

## **Impact of Educational Program Regarding Ventilator-Associated Pneumonia Bundle on Critical Care Nurses' Knowledge and Practices**

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### **Abstract**

Ventilator-associated pneumonia (VAP) is considered as a leading cause of infection related mortality and morbidity in intensive care units (ICUs) together with increasing the length of ICU stay and raising the cost of antibiotic treatment of VAP especially in developing countries. Education of ICU healthcare providers is widely viewed as a fundamental measure in reducing VAP. So, this study aimed to assess the effectiveness of educational program on knowledge regarding care bundle on prevention of ventilator-associated pneumonia among intensive care unit nurses. Ventilator-associated pneumonia (VAP) is one of the most common hospital-acquired infections. It is a form of nosocomial pneumonia that occurs in patients undergoing mechanical ventilation for longer than 48 hours. Recently reported VAP rates 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. VAP is the most serious health care-associated infection and is the leading cause of morbidity and mortality from device-associated infections, especially in the intensive care unit (ICU). Attributable mortality rate estimates vary from 10% to 65%, with a mean of about 30%. Furthermore, VAP has long been recognized as a cause of prolonged ICU stays and increased hospital costs. An increase of 7 to 9 days in ICU stay has been reported for a patient with VAP, and Kollef et al<sup>5</sup> reported in 2012 that the cost per patient increases by US\$40 000 when the patient has VAP. **Study design:** Quasi-experimental research design was adopted in this study. **Setting:** the study was conducted in two intensive care units at Meniet EL Nasr Central Hospital and Dekirnis Central Hospital. **Sample:** A convenience sample of all critical care nurses (100) assigned to two groups (50 for the study group, and 50 for control group). **Tools:** Utilizing one tool, self-administrated questionnaire sheet in Arabic language. It was composed of two parts (demographic data and knowledge assessment questionnaires). **Results:** the present study results indicated that, the nurses' knowledge of care bundle and ventilator-associated pneumonia was statistically significant improved after the implementation of the educational program either immediately or 3 months later than before its implementation in the study group. While, there were insignificant differences in the control group throughout the study stages. **Conclusion:** the study concluded that the health education program was effective in improving nurses' knowledge in the two post-program tests than initial survey in the study group. **Recommendation:** the study recommended that the provision of continuing education programs is suggested in order to refresh and update nurses' knowledge, as well as reinforce proper practice related to implementation of care bundle and consequently reducing VAP rate.

**Keywords:** Ventilator-associated pneumonia (VAP), Intensive Care Unit, education, care bundle, ICU nurses.

### **Introduction:**

Ventilator-associated pneumonia (VAP) is one of the most common encountered hospital-acquired infections seen in the critical care setting. Pneumonia is the second most common nosocomial infection in critically ill patients, affecting 27% of all critically ill patients (**Chithra, & Raju, 2017**). It is the most substantial sub-type of pneumonia, occurring in patients who are mechanically ventilated via an artificial airway, causing substantial morbidity, a two-fold increase in mortality rate, extra costs, all coupled with the prolonged use of ventilators and extended stays in intensive care units (ICU) and hospitals (**Mishra, & Rani, 2020**).

The estimated risk of developing VAP is 1.5 % per day and decreases to less than 0.5% per day after the 14th day of mechanical ventilation. VAP increases the duration of hospitalization by seven days and thereby the cost of health-care (**Timsit, Esaied, Neuville, Bouadma,& Mourvllier, 2017**). VAP is classified into early-onset which occurring less than five days and late-onset occurring equal and more than five days. Furthermore, **Bouadma, et al., (2015)**, cited VAP as "oropharyngeal colonization of pathogens acquired through an exogenous source like infected hands and attire of health care professionals, contaminated respiratory instruments, and intensive care environment, through hospital water or air". These pathogens reach the lung parenchyma and alter the host defense mechanism. Accordingly, **Mishra and Rani (2020)** pointed out the infection control department role as an indispensable role in the education of the nursing staff on infection control procedures, surveillance nurses on the prevention of VAP among intubated

patients. Reduction in the incidence rate of VAP, ultimately decreases the associated burden of illness.

Basically, the Institute for Healthcare Improvement (IHI) recommended the practice of bundles, simple sets of evidence-based practices that, when performed collectively and reliably, have been proven to improve patient outcomes. The components of Ventilator Bundle include: i) Elevating head of the bed to 30-45 degree, ii) Daily 'sedation vacation' to assess readiness to extubate, iii) Peptic ulcer disease prophylaxis, iv) Deep venous thrombosis prophylaxis (**Institute for Healthcare Improvement, 2020; Lavallée, Gray, Dumville, Russell, & Cullum, 2017**).

Knowledgeable and skilled nurses are crucial in providing patient care, timely and correct decision minimizes the risks to patients. According to previous international surveys, the theoretical and applied knowledge of critical care nurses has been limited and inadequate regarding evidence based guidelines, protocols and care bundles (**Chithra, & Raju, 2017; Dipali,& Dumbre,2019**).

