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PRIMARY RESEARCH

Effectiveness of electronic learning module in implementing ventilator-associated pneumonia prevention measures among intensive care unit nurses

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Abstract. One of the vital principle 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 Intense Care Unit (ICU) nurses to incorporate evidence based practice into daily care for critically ill patient. Study aimed to evaluate the effectiveness of electronic learning module in implementation of ventilator-associated-pneumonia prevention measures among intensive care unit nurses. Quasi experimental design was used. The current study was conducted in intensive care unit of Al Noor Specialist Hospital in Makkah. Convenience sample of 109 ICU nurses was recruited. This study was conducted by using two tools; knowledge assessment tool and VAP bundle checklist . 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 performance was apparent before exposure to module (61.73%), while ICU nurses performance showed tremendous improvement (>99%) in the last observation. The difference between pre- and post test observation was highly significant ($p > 0.005$). 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

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. It is a form of nosocomial pneumonia that occurs in patients undergoing mechanical ventilation for longer than 48 hours [1, 2, 3]. 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. Amandu *et al* [4] centers for Disease Control and Prevention (CDC) reported that VAP rate decreased from 2002-2009. In

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which the mean VAP rate among medical ICUs dropped from 4.9 to 1.4 events per 1,000 ventilator-days and from 9.3 to 3.8 per 1,000 ventilator-days in surgical ICUs. 5. Aloush [5] Despite advances in preventive strategies and treatment modalities, VAP remains the most common infectious complication among patients admitted to ICU. It results in high morbidity and mortality rate , prolonged hospital lengths, and increased the cost of hospitalization as well as affected patient safety [6, 7, 8].

Guidelines have been published by the Centers for CDC and the American Thoracic Society (ATS) stressed on the importance of proper staff orientation about the principles of infection control and high prioritization of hand hygiene using alcohol as a disinfectant agent [9]. Guidelines also puts a great emphasis on the sedation control and ventilator weaning protocols [9, 10]. Although the published guidelines helped in decreasing the infection rate, there is a lack of knowledge and information with regards to the extent of benefits of the guidelines amongst nursing employees [9]. The lack of knowledge on preventive measures among the nursing staff and their competency deficiency is considered as an obstacle to effectively exercising the guidelines [11].

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 achieve best care for ICU-ventilated patients [12].

Browne *et al* [13] reported that VAP is divied into two main category. Frist Early onset VAP which occurr during the first four days of Mechanical Ventilation (MV) usually is less severe and associated with a better prognosis. It is more likely to be caused by lesser resistant strains of bacteria. Second, late-onset VAP which develop five or more days after initiation of MV. It is caused by Multidrug-Resistant (MDR) pathogens and is associated with a higher degree of morbidity and mortality. Diagnosing VAP requires a high clinical suspicion combined with bedside examination, radiographic examination, and microbiologic analysis of respiratory secretions. Intubated patients are at risk for VAP because of their poor cough, poor gag reflexes and immobility. Furthermore, the risk for VAP is greater for intubated children than for intubated adults [14]. Risk factors associated with VAP development were categorized, as two factores . Intrinsic factors as age, comorbidity and severity of disease. While extrinsic factors like potential hospital environmental, prior exposure to antibiotics and tracheal intubations [15]

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 [16]. E-learning, sometimes also called online learning or Web-based learning, it is a type of distance learning in which training or educational material is delivered electronically to a remote learner via the internet or intranet. An e-learning system provides a configurable infrastructure that integrates learning material, books, and services into a single solution to quickly, effectively, and economically create and deliver training or educational content. It has become an important alternative to classroom learning [17] Primarily, it was reported that computer-based learning among the ICU nursing employees prompted higher results compared to those receiving conventional learning [18].

The progressive development in Information and Communication Technology (ICT) enables the capability to touch every aspect of life virtually including teaching and learning [17]. E-learning is considered as a by-product of such development and application of

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the new techniques of teaching and learning on the clinical field of nursing [19]. Bahreini *et al*. [20] stated that, technology encompasses the transfer from the conventional teaching and learning to e-learning as a lifelong process either individually or assisted by the educator. The e-learning infrastructure comprised of learning materials, the services, and the reference books in an integrated system which provides one single solution for an economically cost-effective submission of education and training components.

