Effect of an Educational Program for Nurses about Prevention of Ventilator Associated Pneumonia in Neonatal Intensive Care Units

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ABSTRACT

Background: Ventilator associated pneumonia is a sever consequence in neonates receiving mechanical ventilation which represents 6.8-32.2% of healthcare-associated infections among neonates. **The study aimed** to evaluate effect of an educational program for nurses about prevention of ventilator associated pneumonia in neonatal intensive care units. **Subjects and methods: Design:** A quasi-experimental research design was used (one group). **Setting:** This study was applied in neonatal intensive care units at El-Salam hospital & Specialized obstetric hospital and Al-Hayat hospital affiliated to the universal health insurance in Port Said Governorate. **Subjects:** The study included all nurses working in the previous settings (60 nurses) and 40 mechanically ventilated neonates. **Tools:** Two tools were used; questionnaire sheet and observational checklists. **Results**: The present study showed that only two fifths of the studied nursing staff had satisfactory total knowledge score pre-program and increased to one hundred percent immediately post program, while slightly decline at follow up phase. Also, improvements in total practices of the studied nurses throughout program phases occur which nearly one quarter of them had adequate total practice score pre-program phase, while majority of them had adequate total practice score in immediate post program phase and at follow up phase. **Conclusion:** The training program was successful in enhancing nurses' skills and knowledge in reducing ventilator-associated pneumonia. **Recommendations**: Periodic in-service training programs are recommended to enhance nurses' performance to protect newborns against ventilator-associated pneumonia.

Keywords: Educational program, Neonatal intensive care unit, Nurses, Prevention, Ventilator associated pneumonia.

INTRODUCTION

The first 28 days of life are known as the neonatal period. The risk of death is greatest for newborns. Around 45% of neonatal deaths happen during the first 24 hours and 75% happen within the first week of life (The United Nations Children's Fund (UNICEF), 2021). During the first six to ten hours of life, there are several modifications that must be made and that take weeks to be completed (Bhalla, Newth, & Khemani, 2015). The four interdependent functions of respiration, circulation, thermoregulation, and the capacity to maintain blood glucose levels are where the most extreme and quick extra-uterine shifts take place. Due to their undeveloped lungs, ill newborns at both full and preterm gestations have a tough time adapting to their new surroundings and face numerous health risks. Before neonatal intensive care units (NICUs) were built, the mortality rates were high and it was difficult for sick newborns to survive (Shann & Duke, 2017).

Respiratory tract infections represent a large portion of nosocomial infections, and they are more common among critically ill newborns that are hospitalized in NICUs (Sahlol, Madkour, & Soliman, 2016). The mortality of neonates especially those who were born extremely preterm have improved significantly in recent decades due to advances in mechanical ventilation in the NICUs. Although mechanical ventilation is unique compassionate modalities in the intensive care units, it causes a lot of complications and problems and has a considerable negative impact on the prognosis of critically sick newborns (Chakkarapani et al., 2020).

A nosocomial lower airway infection, or pneumonia, in intubated patients with onset after at least 48 hours of invasive mechanical ventilation is known as ventilator-associated pneumonia (VAP). It is the second most frequent reason for antibiotic usage in the NICUs, and it is linked to an increased risk of bronchopulmonary dysplasia, extended mechanical breathing, and prolonged hospital stays (Dell'Orto et al., 2019). Additionally, the center for disease control and prevention defined VAP as it is the second most typical nosocomial infection in NICUs, which increases the risk of morbidity, requires extended mechanical ventilation, necessitates the use of antibiotics, and prolongs hospital stays in NICUs, it causes 6.8% to 32.3% of nosocomial infections (Jiang et al., 2018).

There were several risk factors noted to be associated with increased risk of VAP as low birth weight, longer days spending on mechanical ventilation, opiate treatment for sedation, repeated suctioning and recurrent intubation, bloodstream infection, and usage of steroid dregs. Infants with low birth weights have immature immune systems, which

increases their risk of nosocomial illness. Additionally, the mucous membranes and skin are less effective barriers and more permeable (Lamichhane & Mishra, 2019).

To start the proper treatment, a neonatal VAP diagnosis must be made accurately. The center for disease control and prevention / National Healthcare Safety Network VAP criteria included radiographic, clinical, and microbiologic components, such as fresh and recurring radiographic infiltrates and deteriorating gas exchange in infants ventilated for at least 48 hours (pulse oximetry 94%, increased oxygen requirements), and who exhibit at least three of the following: Leukopenia, changes in the characteristics of respiratory secretions, respiratory discomfort, temperature instability without further known cause, and bradycardia or tachycardia (Iosifidis, Pitsava & Roilides , 2018).

The involvement of neonatal intensive care nurses in reducing VAP and associated risk factors is crucial (Khanali-Mojen, Rassouli, Tajalli, Baghestani, and Jafari, 2019). The neonatal nurses must be aware of potential problems and implement safety measures, such as: determine whether the patient is ready to be extubated, prevent unintentional extubation and reintubation, utilize noninvasive ventilation whenever possible, practice good hand hygiene, wear gloves, and use separate suction catheters for tracheal and oral suction. Maintain oral hygiene and swab the mouth with saline, avoid injecting saline through an endotracheal tube (ETT), and only suction an ETT when there is a visible discharge or changes in breathing or respiratory status. Prevent interrupting the ventilator circuit. Precautions must be taken include elevating the head 15 to 30 degrees, avoiding bloating and excessive sedation, and overdosing to prevent the development of drug resistance (McBeth, Montes, Powne, North, Natale, 2018).