However, Intensive care nurses are in the best position to bring the evidence based guidelines into practice as they are at the patient's bedside 24 hours a day and therefore they play a substantial role in the prevention of VAP. Nevertheless nurses need to be aware and up-dated of the problem as well as knowledge on ventilator care bundle so as to adhere to such practices (**Arumugam, Sivakumar, & Balasubramanian, 2016**).

Up to the researchers' knowledge, no interventional study was conducted in el Dakahlia governorate, Egypt to improve ICU nurses' knowledge towards

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ventilator associated pneumonia. Therefore, this study aimed to assess the effectiveness of educational program on knowledge regarding care bundle on prevention of ventilator-associated pneumonia among intensive care unit nurses.

**Significance of the study:** VAP constitutes a serious burden for nurses system and worsens the patient's outcomes; thus, several preventive measures have been implemented. This study reviews the current knowledge on VAP and its preventive measures. From the researcher experience in ICU found unsatisfactory nurses' knowledge and inadequate practices regarding implementation of care bundle for mechanical ventilated patients, which elevating VAP rate. In consequences, education is widely viewed as a necessity in reducing VAP.

### **Aim of the study:**

The study aimed to evaluate the effectiveness of educational program on knowledge regarding care bundle on prevention of ventilator-associated pneumonia among intensive care unit nurses.

### **Research Hypotheses:**

To fulfill the aim of the study, the following research hypotheses were formulated:

There will be significant difference between post-educational program nurse's knowledge scores than the pre-educational program nurse's knowledge scores in the study group.

There will be insignificant difference in nurse's knowledge scores throughout three study stages in the control group.

### **Subjects & Methods**

**Research design:** Quasi-experimental research design had been

used in this study pre and post tested for study and control groups.

**Study sample:** A convenience sample including all available nurses (100) nurses divided into (50) nurses at Meniet ELNasr intensive care unit and (50) nurses at Dekirnis ICU and willing to participate in the study.

**Setting:** this study was conducted in two intensive care units at Meniet EL\_Nasr Central Hospital and Dekirnis Central Hospital. Each ICU of Meniet El-Nasr and Dekirnis hospital has four rooms, which are divided as: two intensive care; and two-cardiac care. Each ICU unit involves three mechanical ventilator and 50 nurses.

### **Tools of data collection:**

One tool was developed by the researcher to collect the necessary data for this study, and composed of two parts as the following:

**Part1:Nurses' demographic and occupational data:** It incorporated critical care nurses' demographic data (age, sex, and qualifications), their occupational profile (years of experience) and their training needs (attendance of educational courses regarding critically ill patients' care).

**Part2:Self-administrated nurses' knowledge regarding VAP bundleQuestionnaire:** This questionnaire was developed and translated to simple Arabic language to investigate critical care nurses' knowledge regarding ventilator associated pneumonia such as definition, signs & symptoms, diagnostic procedure, VAP bundle and standard precautions. This tool was designed on the highlight of related literatures (Aferu, 2016; Alcan, et al., 2016; Ali, 2013; Al-Sayaghi, 2014; Subramanian, Choy, Gobal, Manso, & Ng, 2013). These knowledge questions were classified into 13 categories, all of these

categories involved 101 questions (67 multiple choice (MCQ), and 34 Yes and No questions). It was arranged as the following: Respiratory system (6 items); Function of the mechanical ventilator (6 items); Ventilator associated pneumonia (6 items); Mechanical ventilator (5 items); The rendered nursing care for critically ill patients(6 items); The rendered nursing care for endotracheal tube (25 items); The rendered nursing care during Endotracheal tube (ETT) suctioning (14 items); Blood gases analysis(5 items); Nasogastric feeding(5 items); Airway care (2 items); the patient mobilization (3 items); The chest physiotherapy (10 items); The mechanical ventilator circuits sterilization (8 items).

**Scoring system of the nurses' knowledge questionnaire:** The total score for knowledge was 101 grades. The score ranged from 0 to 101. Each knowledge question was scored as (1) for the correct answer and (0) for the wrong answer and don't know. A higher score indicated greater nurses' knowledge. Knowledge score was categorized as follows: Scores less than 75% (less than 75.75 grade) was considered unsatisfactory knowledge level and the scores equal or more than 75% (equal or more than 75.75 grade) considered satisfactory level of knowledge (Sobehi, et al., 2018; Haza'a, Al-Qubati, Mohammed, Abdel-Aziz,& Mehany, 2020).

**Tools validity:** The content validity of the developed tools was tested by five experts of emergency nursing, and their recommended substantial adjustments had been made.

**Pilot study:** Face validity of the developed tools was tested by conducting a pilot study on the targeted group: 10% (10 nurses) of the total sample size of

critical care nurses, who were selected randomly from the above-mentioned settings. The nurses included in the pilot study were excluded from the whole study sample. Accordingly, the necessary modification was made, some questions were added, and others were clarified or omitted.

**Reliability assessment:** Internal consistency was tested by using Cronbach's  $\alpha$ . that was emerged as very good (0.81).