But *et al*. [21] 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 impact of e-learning is not bounded to the classroom but extends further to include the professional lifetime of the health practitioner. The e-learning module includes internet courses, web-based applications, multimedia materials, and a visual learning environment such as Moodle, a learning management system, and Blackboard [22]. 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 [23]. Integration of nursing education about VAP prevention measures with proper implementation of VAP bundle, provide a significant reduction of VAP incidence among intensive care unit patient and marked improvement of staff nurses knowledge and awareness of VAP prevention measures. Therefore, It is essential to apply the technique of e-learning in the teaching programs for ICU-nursing staff with focus in the preventive measures of VAP in patients receiving artificial ventilation [24].

Problem Statement

Bangert and Easterby [25] 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 [26]. Thus, the nursing employee who becomes e-learners suffer from frustrations, cease using such technology. The shift from the conventional way of teaching and learning is subject to many challenges. The transition may be contingent on the acceptability of the educators and the learners to undertake such a new process, which is also affected by many factors including socio-demographic elements [23].

On the other hand, the VAP is considered one of the most serious infection in the ICU, with the management of risk heavily depended on sincere efforts of the ICU nursing staff [9]. Hence, disseminating the necessary knowledge and explaining the proper protocol of applying the preventive measures of VAP are of utmost importance in order to achieve an appropriate level of adherence and computability among ICU-nursing staff [27]. It is important to apply an effective and productive methodology to realize the goal of teaching together with sustained learning [24].

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. Cottrell and Donaldson [28] 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

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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 [16].

Study Aim

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

Null Hypothesis H0

1- Implementation of electronic learning module has no effect on VAP prevention measures among intensive care unit nurses.
2- There is no a relation between demographic characteristic and baseline knowledge of VAP prevention measures among intensive care unit nurses.

Alternative Hypothesis Ha

1- Implementation of Electronic learning module has an effect on VAP prevention measures among intensive care unit nurses.
2- There is a relation between demographic characteristic and baseline knowledge of VAP prevention measures among intensive care unit nurses.

The Objectives of the Study

1. To assess ICU nursing knowledge and practice about the preventive measures of VAP.
2. To determine the effect of VAP prevention E-learning module on nurses knowledge and practice about VAP prevention measures .
3. To determine the relationship between ICU nurses sociodemographic data with nurses knowledge and practice about VAP prevention measures.

THEORETICAL FRAMEWORK

The researcher adopted the framework organization developed by the Community and Hospital Infection Control association (CHICA-Canada). According to Murphy *et al* [29] the Infection Preventions (IP) enables the establishment of the core competencies, which develops forward towards expertise. The APIC framework consist of the four-domain area for future-oriented competency development, leadership, infection prevention and control, technology, and performance improvement or implementation science. The framework guide the entire process of the research study.

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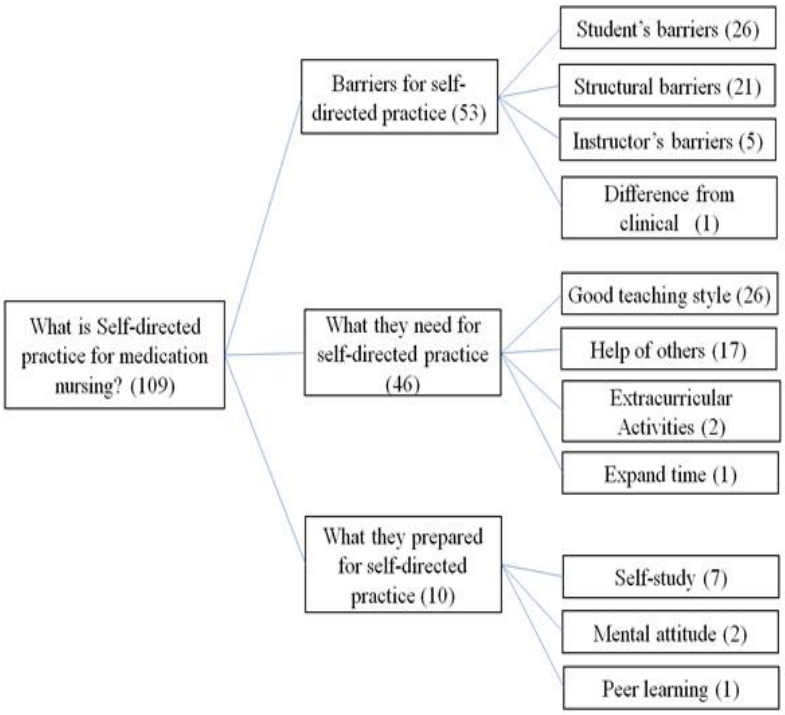