Significance of the study:

One of the most frequent problems, ventilator-associated pneumonia has a significant effect on nurses' competence in critical neonatal care. Because the insertion of an ETT decreases the lower respiratory tract's natural ability to fight respiratory infections and raises the risk of infection, all mechanically ventilated newborns are at risk for VAP. It is linked to higher rates of morbidity and mortality, longer stays in the NICU, and higher health costs (Malhotra, Kumar, Thapar, & Bagga, 2018). Nurses working in the NICU should have comprehensive VAP prevention knowledge and practical abilities since they play a significant role in the care of babies and help other medical professionals improve the standard of care. Therefore, this study was conducted to evaluate effect of an

educational program for nurses about prevention of ventilator associated pneumonia in neonatal intensive care units.

AIM OF THE STUDY:

The study aim was to evaluate effect of an educational program for nurses about prevention of ventilator associated pneumonia in neonatal intensive care units.

Research Objectives:

- Assess nurses' knowledge and practice about prevention of VAP in neonatal intensive care unit.
- Design an educational program for nurses about prevention of VAP in neonatal intensive care units.
- Implement an educational program for nurses about prevention of VAP in neonatal intensive care units.
- Evaluate effect of an educational program on nurses' knowledge and practice about prevention of VAP in neonatal intensive care unit.

Research hypotheses:

- Nurses' knowledge about prevention of VAP in neonatal intensive care unit will be improved after implementation of an educational program.
- Nurses' practice about prevention of VAP in neonatal intensive care unit will be improved post applying of an educational program.

SUBJECTS AND METHOD:

1- Technical design

Study design

A quasi-experimental one-group (pre-post-follow up) research design was used in the study.

Study setting

This study was applied at neonatal intensive care units (NICU) at three hospitals affiliated to the universal health insurance in Port Said governorate (El-Salam hospital & Specialized obstetric hospital & Al-Hayat hospital)

Study subjects

Convenience sampling include all nurses available at NICU at the previous mentioned settings and were providing care for neonates undergoing mechanical ventilation regardless of their age and qualification or experience and comprised 60 nurses. In addition to, 40 neonates undergoing mechanical ventilation for more than 48 hours from both gender.

Tools of data collection:

Two tools were utilized for data collection:

Tool (I): Questionnaire sheet about prevention of VAP, it was adapted from Elbilgahy, Ouda, Elassmy, and Hashem (2016) in an Arabic language to assess the nurses' knowledge about prevention of VAP in neonates and modified by the researcher. Questions were in the form of multiple choice questions. This tool was used before, after and follow up after 3 months of program application. It comprised of two main parts:

Part (I):

(A)- Personal data and professional characteristics of the studied nurses which included: age, level of education, years of experience in NICU, marital status and number of training courses about prevention of VAP in neonates.

(**B)**- Demographic and neonatal clinical data of MV like admission age, gender, gestational age at birth, birth weight, medical diagnosis, type of delivery and duration of MV.

Part (II): Assess the nurses' knowledge about prevention of VAP in neonatal intensive care unit (pre / post & follow up). It included 30 multiple choice questions about VAP and its prevention in NICU. **Five** questions covered definition, risk factors, signs & symptoms, VAP early onset, late onset and **twenty five** questions covered nursing intervention for prevention of VAP (6 questions about hand washing & wearing gloves, 6 questions about oral care,4 questions about mechanical ventilator equipment care, 2 questions about endotracheal tube care, 3 questions about suctioning and 4 questions about positioning of neonate).

Scoring system of questionnaire sheet:

Knowledge about nurses: Answers were graded using a researcher-created template key answer, with 1 point awarded for accurate response and 0 for unknown or incorrect ones. To get the overall score for nurse knowledge, the score obtained for each question

was added. Make a total score for the nurse and convert it to a percentage. A score of more than or equal to 75% indicates knowledge satisfaction, and a score of less than 75% indicates unsatisfactory knowledge (Akl, Sadoon, and Sayed, 2020).

Tool (II): Ventilator-associated pneumonia prevention Observation Checklist, it was developed based on (Smith, Duell & Martin, 2018; Bowden & Greenberg, 2016; CDC, 2015). The observation checklists were utilized to evaluate the neonatal nurses' practice about prevention of ventilator-associated pneumonia in NICU. This tool covers the actual nurses' preventive practices including: hand washing and wearing gloves, endotracheal tube suctioning technique, mouth care, axillary temperature, position of neonates and chest physiotherapy. The tool was modified and tested for its content validity and reliability prior application in NICU**.**

Scoring system of observational checklists:

Each correct step of the procedure was rated using an observation checklist scoring system, which used the completion (1) and incomplete (0). The total score of the checklists were 89 grades. Total nurses' score was calculated then converted to percentage and evaluated as follows:

• Adequate ≥ 75 %.

• Inadequate less than75% (Akl et al., 2020).

2- Operational Design

The operational design includes a description of the study preparatory phase, content validity, reliability of the tool, pilot study, and fieldwork.

Preparatory phase

During this phase, the researcher studied regional and international related literature, using internet search, textbooks, and scientific publications. This improved familiarity with the research topic and aided in the preparation of the tools for gathering data.

Content Validity of the study tools:

The tools were created in their initial forms and then given for face and content validation to a group of seven pediatric nursing, medical surgical nursing, and pediatric medicine professionals. Following the advice of these specialists, the tools were

modified. Changes were made according to experts opinions. The completion of this phase took three months.

