prevention module ICU nurses practice improved to had high level in 1st, 2nd & 3rd observation. The present study concluded that, there is statically difference between ICU nurse's knowledge after exposure to module and level of education. As well as there is statistically significant difference between ICU nurses age with practice before and after exposure to VAP prevention module for middle age group.

Recommendation for Research

- Encourage a collaboration channel between infection control department and nursing administration, to control the incidence of VAP of ventilated patient and recruit a qualified nurse in the ICU.

- Activate utilization of E-learning program for other care bundle as central related bloodstream infection (CRBSI) or catheter associated urinary tract infection (CAUTI) to provide nurses with evidence based practice.

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