**Ethical considerations:** Before conducting the study, ethical approval was obtained from the research ethics committee of the faculty of Nursing, Mansoura University. An explanation regarding the aim of the study, and the expected outcomes were clarified for the studied sample. Each nurse was interviewed individually after taken their consent to contribute in the study; they were enhanced cooperatively to participate in the study. Participants were also informed about their right to withdraw from the study at any time without giving a reason. All data and information obtained were protected through coding to ensure confidentiality.

**The study procedure:** The current study was conducted on four phases: preparatory / or assessment phases, planning phase, implementation phase, and evaluation phase. Data were collected across two study phases that were: preparatory / or assessment phases (baseline data); and evaluation phase (immediate post and follow up data).

**Phase1: reparatory/Assessment phase:** This phase involved the preparation of data collection tools based on reviewing the pertinent current, national and international literature. Obtaining ethical approval and hospital permission. Verbal informed consents were obtained also from nurses.

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**Initial data collection:** Baseline assessment was conducted for both study and control group by distributing self-administered demographic and occupational questionnaire using Tool I (part1), and knowledge assessment test regarding prevention of VAP by Tool 1 (part 2),

### **Phase2:Planning phase of the educational program**

- The researcher designed the ventilator-associated pneumonia bundle educational program based on review of related literatures: **Kao et al., (2019); Walimanna Gamage (2019); Branco et al., (2020); Alsoda et al., (2019); Alvarez Lerma et al., (2014); Mogyoródi et al.,( 2016).**
- The targeted educational program involved 6 group based sessions. These sessions focused on Respiratory system (structure, physiology, and functions); mechanical ventilator (appropriate functions, its alarms, appropriate role of nurse); Ventilator associated pneumonia (definition, causes, Risk factors, and prevention); VAP bundle components; the rendered nursing care for critically ill patients. The developed educational program was tested for content related validity by five critical care and emergency nursing experts.
- The printed booklet containing the content of the program was designed and developed using appropriate illustrations, simple Arabic language, attractive and suitable format.

### **Phase3: Implementationof the educational program:**

- The current study was carried out over period of 18 months, starting from first week of February (2018)

up to the first week of July (2019) for data collection and implementation of the educational program. The researcher visited the previous mentioned study settings, three days/week from 10.00 am to 4.00 pm.

- The implementation of the educational program were premeditated based on the actual nurses' needs assessment of the studied nurses through the initial collected data and the reviewed literature. The implementation of the program covered the theoretical aspects concerned to prevention of ventilator-associated pneumonia. It was aimed to improve the nurses' knowledge regarding prevention of VAP. Nurses were divided into small groups, the implementing educational program were proceed over 6 demonstrated sessions (around 45-60 minutes for each) at various morning shifts by moderate of 3 sessions/week. It was given over a period of 18 weeks.
- The researchers utilized different teaching methods during implementation of educational program, it was included: lectures, brain storing, group discussion, clinical scenarios; besides various teaching media such as watching videos, power point presentation and hand-out for prevention of VAP.

**Phase3:Evaluation phase:** Immediately after ended the implementation of educational program, nurses' knowledge were evaluated for both the study and control groups using the same study tool of pre-test, for the post-tests (immediately post-test and 3 months follow-up test) that done for comparing between the both study groups to evaluate the program effectiveness. After

that, the study group nurses at the ICU from Meniet EL\_Nasr Hospital, had copies from the booklets of the implemented educational program regarding prevention of VAP.

**Statistical Analysis:** The collected data were coded and entered to the statistical package of social sciences (SPSS) version 24. After complete entry, data were explored for detecting any error, then, it was analyzed by the same program for presenting frequency tables with percentages. Qualitative data was presented as number and percent.

**Results:**

**Table (1): Critical care nurses' demographic and occupational characteristics:**

Demographic and occupational characteristics	Total number of nurses =100						P- value	
	Study (N=50)		Control (N=50)		Total (N=100)			
	No	%	No	%	No	%		
<b>Age in years</b>								
20- 29	16	32	15	30	31	31	0.51 & 0.775	
30- 39	24	48	22	44	46	46		
40-50	10	20	13	26	23	23		
≥50ys	----	----	----	----	----	----		
SD±Mean	$34.33 \pm 5.33$		$34.12 \pm 5.54$		$33.70 \pm 5.43$			
<b>Educational level</b>								
Diploma of nursing	7	14	12	24	19	19	2.47 & 0.29	
Nursing diploma	27	54	20	40	47	47		
Technical Institute	16	32	18	36	34	34		
Bachelor of nursing	----	----	----	----	----	----		
<b>Experience years</b>								
≤10 yrs	42	84	34	68	76	76	3.5 & 0.06	
≥10 yrs	8	16	16	32	24	24		
SD±Mean	$8.10 \pm 2.40$		$9.34 \pm 3.46$		$8.72 \pm 3.02$			
<b>Previous attendance of training program about (VAP) bundle</b>								
Yes	5	10	11	22	16	16	1.11 1.11&	
No	45	90	39	78	84	84		
<b>Average of cases taken nursing care per shift</b>								
2 cases	22	44	24	48	46	46	1.11 1.11&	
3 cases	28	56	26	52	54	54		
SD±Mean	$2.0 \pm 1.0$		$2.52 \pm 0.50$		$2.54 \pm 0.50$			