Reliability of the study tools:

Cronbach's alpha was used to assess the internal consistency of the tools.

Study tools	**No. of items**	**Cronbach alpha**
Tool I	30	0.78
Tool II		
Hand washing and wearing gloves checklist	15	0.98
Endotracheal tube suctioning observation checklist	25	0.89
Mouth care observation checklist	13	0.79
Axillary temperature observation checklist	15	0.97
Chest physiotherapy observation checklist	12	0.89
Position of neonate observation checklist	8	0.88

Pilot study:

Before beginning the data collection phase, a pilot study should be done. It was conducted on a sample of roughly 10% of the primary study sample who worked at El-Salam hospital, Al-Hayat hospital and Specialized obstetric hospital. Based on the pilot study, some modifications of the tools were done, and hence the pilot nurses were not included in the main study sample and the number of pilot sample was **7** nurses. The pilot study took fifteen days from January 2021 to February 2021.

Fieldwork:

Data were gathered for 14 months, from March 2021 to April 2022. Three days a week, the researchers went to the above mentioned studied settings (Saturday, Sunday, and Thursday). Each nurse was interviewed after agreeing to participate in the study, and the investigators collaborated to increase participation by introducing themselves, discussing the study's objectives, and describing anticipated outcomes. Data gathering was divided into four phases (assessment phase, planning, implementation and evaluation phase).

Assessment phase: Assessment of nurses' knowledge about VAP and its prevention in NICU pre / immediate post and follow up after 3 months of program application was performed using tool (I) including definition, risk factors, signs & symptoms, early & late VAP onset and nursing intervention for prevention of VAP (hand washing & wearing gloves, mechanical ventilator equipment care, endotracheal tube care, suctioning and positioning of neonate).

Assessment of nurses' practice about VAP prevention in NICU (pre / immediate post-follow up test) was applied using tool (II) covering the actual nurses' preventive practices including: hand washing and wearing gloves, endotracheal tube suctioning technique, mouth care, axillary temperature, position of neonates and chest physiotherapy. The observation was carried out during the morning and evening shifts.

Planning phase: Based on the results of phase one's work, the researcher constructed the educational program depend on the needs assessment of the nursing staff who were the subject of the study, using a review of relevant literature and the most recent evidence-based recommendations for VAP prevention. The overall aim of the educating program was to improve nurses' knowledge and practice about prevention of ventilator associated pneumonia in NICU. The educational program covered the theoretical and practical skills related to VAP in NICU. The researcher created a booklet outlining the program's content; it was written in plain Arabic language and accompanied by pictures and illustrations. It was intended to be given to nurses at the end of the program to aid in their comprehension of the content.

Implementation phase: The educational program is divided up into six sessions, three theoretical and three practical. Each session lasts 40–50 minutes, with 10 minutes allotted for questions from nurses and open discussion. Beginning in June 2021 and ending in late October 2021, the program was operated three days a week for five months. Each group was given an explanation of the educational program before the session began, for example (introduction, meaning, training plan, and learning objectives).

Nurses were classified into small groups; (4- 6 per one group) for theory and practical sessions and the re-demonstration on practical session were done personally for each nurse. There were 3 sessions per week according to the number of nurses in each hospital.

The educational program was displayed in a simple and clear form, following the basics of adult learning, relying on interactive learning and active participation. It was done using a lot of teaching methods as lectures, group discussion, brain storming, demonstration and re-demonstration of practice. In addition, different audiovisual materials were used as power point, pictures, videos and handout to support the teaching of each topic.

Evaluation phase: The efficacy of the program was relied on assessing the improvement in nurses' knowledge and their practices. This was achieved through comparing the pretest with immediate posttest after the application of the program, and the follow-up test conducted 3 months later.

3- Administrative Design

Prior to beginning any phase of the study, the Hospital Director and the Head of the Neonatal Intensive Care Unit were informed via an official letter from the Dean of the Faculty of Nursing and informing Universal Health Insurance of the chosen field of study.

Ethical considerations

An approval was taken from Research Ethics Committee of the Faculty of Nursing, Port-Said University {Code Number: NUR (9/7/2020). Moreover, consent was taken from each participant (neonatal nurses) after illustration of the study aim and data collection process to understand the value of her involvement. In addition, the investigator assured that the information gathered was confidential and to be used only for the purpose of the study. The researcher emphasized that their participation was voluntary and each nurse has the right to withdraw from the study at any times with no rationalization as well as confidentiality was assured.

4- Statistical Design

The SPSS version 20.0 statistics program was used for data entry and statistical analysis. The mean and standard deviation are two ways that data are described. To evaluate the reliability of the instrument in terms of internal consistency, Cronbach's alpha was determined. The chi-square test was utilized to compare qualitative category variables. The link between the quantitative variables was evaluated using the Pearson correlation test. To find differences between pre- and post-intervention in the same group,

paired samples t-tests were performed. P-values 0.05 were regarded as statistically significant, and p-values 0.01 as highly significant in statistical tests.

RESULTS:

Table (1): illustrates that more than half of the studied nurses' age ranged from 30 to less than 35 years with mean 36.5 ± 8.9 and nearly two thirds of them were married. In relation to level of education, more than half of them (53.3%) graduated from technical nursing institutes, while minority of them (5%) had secondary nursing education. Also, 45% of them had 1 to less than 3 years' experience in NICU, and two fifths of them (40%) attended courses about prevention of VAP in NICU.