FIGURE 1 . APIC model of competence for IP [29]

METHODOLOGY

Study Design

Quantitative quasi experimental design will be used to conduct this study , which is defined as an empirical study used to estimate the causal impact of an intervention on its target population.

Study Setting

The current study was conducted in the 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 [30].

Study Sample

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

Inclusion criteria

1. Nurses have at lest three month experience in ICU.

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Study Tools

Tool I : VAP knowledge assessment

This part 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 demographic characteristic for ICU nurses, includes age, sex, marital status, level of education, Working experience and attending training courses rerated 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 relevant literatures as [10, 31, 32]. It Consisted of 32 multiped choice question which is covered VAP incidence , definition , risk factors , clinical manifestation , classification , bundle prevention element and nursing management to prevent VAP.

Scoring System

The tool 32 questions each question 5% scoring with total of 100% by the use of the following equation accredited result of the nurse 10/32 (total questions number).

Scored	Category
(90%-100%)	High knowledge
(80%-89%)	Moderate knowledge
(70%-79%)	Average knowledge
(less than 70%)	Poor knowledge

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 [30] guideline for VAP bundle. It aimed to asses nurses performance before and after E-learning module of VAP prevention measures, which included Preparing equipment, positioning, ability of spontaneous breathing, hand washing, moth care, DVT and PUD prophylaxis's finally documentation.

Scoring System

Was consist of 10 items , in which each item counted by 10%. 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.

Scored	Category
(90%-100%)	High practice
(80%-89%)	Moderate practice
(70%-79%)	Average practice
(less than 70%)	Poor practice

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Data Collection Process

The researcher was initiated data collection process by conducte 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 27 nurses. Collecting post-test was consume 3 month in which the researcher met the participated nurses at different shift due to nurses 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 bassline data for nurses performance. Direct observation for the 6 nurses was started at the beginning of each shift. Each nurse consume 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 nurses read the module, which contained illustrated images , video and algorithm in which each nurses expend 25-30 min in this part.
- The nurses after E-learning module moved to immediate post-test which was similar structure to the pre-test using tool I part II.

Phase III: Post Observation Phase

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

Phase IV: Follow-Up Phase

Follow up of nurse's performance was implemented by repeating observation checklist three time 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 were considered and the tool was modified accordingly.

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Pilot Study

A pilot study was conducted on 10% (20 nurses) to test clarity, feasibility, and applicability of the study that nurses excluded from the main sample.

Ethical Consideration

Ethical approval was obtained from the Makkah region ministry of Health Institutional Review Board department. As well as the study activities was not started until Institutional Review Board (IRB) approval obtained. 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.

Confidentiality and Anonymity

The digital data was not included name or identifying personal data. Furthermore, information received from the nurses was treated confidentially and privacy was assured for all nurses, each nurse was allocated by separated code to ensure anonymity of collected data.

Statistical Analysis

All data were analyzed by using statistical package for social sciences (SPSS for Window). Each sheet of sociodemographic collected data was analyzed statistically by the use of descriptive statistic frequency and percentage. In which questioner and observation checklist were analyzed. Data was presented as mean score and slandered deviation with 95% conference interval. ANOVA test or *t*-test was used to compare continuous variables between different groups, and Chi-square or Fisher-exact test were used to compare categorical data.