There were no significant differences amongst the baseline demographic and occupational characteristics between the groups which indicate the homogeneity of the both groups as shown in **table (1)**. The mean age of the participants in the study group

Besides, Quantitative data were described as mean / SD as appropriate. The study data were tested for normality by Kolmogorov-Smirnov test. For not normally distributed variables, Friedman test was utilized for comparison between more than two related groups. The Chi-Square, Monte Carlo and fisher's exact test were used to check if there significant difference in the variables proportions. All tests were performed at a level of significance (P-value) equal or less than 0.05 was considered to be statistically significant.

was 33.28 (SD=5.33), whereas the mean age was 34.12 (SD=5.54) in the control group. Slightly half of the participants in the study group (54%), and the control groups (40%) were nursing diploma. Approximately more than two-third of the participants in the study and the

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control groups had five to less than ten years of experience (84%, 68%, respectively). More than three fourth of the participants in both groups didn't attend any training program about (VAP)

bundle (90%, 78% respectively). Regarding Average of cases taken nursing care per shift, more than half of the participants in both groups take care of three cases per shift.

**Table(2):Comparison between study and control group according to the total knowledge level toward ventilator associated pneumonia (VAP) bundle pre, immediate, 3 months post program :**

Knowledge level	Nurses No=100															
	Study group (N=50)						Control group (N=50)						(Study vs Control group)			
	Pre		Immedia te Post		3 months post		Pre		Immediat e Post		3 months post		Pre	Immedi ate post	3 month s post	
	N o.	%	N o.	%	N o.	%	N o.	%	N o.	%	N o.	%				
<b>Respiratory system</b>																
Unsatisfactory knowledge	29	78	5	10	8	16	$\chi^2=50.00, p\le0.001$	43	86	44	88	41	82	$\chi^2=0.328, p>0.05$	$\chi^2=7.25, p\le0.01$	$\chi^2=6.24, p\le0.01$
Satisfactory knowledge	11	22	95	90	42	84		7	14	6	12	9	18			
Median	3		6		5			3		3		3				
<b>Function of mechanical ventilator</b>																
Unsatisfactory knowledge	50	100	25	50	28	56	$\chi^2=80.26, p\le0.001$	50	100	50	100	50	100	$\chi^2=2.34, p\le0.10$	$\chi^2=0.5, p\le0.56$	$\chi^2=8.03, p\le0.001$
Satisfactory knowledge	---	---	25	50	22	44		---	---	---	---	---	---			
Median	1		4.5		4			1		1.5		1.5				
<b>Ventilator associated pneumonia</b>																
Unsatisfactory knowledge	50	100	2	4	2	4	$\chi^2=87.98, p\le0.001$	50	100	50	100	50	100	$\chi^2=0.644, p\le0.867$	$\chi^2=0.6, p\le0.52$	$\chi^2=8.64, p\le0.001$
Satisfactory knowledge	---	---	48	96	48	96		---	---	---	---	---	---			
Median	2		6		6			2		2		2				
<b>Mechanical ventilator</b>																
Unsatisfactory knowledge	50	100	5	10	11	22	$\chi^2=84.31, p\le0.001$	50	100	50	100	50	100	$\chi^2=0.200, p\le0.905$	$\chi^2=0.250, p\le0.882$	$\chi^2=8.42, p\le0.001$
Satisfactory knowledge	---	---	45	90	39	78		---	---	---	---	---	---			
Median	2		4		4			2		2		2				
<b>The rendered nursing care for critically ill patients</b>																
Unsatisfactory knowledge	50	100	5	10	10	20	$\chi^2=92.19, p\le0.001$	49	98	49	98	50	100	$\chi^2=1.355, p\le0.508$	$\chi^2=0.765, p\le0.444$	$\chi^2=8.27, p\le0.001$
Satisfactory knowledge	---	---	45	90	40	80		1	2	1	2	---	---			
Median	3		5		5			2		2		2				

**Effectiveness of the educational program on participants' knowledge regarding care bundle on prevention of ventilator-associated pneumonia among intensive care unit nurses:** Friedman test was used to examine the difference in knowledge level among the participants in the study and the control groups after 3 months of

implementing the educational program. The results showed that there was a highly statistically significant difference in knowledge level regarding all knowledge categories in study group, in contrast no or minimal significant difference in control group. At baseline, the participants in both groups reported similar unsatisfactory knowledge level

regarding respiratory system, Mechanical ventilator, its functions, VAP, and the rendered nursing care for critically ill patients(78%, 100%, 100%, 100% respectively) as portrayed in **Table (2)**. In contrast at immediate and 3 months post-tests, this unsatisfactory knowledge level improved in the study group to satisfactory one (84%, 78%, 44%, 96%, 80% respectively) but remained the same at control group. Furthermore, Friedman test results indicated very highly statistically

improvements in study group regarding all previous mentioned categories (**p ≤0.001**), compared with the control group results, no statistical differences were detected at the three study stages (**P=0.729, P= 0.905, P= 0.10, P= 0.867, P=0.508 respectively**). Additionally, Chi square test was indicated highly statistical significant difference between the study and the control groups at immediate and post 3 months stages (**p ≤0.001**) for the all the above mentioned categories.