Table (2): shows that two fifths of the nursing staff had satisfactory knowledge preprogram implementation and the percentage increased to 100 % immediate post program, while slightly decline to 90.7% in follow up phase. Also in this table, statistical significant differences were found between nurses' knowledge pre & immediate post and pre& follow up phase ($p \leq 0.001$**). On the other hand, there was no statistical significant variance about nurses' knowledge immediate post and follow up phase of program application ($p= 0.233$)

Table (3): indicates 40% of the studied nurse had satisfactory knowledge concerning definition, risk factors, signs & symptoms, and VAP onset preprogram and this percent increased to 100% immediate post program, then became 83.3% in follow up phase. Regarding preventive measures of VAP, most of the studied nurses had satisfactory knowledge regarding hand washing and wearing gloves preprogram and reaching to 100% at immediate post program, while this percentage declined to 96.2% & 92.5% in follow up phase respectively.

Concerning to ventilator equipment care and position, 25% & 20% of the studied nurses had satisfactory knowledge respectively in the preprogram phase compared to all of them in the immediate post program, while most of them had satisfactory knowledge at the follow up phase (83% & 88.8% respectively). Regards to nurses' knowledge about oral care, 50%, 100%, and 85% of the nursing staff had satisfactory knowledge pre program & immediate post program and in follow up phase respectively.

In relation to endotracheal tube care, it was evident that 45% of the studied nurses had satisfactory knowledge in caring of endotracheal tube in pre program phase and it increased to 100% immediate post program phase then slightly declined to 90% in follow up phase. Regarding endotracheal suction, less than half of them (43.3%) had

satisfactory knowledge in preprogram phase and reached to 100% immediate post program phase, while became 94.4% in follow up phase.

Table (4): reveals that there was a highly statistical significant difference between the studied nurses practice pre / immediate post & pre / follow up & immediate post/ follow up phase of program implementation. In relation to hand washing & wearing gloves, 30% of the studied nurses had "adequate" practice score compared to 100% of them had adequate practice score. While, 76% of them had adequate practice score during follow up phase of program implementation

As regards to total nurses' practice about endotracheal suction pre program, two fifths of the studied nurses had "adequate" practices score (40%). While, immediately after the program and after 3 months 100% & 88.8% of them had adequate practice score respectively. In relation to axillary temperature, pre program, three quarters of the nurses had "adequate" practice score. While, immediately post program and during follow up phase, all of them had adequate practice score (100%).

Regarding oral care, none of the studied nurses (0.0%) had "adequate" practice score pre program compared to 100% of them had adequate practice score immediate post program, while, 74% of them had adequate practice score during follow up phase of program implementation.

Moreover, 35%, 100% and 76% of the studied nurses had "adequate" practice regarding chest physiotherapy in pre program, immediate post program and follow up phase respectively. Also this table shows that 20% of the studied nurses had "adequate" practice score before program implementation in relation to position of neonates. While, immediately post program and during follow up phase, 80% &50% of them had adequate practice score respectively.

Figure (1): shows that improvements in total practices of the studied nurses throughout program phases from 26.7% of them had adequate total practice score preprogram phase to 95% in immediate post program phase and declined to 77.8% at follow up phase.

Table (5): reveals that there were highly statistical significance differences among mean score of nurses' practice pre / immediate post & pre / follow up & immediate post & follow up phase ($p \leq 0.001$**), which the mean score of nurses' total practice was 30.04 prior the program implementation. Immediately post the program, this mean was improved to 63.5 and 50.15 at follow up phase.

Table (6): demonstrates that, there was statically significant positive correlation between total score of nurses' knowledge regarding VAP prevention in pre/ immediate post & follow up phases and their total practice score in pre program phase ($P < 0.05$). Also this table clarifies that, there was statistically significant positive correlation between total practices of the studied nurses about VAP prevention in immediate post program phase and their total score of knowledge about VAP prevention in immediate post and follow up phases ($P < 0.01$)

Table (1): Percentage distribution of the studied nurses according to their personal data and professional characteristics (n=60).

Variable	Nurses (n=60)	
	No.	%
Age in Years		
20 <25	8	13.3
25 <30	12	20.0
30 <35	34	**56.7**
≥ 35 years	6	10.0
Range	(20- 45)	
Mean ± SD	36.5 ± 8.9	
Marital Status		
Single	12	20.0
Married	40	**66.6**
Divorced	5	8.4
Widowed	3	5.0
Level of education		
Baccalaureate nursing degree	25	41.7
Technical institute of nursing	32	**53.3**
Secondary nursing education	3	**5.0**
Years of experience in NICU		
< 1 years	12	20.0
1 - 3years	27	**45.0**
4 – 6 years	15	25.0
≥ 7 years	6	10.0
Previous training about prevention of neonates VAP		
Yes (two)	24	40.0
No	36	**60.0**

Table (2): Levels of nurses' total knowledge about VAP and its prevention

Variable	Pre		Immediate post		Follow up		Test of significance		
	No	%	No	%	No	%	χ2& P1	χ2& P2	χ2& P3
Satisfactory knowledge	24	40.0	60	100.0	49	90.7	χ2=60.84 ≤ 0.001**	χ2=54.462 ≤ 0.001**	FET 0.233
Unsatisfactory knowledge	36	60.0	0	0.0	5	9.3			