RESULTS OF THE STUDY

Table 1 shows the frequency distribution of sociodemographic data among 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 statues it was observed that more than half 55% of the ICU nurse's were married, while only 1.8% were 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 two 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 months ago.

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TABLE 1 . Show the frequency distribution of socio-demographic data among 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: Bachelors in nursing *MSN: Master in nursing *N: number of ICU nurses

TABLE 2 . Frequency distribution of pre/post-test among ICU nurses for VAP prevention measures

Knowledge Question	Before Exposure to Module Pretest Frequency					
	Correct		Don't Know		Wrong	
	N	%	N	%	N	%
Definition of VAP(Q1)	81.4	88	2.5	2.7	7.5	8.2
Pathophysiology of VAP, Q (2-3)	82.5	75.6	7	2.7	39	35.7
Risk factors of VAP, Q (4-7)	71.7	65.8	5	6.4	32.2	29.5
VAP prevention measures Q (7,9,10,12,13,14, 24,25,26,27,30,31)	79	72.4	9	8.25	21.8	20
Classification &Causes of VAP, Q (8,11)	51.5	47.2	5.5	5.04	52	47.7
Clinical manifestation of VAP, Q (18,19,20)	57.6	52.9	11	10	40.3	37
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

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

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Table 2. Continue..

Knowledge Question	After Exposure to Module Immediate 1st Post Frequency					
	Correct		Don't Know		Wrong	
	N	%	N	%	N	%
Definition of VAP(Q1)	108	100	0	0	0	0
Pathophysiology of VAP, Q (2-3)	108	100	0	0	0	0
Risk factors of VAP, Q (4-7)	108	100	0	0	0	0
VAP prevention measures Q (7,9,10,12,13,14, 24,25,26,27,30,31)	56	51.4	4	3.66	48.9	44.8
Classification &Causes of VAP, Q (8,11)	54.5	50	1	0.91	53.5	49
Clinical manifestation of VAP, Q (18,19,20)	12	11	17.6	16.2	79.3	72.7
Nursing care for VAP patients, Q (15,16,21,22 ,23,28,29,32)	56.2	51.6	2.75	2.75	50	46.2

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

Table 2. Continue..

Knowledge Question	After Exposure to Module 2nd & 3rd Post Frequency					
	Correct		Don't Know		Wrong	
	N	%	N	%	N	%
Definition of VAP(Q1)	108	100	0	0	0	0
Pathophysiology of VAP, Q (2-3)	108	100	0	0	0	0
Risk factors of VAP, Q (4-7)	107	99.7	1	0.92	2.5	0.22
VAP prevention measures Q (7,9,10,12,13,14, 24,25,26,27,30,31)	49.7	86.9	2.08	1.92	3.08	2.8
Classification &Causes of VAP, Q (8,11)	108	100	0	0	0	0
Clinical manifestation of VAP, Q (18,19,20)	48.3	44.3	24.3	22.3	36.3	33.3
Nursing care for VAP patients, Q (15,16,21,22 ,23,28,29,32)	93.5	85.7	4.37	4	11	10.2

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

Table 2. Continue..

Knowledge Question	$M \pm S.D$	t-test	p-value
Definition of VAP(Q1)	9.63 ± 28.4	3.53	0.001
Pathophysiology of VAP, Q (2-3)	21.10 ± 27.6	7.9	.000
Risk factors of VAP, Q (4-7)	66.7 ± 21.2	32.7	.000
VAP prevention measures Q (7,9,10,12,13,14, 24,25,26,27,30,31)	24.3 ± 12.17	20.8	.000
Classification &Causes of VAP, Q (8,11)	25.76 ± 30.3	8.8	.000
Clinical manifestation of VAP, Q (18,19,20)	39.4 ± 29	14.1	.000
Nursing care for VAP patients, Q (15,16,21,22 ,23,28,29,32)	39.4 ± 29	14.1	.000

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

Table 2 show the frequency distribution of pre/post-test among ICU nurses for VAP prevention measures before and after exposure to VAP prevention module.