**Table (3): Comparison between study and control group according to the total knowledge level toward ventilator associated pneumonia (VAP) bundle pre, immediate, 3 months post program (continued....):**

Knowledge level	Nurses No=100																
	Study group (N=50)						Control group (N=50)						(Study vs Control group)				
	Pre		Immediat e Post		3 months post		Test of significa nce $\chi^2$ P	Pre		Immedia te Post		3 months post		Test of significa nce $\chi^2$ P			
	No.	%	N o.	%	N o.	%		N o.	%	N o.	%	N o.	%				
<b>The rendered nursing care for endotracheal tube</b>																	
Unsatisfactory knowledge	49	98	3	6	4	8	$\chi^2=88.03$ , $p\leq0.001$	49	98	49	98	48	96	$\chi^2=4.68$ , $p\leq0.096$	$\chi^2=0.6$	$\chi^2=8.56$ , $p\leq0.53$	$\chi^2=8.4$ , $p\leq0.001$
Satisfactory knowledge	1	2	47	94	46	92		1	2	1	2	2	4				
Median	11.5		23		22			10		10		11					
<b>The rendered nursing care during Endotracheal tube (ETT) suctioning</b>																	
Unsatisfactory knowledge	37	74	---	---	---	---	$\chi^2=76.09$ , $p\leq0.001$	38	76	37	74	36	72	$\chi^2=1.09$ , $p\leq0.579$	$\chi^2=0.9$	$\chi^2=8.32$ , $p\leq0.001$	$\chi^2=8.0$ , $p\leq0.001$
Satisfactory knowledge	13	26	50	100	50	100		12	24	13	26	14	28				
Median	8		14		14			7		7		8					
<b>Blood gases analysis</b>																	
Unsatisfactory knowledge	40	80	2	4	3	6	$\chi^2=86.00$ , $p\leq0.001$	42	84	39	78	41	82	$\chi^2=2.88$ , $p\leq0.236$	$\chi^2=0.6$	$\chi^2=8.39$ , $p\leq0.001$	$\chi^2=7.9$ , $p\leq0.001$
Satisfactory knowledge	10	20	48	96	47	94		8	16	11	22	9	8				
Median	2		5		5			2		2		2					
<b>Nasogastric feeding</b>																	
Unsatisfactory knowledge	44	88	2	4	3	6	$\chi^2=73.75$ , $p\leq0.001$	46	92	46	92	44	88	$\chi^2=1.87$ , $p\leq0.391$	$\chi^2=0.0$	$\chi^2=8.07$ , $p\leq0.001$	$\chi^2=7.8$ , $p\leq0.001$
Satisfactory knowledge	6	12	48	96	47	94		4	8	4	8	6	2				
Median	2		5		5			2		2		2					
<b>Airway care</b>																	
Unsatisfactory kn owledge	49	98	4	8	4	8	$\chi^2=90.00$ , $p\leq0.001$	50	100	46	92	47	94	$\chi^2=1.52$ , $p\leq0.467$	$\chi^2=0.4$	$\chi^2=8.19$ , $p\leq0.001$	$\chi^2=8.3$ , $p\leq0.001$
Satisfactory knowledge	1	2	46	92	46	92		---	---	4	8	3	6				
Median	1		2		2			1		1		1					

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**Table(3):**demonstrates the distribution of participants' knowledge in both groups regarding nursing care for endotracheal tube, nursing care during endotracheal suctioning, blood gases analysis, nasogastric feeding, and airway care at the three study stages. At the baseline assessment, unsatisfactory knowledge level was reported by both study groups regarding all the above mentioned categories. Compared to immediate post-test, this unsatisfactory level elevated in study group but remained diminished in control group: nursing care for endotracheal tube (study group: 94 %, and control group: 2 %);

**Table(4):Comparison between study and control group according to the total knowledge level toward ventilator associated pneumonia (VAP) bundle pre, immediate, 3 months post program (continued.....):**

Knowledge level	Nurses No=100														
	Study group (N=50)						Test of significance $\chi^2$ P	Control group (N=50)					Test of significance $\chi^2$ P		
	Pre		Immediate Post		3 months Post			Pre		Immediate Post		3 months post			
	No	%	No	%	No	%		No	%	No	%	No	%		
<b>The patient mobilization</b>															
Unsatisfactory knowledge	42	84	1	2	1	2	$\chi^2=84.00$ , $p\leq0.001$	44	88	38	76	44	88	$\chi^2=5.54$ , $p\leq0.06$	
Satisfactory knowledge	8	16	49	98	49	98		6	12	4	6	12			
Median	2		3		3			2		2		2			
<b>The chest physiotherapy</b>															
Unsatisfactory knowledge	45	90	2	4	2	4	$\chi^2=76.47$ , $p\leq0.001$	45	90	44	88	41	82	$\chi^2=2.16$ , $p\leq0.339$	
Satisfactory knowledge	5	10	48	96	48	96		5	10	6	12	9	18		
Median	6		9		9			6		5		5			
<b>The mechanical ventilator circuits sterilization</b>															
Unsatisfactory knowledge	40	80	---	---	---	---	$\chi^2=73.57$ , $p\leq0.001$	42	84	39	78	41	82	$\chi^2=1.83$ , $p\leq0.399$	
Satisfactory knowledge	10	20	50	100	50	100		8	16	11	22	9	18		
Median	4		8		7.5			3.5		3		3.5			
<b>Total knowledge level</b>															
Unsatisfactory knowledge	49	98	2	4	2	4	$\chi^2=93.48$ , $p\leq0.001$	49	98	49	98	48	96	$\chi^2=4.81$ , $p\leq0.09$	
Satisfactory knowledge	1	2	48	96	48	96		1	2	1	2	2	4		
Median	48		93		91			46.5		46.5		48			