P1: comparison among pre & immediate post
P2: comparison among pre & follow up after 3 months
P3: comparison among immediate post & follow up after 3 months
FET: Fisher's Exact Test χ2 : Chi square

Table (3): Total scores of nurses' knowledge regarding VAP & its prevention

Total scores of knowledge	Pre (60)		Immediate post (60)		Follow up (54)		Test of significance	
	Satisfactory %	Un satisfactory %	Satisfactory %	Unsatisfactory %	satisfactory %	Unsatisfactory %	X2 (P. value) Pre / Post	X2 (P. value) Pre/follow up
Knowledge about definition, risk factors, signs and symptoms, VAP onset	40.0	60.0	100.0	0.0	83.3	16.7	35.17 ≤ 0.001**	13.945 0.002*
Preventive measures of VAP: Hand washing	70.0	30.0	100.0	0.0	96.2	3.8	16.490 0.026*	11.287 0.007*
Wearing gloves	80.0	20.0	100.0	0.0	92.5	3.8	1.140 0.432	3.876 0.087
Oral care	50.0	50.0	100.0	0.0	85.0	15.0	26.667 ≤ 0.001**	5.070 0.057
Ventilator equipment care	25.0	75.0	100.0	0.0	83.0	17.0	47.333 ≤ 0.001**	38.232 ≤ 0.001**
Endotracheal tube care	45.0	55.0	100.0	0.0	90.0	10.0	28.516 ≤ 0.001**	25.020 ≤ 0.001**
Endotracheal suction	43.3	56.7	100.0	0.0	94.4	5.6	30.140 ≤ 0.001**	25.223 ≤ 0.001**
Position of neonates	20.0	80.0	100.0	0.0	88.8	11.2	50.130 ≤ 0.001**	40.032 ≤ 0.001**

P1: comparison among pre & immediate post
P2: comparison among pre & follow up after 3 months
P3: comparison among immediate post & follow up after 3 months χ2 : Chi square

Table (4): Distribution of total nurses' practice about prevention of VAP pre / immediate post and follow up after 3 months of program implementation.

Variable	Pre (60)		Immediate post (60)		Follow up (54)		Test of significance		
	No	%	No	%	No	%	χ^2& P1	χ^2& P2	χ^2& P3
Total nurse practice in hand washing and wearing gloves									
Adequate	18	30.0	60	100.0	41	76.0	χ2=55.455 ≤ 0.001**	χ2=49 ≤ 0.001**	χ2=28.47 ≤ 0.001**
Inadequate	42	70.0	0	0.0	13	24.0			
Total nurse practice in endotracheal tube suction									
Adequate	24	40.0	60	100.0	48	88.8	χ2=30.490 ≤ 0.001**	χ2=29.673 ≤ 0.001**	**FET** .012*
Inadequate	36	60.0	0	0.0	6	11.2			
Total nurse practice in oral care									
Adequate	0	0.0	60	100.0	40	74.0	χ2=80 ≤ 0.001**	χ2=46.36 ≤ 0.001**	χ2=28.64 ≤ 0.001**
Inadequate	60	100	0	0.0	14	26.0			
Total nurse practice in axillary temperature									
Adequate	45	75.0	60	100.0	54	100.0	χ2=18.47 ≤ 0.001**	χ2=18.47 ≤ 0.001**	-
Inadequate	15	25.0	0	0.0	0	0.0			
Total nurse practice in chest physiotherapy									
Adequate	21	35.0	60	100	41	76.0	χ2=72.33 ≤ 0.001**	χ2=31.36 ≤ 0.001**	χ2=26.47 ≤ 0.001**
Inadequate	39	65.0	0	0.0	13	24.0			
Total nurse practice in position of neonates									
Adequate	12	20.0	48	80.0	27	50.0	χ2=70.98 ≤ 0.001**	χ2=20.47 ≤ 0.001**	**FET** .010*
Inadequate	48	80.0	12	20.0	27	50.0			

P1: comparison among pre & immediate post
P2: comparison among pre & follow up after 3 months
P3: comparison among immediate post & follow up after 3 months
FET: Fisher's Exact Test χ2 : Chi square

(*) Statistically significant at P< 0.05 (**) Highly statistical significance at P< 0.01.