It was shown, the frequency and percentage distribution of the ICU nurses for different three periods: pre-test, immediate post-test (1), post-test (2) two weeks after immediate post-test and post-test (3) two weeks after post-test (2). In which 2nd and 3rd 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 post-test, 2nd & 3rd post-test.

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

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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 among ICU nurses (*p*-value =.000*). There was statistically significant difference between pre-test knowledge and immediate post-test,2nd & 3rd (*p* - value ≤ .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 3 . Shows Knowledge assessment of pre post-test among 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	Immediate Post-Test	Post-Test 2nd & 3rd		
Mean±Std. D	72.66± 12.096	96.2±.2.15	91.32±2.86	109	.000*

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

TABLE 4 . Shows frequency distribution for level of knowledge among ICU nurse's for VAP prevention measures before and after exposure to VAP prevention module

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

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

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

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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*).

TABLE 5 . Shows frequency distribution for performance assessment among ICU nurses for VAP prevention measures

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

**2nd & 3rd post-test = Were combined in one table were both test result identical

Table 5 shows frequency distribution of performance assessment among 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 assess hemodynamic status 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%) assessed hemodynamic status 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.

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Table 5. Continue...

Statement	Nurses Performance of ICU Nurses after Exposure to Module			
	2nd Observation		3rd Observation	
1-Had Washing	Done *N*%	Not Done *N*%	Done *N*%	Not Done *N*%
	109(100%)	0	109(100%)	0
2- Preparing the equipment				
Bag - valve–mask	109(100%)	0	109(100%)	0
Sterile Gloves	109(100%)	0		0
Stethoscope	109(100%)	0	109(100%)	0
Chlorhexidine	109(100%)	0	109(100%)	0
Tooth brushing	109(100%)	0	109(100%)	0
3- Patient positioning	109(100%)	0	109(100%)	0
4- physical assessment of the respiratory tract				
Inspection	107(99%)	2(1.8%)	107(99%)	2(1.8%)
Percussion	103(95.4%)	6(5.5%)	105(96.5%)	6(5.5%)
Auscultation	107(100%)	2(1.8%)	108(100%)	1(0.9%)
5- Wean from ventilator				
hemodynamic status	103(94.5%)	6(5.5%)	103(94.5%)	6(5.5%)
oxygenation status	109(100%)	0	109(100%)	0
discontinues sedation	109(100%)	0	109(100%)	0
Vital signs	109(100%)	0	109(100%)	0
6- Performing subglottal suctioning	109(100%)	0	109(100%)	0
7- Moth cleaning				
Mouth rinse	109(100%)	0	109(100%)	0
Tooth brushing	109(100%)	0	109(100%)	0
Oral suctioning	109(100%)	0	109(100%)	0
8- Peptic ulcer prophylaxis's	109(100%)	0	109(100%)	0
9- DVT prophylaxis's	109(100%)	0	109(100%)	0
10- Documentation	109(100%)	0	109(100%)	0

**2nd & 3rd post-test = Were combined in one table were both test result identical

TABLE 6 . Shows distribution of Performance assessment among ICU nurses 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
	Baseline Observation	1st observation	2nd & 3rd Observation		
$M \pm S.D$	61.73±5.97	99.4± 2.3	99.52±100	216	.000*

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

It was observed that, there was statically significant difference between ICU nurses performance before and after exposure to VAP prevention module with (*p*-value ≤ 000*). While it observed that, ICU nurses performance 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 performance among ICU nurse's for VAP prevention measures

Score of Level of Performance	Baseline		1st observation		2nd &3rd observation		X^2	Test of Sig.
	N	%	*N*	%	*N*	%		
High (90%-100%)	0	0	107	99.1	109	100		
Moderate (80%-89%)	3	2.8	2	0.92	0	0		
Average (70%-79%)	3	2.8	0	0	0	0	216.6	.000*
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 * X^2 (2) = chi square test with *2nd&3rd post-test = Were combined in one table were both test result identical

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

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,2nd and 3rd observation after exposure to VAP prevention module for ICU nurses levels of performance, (p-value ≤ 0.000*).