**Table (4):**portraysthe distribution of participants' knowledge in both groups regarding nursing care for patient mobilization, chest physiotherapy, and

nursing care during Endotracheal suctioning(study group: 100 %, and control group: 26 %); Blood gases analysis (study group: 96 %, and control group: 22%); Nasogastric feedingAirway care (study group: 96 %, and control group: 8 %). Furthermore, Friedman test results indicated very highly statistically differences in the study group regarding all previous mentioned categories (**p≤0.001**), comparing with the control group results insignificant differences was detected at the three study stages (**P=0.096**, **P=0.579**, **P=0.236**, **P=0.391**, **P=0.467respectively**).

**mechanical ventilator circuits sterilization at the three study stages.** At the initial survey, unsatisfactory knowledge level was detected by both

study groups regarding all the previous mentioned categories. Compared to 3 months post-test, the study group showed satisfactory level, in contrast to, the control group who reported the lower satisfactory level: patient mobilization(study group: 98 %, and control group: 12%); chest physiotherapy (study group: 96%, and control group: 18%); mechanical ventilator circuits sterilization(study group: 100%, and control group: 18%). Furthermore, Friedman test results indicated very highly statistically improvements in the study group regarding all the previously mentioned categories ( $p \leq 0.001$ ), comparing with the control group results insignificant differences was indicated at the three study stages ( $P=0.06$ ,  $P=0.339$ ,  $P=0.399$ , respectively).

**Figure (1):Comparison between study and control group according to the total knowledge level toward ventilator associated pneumonia (VAP) bundle pre, immediate, 3 months post program**



**Figure(4):**demonstrates the distribution of participants' total knowledge level in both groups at the three study stages. At the initial survey, unsatisfactory knowledge level was reported by both study groups (98 % for each group). Compared to immediate post-test, the study group showed

Comprehensively, **Friedman results** indicated very highly statistical improvements in study group median score from baseline (48) to immediate post-test (93) and 3 months post-test (91)at ( $\chi^2=93.48$ ,  $P \leq 0.001$ ), in contrast to the control group results showed insignificant differences at ( $\chi^2=4.81$ ,  $P=0.09$ ), with minimal change of median score from baseline (46.5) to immediate post-test (46.5) and 3 months post-test (48)at the three study stages, in addition, to chi square test demonstrated statistical differences between immediate post and 3 months post-test percentages at ( $P \leq 0.001$ ).

satisfactory level, in contrast to, control group who reported the lower satisfactory level:(study group: 96 %, and control group: 2%). In the same line, 3 months post-test showed satisfactory level of the study group, and decreased level in control one (study group:96%, and control group:4%).

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**Table (5): Association of the Socio-demographic and occupational characteristics of the studygroup and their total knowledge level about ventilator associated pneumonia (VAP) bundle pre, immediate, 3 months post program:**

Nurses' socio-demographic and occupational variables		Total knowledge level N=50										Test of Significance				
		Pre				Immediate post				3 months post				Chi square, Monte Carlo& or fisher exact test		
		Unsatisfactory knowledge N=49		Satisfactory knowledge N=1		Unsatisfactory knowledge N=2		Satisfactory knowledge N=48		Unsatisfactory knowledge N=2		Satisfactory knowledge N=48		Pre	Immediat e	3 month s post
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	<sup>2</sup> , <sub>1</sub> & P <sub>1</sub>	<sup>2</sup> , <sub>2</sub> & P <sub>2</sub>	<sup>2</sup> , <sub>3</sub> & P <sub>3</sub>
Nurses' age	20- <30ys	16	62	---	---	1	2	15	30	1	2	15	30	MC & .188	MC & .1..	MC & .1..
	30- <40ys	24	48	---	---	1	2	23	46	1	2	23	46			
	40- <50ys	9	18	1	2	---	---	10	20	---	---	10	20			
Nurses' qualification	Diploma of nursing	7	14	---	---	1	2	6	12	1	2	6	12	MC &0.45 4	MC & 0.208	MC & 0.208
	Nursing diploma and specialist	27	54	---	---	---	---	27	54	---	---	27	54			
	Technica l Nursing Institute	15	30	1	2	1	2	15	30	1	2	15	30			
Experience years	5-<10ys	42	84	---	---	2	4	40	80	2	4	40	80	FE &0.16 0	FE &1.00	FE &1.00
	≥10ys	7	14	1	2	---	---	8	16	---	---	8	16			
Previous attendance of training program	NO	45	90	---	---	2	4	43	86	2	4	43	86	MC &0.10 0	FE .1..&	FE .1..&
	Yes	4	8	1	2	---	---	5	10	---	---	5	10			

(\*) Statistically significant at  $p \leq 0.05$ ,  $\chi^2$  = chi square, MC: Monte Carlo test, FE: Fisher Exact test

**Table (5):** shows the association of the socio-demographic and occupational characteristics of the study group and their total knowledge level at the three study phases. Regarding the nurses' age, the Monte Carlo results indicated insignificant relationship between nurses' age and their total knowledge level at the three study phases ( $P=0.189, P=1.00, P=1.00$  respectively).