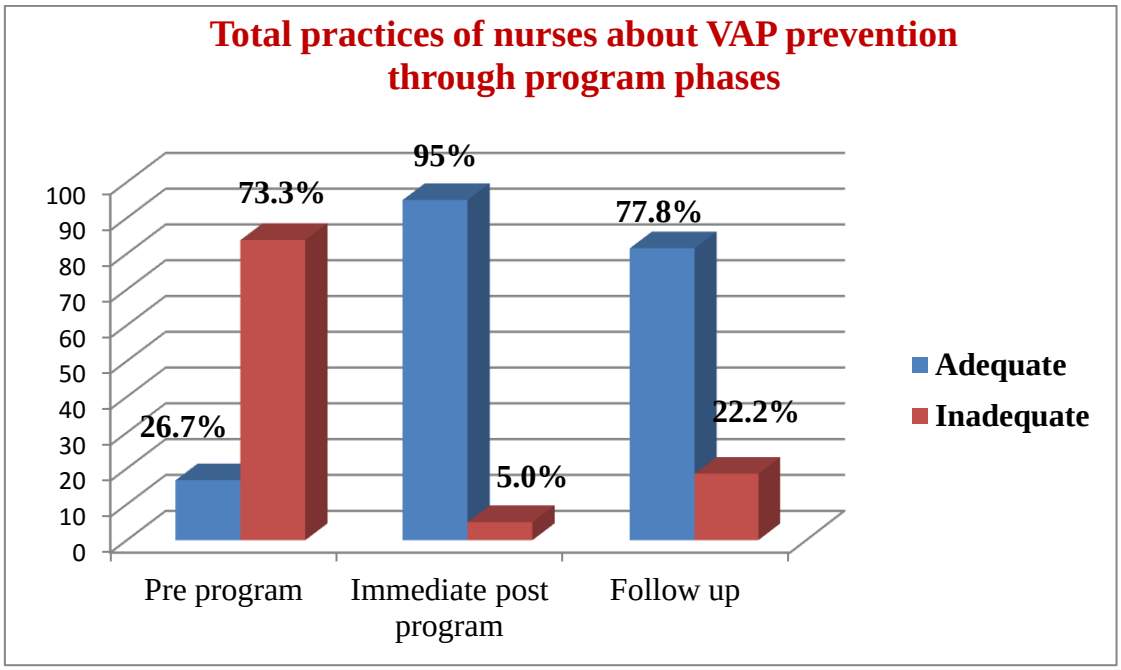

Figure (1): Percentage distribution of total nurses' practices about VAP prevention pre / immediate post and follow up after 3 months of program implementation.

Table (5): Nurses' total practice mean scores about VAP prevention

Practice scores	**Pre (60)**	**Immediate post(60)**	**Follow up (54)**	**Test of significance**		
				P1	**P2**	**P3**
Mean ± SD	30.04 ±12.40	63.3 ± 1.98	50.15 ± 4.7	t=45.95 P ≤ 0.001**	t=39.46 P ≤0.001**	t=22.58 P ≤ 0.05*

(*) Statistically significant at P< 0.05 (**) Highly statistical significance at P< 0.01.

Table (6): Correlation among nurse's practice & nurse's knowledge in different phases of program intervention among the nursing staff.

Nurses' total knowledge score	Nurses' total practice score		
	Pre program	**Immediate Post program**	**Follow- up**
Pre program	r = 0.289***** p = 0.04	r = -0.235 p = 0.111	r = 0.453 p = 0.930
Immediate Post program	r = 0.276***** p = 0.03	r = 0.794** p = 0.000	r = 0.542 p = 0.117
Follow- up	r = 0.290***** p = 0.04	r = 0.541*** *** p = 0. 000	r = 0.477 p = 0.286

r- pearson correlation coefficient
Significant level (p< 0.05) Highly significant level (p< 0.01)

DISCUSSION:

The second most frequent hospital-acquired infection in NICUs is ventilator associated pneumonia, which manifests 48 hours after receiving mechanical ventilator through an endotracheal tube or tracheostomy. Incidence of VAP varies among 1 and 63 incidents per 1000 ventilator days, reflecting the disease impact in each NICU. Ventilator associated pneumonia is a big problem in NICU since it has negative social and economic effects. Therefore, preventing VAP is a crucial issue that needs to be addressed (Sanders-Thompson, 2020).

The purpose of educational programs is to educate nurses practice delivering the right kind of care. Unqualified nurses have given the inadequate care of newborns receiving mechanical ventilation major attention. In addition, care giver must keep up with new information. So, in order to improve their knowledge and practice, they require these intervention programs that include both theoretical and practical training for nurses (Price & Reichert, 2017). So that, the present study aimed to evaluate effect of an educational program for nurses about prevention of ventilator associated pneumonia in neonatal intensive care unit.

Regarding the studied nurses' total knowledge, the present study illustrated that only forty percent of the nursing staff had a satisfactory total knowledge score regarding VAP and its prevention before program implementation. This result can be attributed to the

fact that only two fifths of the studied nurses received training courses about VAP prevention. It may be also due to hospitals and healthcare facilities place little emphasis on teaching VAP prevention. But, the percentage improved to become one hundred percent immediately after the program. This pointed the effectiveness of the educational program since contents of educational program were based on the identified needs and priorities of the nurses, the simplicity of the language and avoiding scientific sophisticated terms. In the follow-up phase, there was a slight decrease in the total knowledge of the nurses. This is normal issue because information is easy to forget, that's way nurses need continuing education and training

The current study was supported by Abou Zed and Mohamed (2019), who concluded that the majority of the study sample had unsatisfactory knowledge prior to the implementation of nursing standards. After the implementation of the nursing guidelines, compared with before the implementation of the nursing guidelines, the knowledge value of nurses was greatly improved, and the difference was statistically significant Also, these results were congruent with Sanders-Thompson (2020) who represented that the nurses had a high level of knowledge following teaching about VAP prevention compared to nurses' knowledge prior to teaching.

In the current present study findings, all nurses had satisfactory knowledge immediately after the program regarding definition & risk factors & signs and symptoms & types of VAP, hand washing & wearing gloves, oral care, ventilator care equipment, EET care, suction, and position of neonates. Furthermore, there were highly statistically significant variations between total knowledge scores before and after follow-up in almost all knowledge domains. The educational program's effect on nurses' understanding of VAP prevention in newborns was the cause of this improvement.