TABLE 8 . Shows relation between sociodemographic data among 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 ± *S.D*	*F*	Sig.	Mean ± *S.D*	*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 8 Shows relation between sociodemographic data among 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 was no statically significant difference between other sociodemographic data among ICU nurse knowledge before and after ex-

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posure to VAP prevention module.

TABLE 9 . Shows relation between sociodemographic data among ICU nurse and VAP prevention measures pre post-test knowledge

Sociodemographic	Baseline before Exposure to VAP Prevention Module			After Exposure to VAP Prevention Module		
	Mean ± *S.D*	*F*	Sig.	Mean ± *S.D*	*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 ± *S.D* = mean & stander deviation * *F*-test =difference test * *p*-value= test of significant

Table 9 Relationship between sociodemographic data and performance observation before and after exposure to e-learning module of VAP prevention measures among ICU nurse. It was observed that, there was statically significant difference between ICU nurses age and performance 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 performance 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 performance.

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 [33, 34]. El-Saed *et al.* [35] conducted a systemic review in the developing countries, their results showed that the incidence of VAP is higher in developing world as compared to rest of the world. This made them concluded a better approach to train the nurses and medical staff in the prevention

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strategies of VAP. But in some cases when nurses were less oriented towards VAP prevention masseurs, it was found that VAP was not included in the nursing curriculum which makes the necessity of some learning program deemed important [36].

The e-learning source used in current study is to evaluate the effectiveness of electronic learning module in implementation of ventilator-associated-pneumonia prevention measures among intensive care unit nurses. It was designed to prepare the nurses with appropriate knowledge to perform the task in given situation accordingly. Moreover, the improvement in familiarity of ICU nurses after exposure to module with VAP concepts and protocols can be associated with convenience and effectiveness of e-learning systems in promoting awareness on VAP prevention approaches [37]. Furthermore, improvements in preferences of e-learning as a preferred medium for learning VAP prevention measures can be attributed to improvement in nurses' confidence towards the learning system [17]. Precisely, the nurses participation in the study of VAP prevention measures using e-learning module, contribute to improvement in their skills, knowledge, and confidence to apply VAP prevention measures and support ICU patients.

Socio Demographic Characteristic Among ICU Nurse's for VAP Prevention Measures

All ICU nurses were female like the study of Micik *et al.* [38] who stated that 90.9% of the participant were female. The present study elaborated that, more than half of the ICU nurse's were in the age group from (25-29) year old this result was in congruent with Kapucu *et al.* [39] 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.* [40] mentioned that nearly half of nurses participant in VAP prevention had baccalaureate degrees in nursing. As well as Tabaeian *et al.* [41] 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 Tabaeian *et al.* [41] 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 Oliveira *et al.* [42] 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 emphasizes 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 Oliveira *et al.* [42] 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.* [39] who founded that 58.3% of nurses had received training on prevention of hospital infections included VAP.

Knowledge Among 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 among ICU nurses. The result reflects the effect of E-learning module among ICU nurses after exposure to VAP prevention module. This result compatible with Mansor and Ng [24] who conduct a study for the impact of education on VAP 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 Gadani *et al.* [43] mentioned that The

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5-hour training module significantly enhanced nurses' knowledge towards evidence based guidelines for the prevention of VAP.

In addition ICU nurses' knowledge mean 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 Rello *et al.* [44] who reveled that an educational initiative increased the average level of knowledge from 53% in a pre-test to 77% following an educational course in post test. Moreover present study results is congruent with a result of Gadani *et al.* [43], 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's in the current study. Ahmed and Abosamra [45] 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 a 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 Gadani *et al.* [43] who reveled 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.

Performance Among 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 [46] who stated that, ICU nurses performance 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 the 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.* [47] 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 currant 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 performance regarding all aspect of assessing patient prior weaning from ventilator was improved including hemodynamic status. This result is in line with Bird *et al.* [48] who conducted a study about adherence to ventilator associated pneumonia bundle in ICU, revealed that performance 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.*

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[49] 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 were attributed to nurses reliance that night shift staff will perform and night shift are relied on morning staff. while almost all ICU nurses performed oral suctioning appropriately. Surprisal, after exposure to module all ICU nurses performed mouth cleaning items appropriately. This result similar to Mclean *et al.* [49] 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 congruent with Sedwick *et al.* [50] 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 performance rate remained greater than 98% for several months. In addition this result in line with Mansor and Ng [24] who concluded that, ICU nurses' performance 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.