In accordance with nurses' qualification, the Monte Carlo results showed no significant relationship between nurses' qualification and their total knowledge level at the three study stages ( $P=0.454, P=0.208, P=0.208$  respectively). Concerning experience years, fisher exact test indicated insignificant differences throughout the study phases at ( $P=0.320, P=0.320, P=0.542$  respectively). For previous attendance of training program, the exact tests showed similar insignificant results at ( $P=1.00$ ).

**Table (6): Association of the Socio-demographic and occupational characteristics of the control group and their total knowledge level about ventilator associated pneumonia (VAP) bundle pre, immediate, 3 months post program:**

Nurses' socio-demographic and occupational variables		Total knowledge level N=50										Test of Significance					
		Pre				Immediate post				3 months post				Chi square, Monte Carlo& or fisher exact test			
		Unsatisfactory knowledge N=49		Satisfactory knowledge N=1		Unsatisfactory knowledge N=49		Satisfactory knowledge N=1		Unsatisfactory knowledge N=48		Satisfactory knowledge N=2		Pre	Immediate	3 months post	<sup>2</sup> <sub>1</sub> & P <sub>1</sub>
Nurses' age	20-<30ys	15	30	---	--	15	30	---	--	15	30	----	--	MC & .261 & .739	MC & .770 & .229	MC & .733 & .267	
	30-<40ys	22	44	---	--	22	44	---	--	21	42	1	2				
	40-<50ys	12	24	1	2	12	24	1	2	12	24	1	2				
Nurses' qualification	Diploma of nursing	12	24	---	--	12	24	---	--	12	24	----	--	MC & 0.594	MC & 0.594	MC & 1.00	
	Nursing diploma and specialist	20	40	---	--	20	40	---	--	19	38	1	2				
	Technical Nursing Institute	17	34	1	2	17	34	1	2	17	34	1	2				
Experience years	5-<10ys	34	68	---	--	34	68	---	--	33	66	1	2	FE & 0.320	FE & 0.320	FE & 0.542	
	≥10ys	15	30	1	2	15	30	1	2	15	30	1	2				
Previous attendance of training program	NO	39	78	---	--	39	78	---	--	38	76	1	2	FE & 0.220	FE & 0.220	FE & 0.395	
	Yes	10	20	1	2	10	20	1	2	10	20	1	2				

(\*) Statistically significant at  $p \leq 0.05$ ,  $\chi^2$  = chi square, MC: Monte Carlo test, FE: Fisher Exact test

**Table (6):** shows the association of the socio-demographic and occupational characteristics of the control group and their total knowledge level at the three study phases. Regarding the nurses' age, the Monte Carlo results demonstrated insignificant relationship between age and total knowledge level at the three study phases ( $P=0.263$ ,  $P=0.265$ ,  $P=0.733$  respectively). As regards to nurses' qualification, the Monte Carlo results showed no significant relationship between qualifications and total knowledge level at the three study stages ( $P=0.594$ ,  $P=0.594$ ,  $P=1.00$  respectively). In relation to experience years, fisher exact test indicated insignificant differences throughout the study phases at ( $P=0.320$ ,  $P=0.320$ ,  $P=0.542$

respectively). For previous attendance of training program, the fisher exact tests showed similar insignificant results at ( $P=0.220$ ,  $P=0.220$ ,  $P=0.395$  respectively).

#### Discussion:

which is related to severe morbidity and high care costs. VAP's pathophysiology, epidemiology, diagnosis, and prevention have been researched widely for decades, but no specific preventive strategy has yet emerged. This study was conducted to examine the effect of education given to nurses to reduce the VAP rate in adult ICUs.

Regarding the demographic and occupational characteristics, chi square test results indicated no statistically significant difference in demographic characteristics between the study and control groups, which indicates the homogeneity of the both groups. This

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homogeneity is the basic requirements for any case-control study as revealed by consistent study of **Oner Cengiz, & Kanan, (2019)**, who reported that "there was no statistically significant difference in descriptive characteristics between the study and control groups".