The result was in agreement with Amin, Samra, and Lawend (2021) who found that nurses' knowledge of the VAP care package significantly increased risk after the program and in subsequent phases related to the significance of VAP factors, signs and symptoms, neonatal positioning, hand hygiene, oral care, ventilation procedures, ETT aspiration, and extubation and weaning attempts. Also, these findings were in line with a study by Hussien, Ghrayeb, and Al-Khatib (2017), which discovered a considerable improvement in the mean knowledge scores for pre-training and post-training programs on VAP preventive packages.

Concerning the studied nurses' total practice, the current study revealed that only a few percent of the studied nurses had an adequate total practice score before program implementation compared to majority of them who had adequate practice in the immediate post program phase. Statistically significant differences were also found between total nurses' practice through program phases (pre, immediate post and follow up phase). This might be due to lack of guidance and the lack of role model can contribute to non-compliance with VAP prevention guidelines and lack of training courses which has been recognized by the three fifths of the nursing staff did not engaged in any training courses about VAP prevention. Post the application of the program implementation, this reflects the positive effect of implementing VAP prevention practices and nurses were excited to apply competent care with neonatal VAP.

The study results supported the findings from Dipanjali, Shivananda, and Yashoda (2021) showed that practice of the staff nurses before implementation of educational intervention was not satisfactory. However, after the administration of the educational intervention, the percentage of practice increased to be 74 %, as evidenced by statistically significant differences in the pre-test and post- test practice scores of the staff nurses. In similar study established by Aloush (2017), the study was conveyed in 10 hospitals in Jordan at NICUs and noticed that the nurses' knowledge and practice were improved post program implementation.

The study findings demonstrated that the mean nurse practice score for preventing neonatal VAP considerably increased after the training and declined throughout the follow-up. The lack of resources, insufficient continuous training, and a lack of documented VAP prevention strategies in the NICU may be to blame for the drop in practice among nurses.

The improvement in this study was similar to study conducted by John, Venkatesan, Satchi, and Thiagarajan (2017), which discovered that the mean value of nurse's practice with modified neonatal VAP preventive care bundle was to be high on the third day of the program in comparison with the first day and second day. This finding was in contrary to the finding of Gomes et al. (2020), who found that the adherence to some VAP care bundle measures was not different between groups of patients (with or without VAP) and showed low values of adherence.

When handling tracheal suction and devices, hand hygiene was practiced in accordance with WHO recommendations to prevent colonization of the mouth cavity. In addition, it was made to clean the hands before invasive operations. Sterile gloves were used only when handling ventilator (WHO, 2017)**.** Current findings showed that less than one third of the nursing staff had an adequate practice score regarding hand washing and gloving use before program compared to all nurses who had adequate practice immediately post program. The finding could be due to a reduction in the number of NICU nurses and work overload may be due to lack of compliance to washing hands & gloving, as well as a lack of resources (sinks, gloves, and soap). On the other hand, significant change were noted regarding nurses' hand washing practices immediately post program application and in the follow up phase.

In the same line, Mahfoz, El Sayed, and Ahmed (2022), who found that there were statistically significant differences related to nurses' practice about hand washing in the pre and post program implementation, which all the nurses completely done hand washing after implementing the instruction. This situation is identical to that described by Ismail and Zahran (2015), which reported that nurses realized the importance of hand washing as a VAP prevention intervention and saw notable changes in nurses' hand washing behaviors quickly after putting the program's instructions into effect.

According to chest physiotherapy practice, there were statistically significant differences between the nurses' practice of chest physiotherapy before program, immediately post program and follow up phase which nearly one third of the studied nurses had adequate practice before program. While after implementing the educational program, all the nurses had adequate practice and most of them had adequate practice in the follow up phase. This may be due to newborn infants are very small and neonatal nurses find difficulty to deal with the newborn and perform chest physiotherapy exactly. The finding was confirmed by Mahfoz et al. (2022) who reported that there were statistical significance variances among the nurses' practice of chest physiotherapy during pre and post-test of nursing care provided for children with mechanical ventilation.

In the light of the study findings, statistical significance difference was found between nurses' practice regarding oral care technique in all phases of program implementation, as none of the studied nurses had adequate oral care practice preprogram compared to all of

them had adequate oral care practice in immediate post program. This may be due to nurses are reluctant to provide oral care to intubated neonates because endotracheal tubes bounds access to their oral cavities and are afraid to dislocate the endotracheal tube. Another reason for not providing oral care is nurses' lack of knowledge of current evidence based practices. Additionally, absence of an oral assessment forms, an oral care protocol and the unavailability of oral care supplies and equipment can greatly affect the quality of oral care provided by the nurses.

This result matched with El bilgahy et al. (2016) who found that not all nurses paid attention to oral care for ventilated children before training program while significant changes were noted regarding nurses' hand washing practices shortly after program application and three months later.

Fever is an important vital sign that indicate the presence of newborn's disorders. Accurate temperature measurement is especially important in newborn infants due to likelihood of nosocomial infections as sepsis and ventilator associated pneumonia (Oguz, Yildiz, Varkal, & Hizli, 2018). Other various measures have been also used to detect fever such as axillary, tympanic and forehead methods due to their readily availability, no risk of perforation, non-invasive procedure, requiring little patient cooperation, feasibly and easy to use (Alayed et al., 2022). The present study explained that three quarters of the studied nurses had adequate practice score regarding axillary temperature. While, all of them had adequate practice score immediately post program and during follow up phase. This may be due to axillary temperature measurements practiced most frequently in NICU and is simple non invasive procedure, and also considered the most important indicator for infection.