More over the present study concluded that all ICU nurses performance 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 Mansor and Ng [24] who revealed that nurses educational intervention had a significant effect on the nurses performance regarding Ventilator care bundle, as reflected in their test scores preintervention was 63.17 and postintervention was 95.

Relationship between sociodemographic data with knowledge and performance among ICU nurse before and after exposure to VAP prevention module.

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 *et al.* [51] who reveled 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 in congregant with Akin *et al.* [52] 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 among ICU nurse and knowledge before and after ex-

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posure to VAP prevention module. This result disagreed with Ahmed and Abosamra [45] who stated that there is strong relationship between years of experiences and previous training and knowledge of nurses for prevention of VAP.

Performance and sociodemographic data. The current study revealed that, there was statistically significant difference between ICU nurses age with performance before and after exposure to VAP prevention module. The study result contradicted with Albaqawi *et al.* [53] who sated that no significant difference between nurses age and holistic nursing care. On other hand Smolle *et al.* [54] stated that middle age was positively related to productivity measures of job performance. Furthermore a study conducted by Speck *et al.* [55] revealed that there were significance differences regarding nurses performance 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 was no statistically significant difference between other sociodemographic data among ICU nurse and performance before and after exposure to VAP prevention module. The result of this study is in congregant with Said [56] 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.* [53] in Saudi Arabia who reported that there were no significant differences between1 holistic care and ICU nurse performance when demographic variables were taken as test factor.

Summary

The finding of the study was elaborated to discuss the effectiveness of electronic learning module among ICU nurses regarding VAP prevention measures. A remarkable improvement was noticed in ICU nurses knowledge and performance after exposure to module. However, a highly statically significant difference was observed after exposure to module between ICU nurses knowledge and nurses with MAN level of education. On the other hand, there were significant difference between ICU nurses' performance before and after exposure to VAP prevention module and middle age nurses group.

CONCLUSION AND RECOMMENDATIONS

Conclusion

The study seeking to evaluate the effectiveness of electronic learning module in the implementation of ventilator-associated-pneumonia prevention measures among intensive care unit nurses. 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 performance it was concluded that, there is statistically significant difference between ICU nurses performance before and after exposure to VAP prevention module. Moreover majority of ICU nurses had poor performance for VAP prevention bundle before exposure to VAP module, while after exposure to VAP prevention module ICU nurses performance 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 performance before and

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after exposure to VAP prevention module for middle age group.

Study Recommendation

1- Further research to assess nurses capability and commitment in implementing VAP bundle element effectively.
2- Replicate the same study of e-learning module regardless geographical location of the participant.

Recommendation for Nursing Administration

1. Encourage a collaboration channel between infection control department and nursing administration, to control the incidence of VAP among ventilated patient and recruit a qualified nurses in the ICU.
2. Create a unified hospital policy and procedures for VAP prevention measures to be applied in all ministry of health (MOH) hospitals.

Recommendation for Nursing Practice

1. Periodic competency evaluation for ICU nurses regarding accurate implementation of VAP prevention measures.
2- Reinforce adherence to CDC guideline for VAP prevention measures.

Recommendation for Nursing Education

1- Integrate orientation program for VAP prevention measures to new staff and continues professional development program for senior staff.
2- 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.

Strength of the Study

The study provides a basis for initiating Information and Communication Technology (ICT) related projects to promote delivery of nursing care with support of evidence based practice. Furthermore, currant study not only evaluated the participant immediately after taking eLearning program but also two more period separated by two weeks from the last evaluation. This was limitation of the previous studies which emphasize that nurses should have more then one evaluations for the nurses to have an information about long-term evaluation of benefits from eLearning program.

Study Limitations

Although the study sample represents Al-Noor specialist hospital ICU nurses, this issue limiting generalization to all Makkah region hospital. but it might be still help to facilitate future study.

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