According to **Akin Korhan, Hakverdioglu Yont, Parlar Kilic, & Uzelli (2014)**, increasing ICU nurses' knowledge of VAP and care bundle activities are the effective way to prevent VAP in the care environment. In the literature, where ICU nurses' knowledge of VAP prevention was evaluated, nurses' knowledge of VAP was reported to be insufficient (**Maurya, Mishra, Azim, Baronia, & Gurjar, 2016; Al-Sayaghi, 2014; Jansson, Ala-Kokko, Ylipalosaari, Syrjälä ,& Kyngäs, 2013**). In the current study, the total median scores before the first education in the study group and the median scores at the first measurement in the control group were detected to be low on the knowledge test. This result comes in agreements with another study of **Dipanjali, Shivananda, & Yashoda, (2021)** entitled as "the effectiveness of the educational intervention on the knowledge and practice of the staff nurses on prevention of VAP in neonates", which showed lower scores of both study groups at pre-test, and showed improvement in the knowledge scores of the nurses after the educational sessions ( $p \leq 0.001$ ). Moreover, in the study of **Meherali, Parpio, Ali, & Javed, (2011)** that examine "the effectiveness of a teaching module on nurses' knowledge to practice evidence based guidelines for the prevention of VAP", the post-tests scores were higher than the pre-test scores although there was a slight decrease in the follow up-test scores conducted after four weeks of the

intervention as compared to post-test conducted immediately after the intervention (pre-test=  $7.8 \pm 2.9$ , post-test 1=  $10.8 \pm 2.0$  & post-test 2=  $9.8 \pm 2.1$ ).

Almost 20 years ago, it was well recognized that there is a deficiency in the mechanical ventilation knowledge among the internal medical staff in the United States (**Al-Otaibi, 2019**). This conclusion is congruent with the current study results related to knowledge of concept of mechanical ventilator, its functions, and the way of its circuits sterilization, as it showed unsatisfactory levels of both study groups at initial assessment which improved later in the study group at immediate and 3 months post-test results after educational intervention. Additionally, these finding compatibles with one large European study that included 318 ICUs, among 11 domains of intensive carerelated individuals, the performance of nurses was lowest in the ventilation domain. The nurses scored an average of 66% across all 11 domains (**Fulbrook, Albarran, Baktoft, & Sidebottom, 2012**)

As regard to the chest physiotherapy and patient mobilization knowledge categories, the current study indicated unsatisfactory level at pre-assessment phase in both study groups which improved later in study group but not in control group at immediate post and follow up phases. This finding is consistent with **Bahgat (2018)and Ramya & Neethu (2013)** who concluded that "more than three quarter of their participants had poor level of total knowledge; pre- intervention which improved to a good level at immediate post and one-month post intervention".

Concerning airway care, ETT suctioning, and rendered NC during suctioning categories, the present study

revealed that unsatisfactory level at pre-assessment phase in both study groups which improved later in study group but not in control group at immediate post and follow up tests. This finding compatibles with the study of **Abdelazeem, Fashafsheh, & Fadllalah, (2019)**, who reported that "The knowledge of the participant regarding ETT and air way care was intermediate pre intervention by 38% then the result improved to becomes good in post intervention I by 46% and get increase by 54% in post intervention II". These finding indicates the hazard of being as a bedside nurse for mechanically ventilated patients with short knowledge about the tools which connecting the patient to mechanical ventilator and airway management. The improvement in these finding from pre to two post-tests reflects the good effect of the educational program:

In relation to nasogastric feeding category, present study showed that unsatisfactory level at initial assessment phase in both study groups which elevated later in study group , while not elevated in control group at immediate post and follow up tests. This finding is in the same line with **Bedier, Abo EL-Ata, & Shehab (2020)**, who cited that "the study results showed statistically significant improvement in nurses total score regarding nasogastric tube feeding and this improvement was tended to decline but sustainable immediately, post 3 month and 6 month after the program implementation compared to pre-test".

In accordance with the association of socio-demographic,occupational characteristics and the total knowledge level of both nurses groups about VAP. The present study presented insignificant association of total knowledge level with selected demographic and occupational

variables. In the same line with the study conducted by **Ghimire and Neupane (2018)** who presented no statistically significant association between respondents' level of knowledge regarding the prevention of VAP with working experience ( $p=0.493$ ) and qualification ( $p=0.459$ ). Similar findings were reported by **Rakhi, and Navita, (2020)**, who demonstrated statistically insignificant relationship between participants' level of knowledge regarding the prevention of VAP with age ( $p =0.17$ ) and qualification ( $p=5.44$ ), and work experience ( $P=0.09$ ). On the other hand, this finding contradicts with the study of **Baby (2012)** who revealed that "there was a significant association between the knowledge level with demographic variables like age, religion and marital status at the level of  $p < 0.05$ ".

**Conclusion:** the study concluded that unsatisfactory knowledge was reported by both study groups before education implementation. Compared to immediate post-test, significant improvements in the study group knowledge were detected, in contrast to, control group who didn't show any significant differences. In the same line, 3 months post-test showed satisfactory level of the study group with highly statistically significant differences, and insignificant lower level in the control group.

**Recommendations:** Based on the results of the present study, the following recommended: Continuous nursing education programs at ICU should be organized within Meniet ELNasr and Dekirnis Central Hospitals. Nurses should add to their daily routine responsibilities the regular reading to update their knowledge. They should always be encouraged to attend scientific workshops and conferences to keep pace

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with the rapid growing plenty of knowledge and practice necessary for proper care bundles implementation.

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