The current study revealed that only one fifth of the nursing staff had adequate practice score before program implementation in relation neonate's position. On the other hand, nurses' practice regarding neonate's position was improved immediately post program implementation and in the follow up phase as majority of them had adequate practice score immediate post program. Also, statistical significance difference was found between nurses' practice regarding neonate's position in all phases of the program. These results were in harmony with Abou Zed and Mohammed (2019) whose results showed that there was an increase in mean value of neonate's position before training (5.33±2.06), immediate post training (11.44±0.83) with highly significant difference.

The current results showed that all of the nursing staff instilled saline during ETT suction to dissolve secretions prior to program implementation compared to all of them didn't perform saline instillation immediately post program. This might be due to long established poor practices about "instillation of saline solution to dissolve secretion" as older nurses teach the procedure to the newly experienced nurses. In addition, this result was attributed to lack of training, as more than half of the studied nurses didn't attend any courses about VAP prevention in the NICU, but educational program was effective enough to change these bad practices about saline instillation.

This was identical to the study by Elbilgahy et al. (2016), who demonstrated that all of the studied nurses introduced saline into endotracheal tube for dissolving secretions before training program, while none of them installed saline into EET post program and after 3 months of program. Also, congruent with Hooven and Polin (2017), who reported that ETT instillation of saline solution or distilled water was avoided.

Furthermore, this study elaborated that there was a statistical positive correlation ($P \leq 0.05$) among the nurses' knowledge score and the nurses' practice in pre, immediate post and follow up phase of program. This explanation is expected because good basic theoretical knowledge on VAP prevention essentially reflected adequate practices and knowledge is also still the first step towards implementing VAP prevention practices. Also, the finding confirmed the effectiveness of the educational program.

Finally, this finding was compatible with Akl et al. (2020) in Egypt and reported that there was a highly statistical significance relation among nurse's knowledge & practice compared to pre with post-application of VAP care bundle to prevent ventilator-associated pneumonia. In contrast, Kalyan et al. (2020), who found among Indian nurses that they possessed good to average knowledge scores on VAP. However, their practices were not associated with their knowledge scores and there were needed to implement new strategies to improve practicing VAP guidelines

CONCLUSION:

Based on the current findings, the study concluded that after the program was applied, overall scores for nurses' knowledge and general practice increased. Immediately following the program, there was a favorable relation between nurses' total knowledge and total practice scores on VAP prevention (P 0.05).

Recommendations:

The study recommended that an ongoing program of on-the-job training is a crucial component for continuous improvements of nurses' competence in preventing neonatal ventilator-associated pneumonia based on the current findings.

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تأثير برنامج تعليمى للممرضين للوقاية من الالتهاب الرئوى المصاحب للتنفس الاصطناعى فى وحدات العناية المركزة لحديثى الولادة

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الخلاصة

المقدمة: يعتبر الالتهاب الرئوى المصاحب للتنفس الاصطناعى ثانى أنواع العدوى المكتسبة داخل وحدات العناية المركزة لحديثى الولادة. **وهدف الدراسة**: تقييم تأثيربرنامج تعليمى للممرضين للوقاية من الالتهاب الرئوى المصاحب للتنفس الاصطناعى فى وحدات العناية المركزة لحديثى الولادة. **التصميم:** استخدام بحث شبه تجريبى لمجموعة واحدة. **مكان الدراسة**: وحدات العناية المركزة لحديثى الولادة في مستشفى السلام ومستشفى النسا التخصصى و مستشفى الحياة التابعة للتأمين الصحي الشامل فى محافظة بورسعيد. **عينة البحث**: تضمنت الدراسة ٦٠ ممرض وممرضة ، بالاضافة الى ٤٠ طفل حديثى الولادة تحت جهاز التنفس الاصطناعى لمدة أكثر من ٤٨ ساعة. **أدوات جمع البيانات:** استمارة استبيان لتقييم معلومات الممرضين، و استمارة ملاحظة لتقييم ممارسات الممرضين للوقاية من الالتهاب الرئوى المصاحب للتنفس الاصطناعى. **النتائج**:خمسي الممرضين فقط محل الدراسة كانوا لديهم درجة اجمالية مرضية من المعلومات فى مرحلة ما قبل البرنامج التعليمى وارتفعت الي ١٠٠% فى مرحلة ما بعد البرنامج و انخفضت قليلا فى مرحلة المتابعة، كما كان هناك تحسن ملحوظ فى اجمالى ممارسات الممرضين للوقاية من الالتهاب الرئوى المصاحب للتنفس الاصطناعى حيث حصل ربع الممرضين تقريبا على درجة اجمالية ملائمة من الممارسات فى مرحلة ما قبل البرنامج مقارنة بأغلبية الممرضين بعد تنفيذ البرنامج وفى مرحلة المتابعة. **الخلاصة**: كان لتنفيذ البرنامج التعليمى أثر فعال فى تحسين معلومات وممارسات الممرضين عن الالتهاب الرئوى المصاحب للتنفس الاصطناعى وطرق الوقاية منه. **التوصيات**: تنفيذ برامج تدريبية دورية للتطوير المستمر فى أداء الممرضين للوقاية من الالتهاب الرئوى المصاحب للتنفس الاصطناعى في وحدات العناية المركزة لحديثى الولادة .

الكلمات المرشدة: البرنامج التعليمى،الممرضين ، الالتهاب الرئوى المصاحب للتنفس الاصطناعى، الوقاية، وحدات العناية المركزة لحديثى الولادة.