
EFFECT OF IMPLEMENTING TRAINING PROGRAM FOR NURSES' ON PREVENTION OF PEDIATRIC VENTILATOR-ASSOCIATED PNEUMONIA

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Abstract:

Ventilator-associated pneumonia (VAP) is **defined** as nosocomial pneumonia developing 48 hour or more after initiation of mechanical ventilation. It is the second most common nosocomial infection in pediatric intensive care units (PICUs), accounting for 20% of all nosocomial infections in the pediatric population. The prevention of VAP is a major focus of many recent safety initiatives and focuses on modification of risk factors. **The main aim of the study** was to evaluate the effect of implementing training program for nurses on prevention of pediatric ventilator-associated pneumonia. A quasi-experimental research design was used in the study. The study was carried on Medical Intensive Care Unit at Mansoura University Children's Hospital. The study involved a convenient sample of 40 critical care nurses regardless of their age, education and years of experience. The study was conducted in Pediatric Intensive Care Unit at Mansoura University Children hospital. Two **tools** were used for data collection including questionnaire to assess the nurses' knowledge about Pediatric ventilator-associated pneumonia and its prevention and pediatric ventilator-associated pneumonia prevention observation checklist. **The results of** the present study indicated that, the nurses' knowledge and practices of ventilator-associated pneumonia and its prevention in PICU was improved after the implementation of the training program either immediately or 3 months later than before its implementation. There is also a need for periodic refreshing in-service training program should be provided to nurses' in PICU in order to improve their knowledge and practices regarding VAP prevention.

Key words: ventilator-associated pneumonia, pediatric intensive care unit (PICU), pediatric and evidence-based nursing for VAP prevention.

Introduction:

Ventilator-associated pneumonia is defined as a hospital-acquired pneumonia that develops in patients who have been treated with mechanical ventilation for 48 hours or longer; who had no signs or symptoms of lower respiratory infection before they were intubated and treatment with mechanical ventilation began⁽¹⁾. It is the second most common nosocomial infection in the pediatric intensive care units (PICUs), accounting for 20% of all nosocomial infections in the pediatric

population and has a rate of 2.9 – 21.6 per 1000 ventilator days and it is the second most common after bloodstream infection for the pediatric population⁽²⁾. Ventilator-associated pneumonia adversely affects pediatric patients' outcomes and results in substantial morbidity and mortality, which in turn prolongs hospital length of stay (LOS) and increases medical cost⁽³⁾.

According to the time of onset and related pathogens, VAP is divided into; early and late-onset VAP. Early-onset

VAP occurs during the first 4 days of intubation and is often caused by Streptococcus pneumonia, Staphylococcus aureus, Escherichia coli, Klebsiella pneumonia, Haemophilus influenzae, or Moraxella catarrhalis⁽⁴⁾. While, late-onset VAP occurs later than 4 days after admission and is usually caused by Pseudomonas aeruginosa, Acinetobacter species, Enterobacter species and methicillin-resistant Streptococcus aureus (MRSA)⁽⁵⁾.

Prevention of VAP focuses on avoiding micro-aspiration of subglottic secretions, preventing oropharyngeal colonization with exogenous pathogens and preventing contamination of ventilator equipment. Evidence-based guidelines for the prevention of VAP have been developed and have been promoted by programs and campaigns of authoritative organizations. Nevertheless, non adherence to these guidelines has been reported⁽⁴⁾. Prevention of VAP is much more cost effective than treatment and several guidelines have recommended measures to decrease the incidence of VAP. The most important measures are continuous medical education, continuous suctioning of subglottic secretions, semi-recumbent position, oral hygiene with chlorhexidine and selective digestive decontamination^(6,7).

Interventions to prevent VAP should begin at the time of intubation and should be continued until extubation. Nurses need to understand the pathophysiology of VAP, risk factors and strategies that may prevent VAP. Use of study education modules on nursing care of patients at risk of VAP and use of ventilator pathways or protocols with pre-printed order sets and monitoring tools can lead to improved outcome for patients⁽⁸⁾. Pediatric Intensive Care nurses play an important role in the prevention of VAP. Being at child's bedside 24 hours daily enables them to put evidence based guidelines into practice. To

adhere to such practices, nurses need to be aware of necessary updated knowledge and practice on current research evidence⁽⁹⁾.

Generally, understanding the importance of recommended practices increases the likelihood of adherence and overcomes barriers such as lack of knowledge. If the nurse does not have enough knowledge on measures proven to decrease VAP rates she may not have the necessary confidence to take action and make decisions regarding such practices. Therefore, empowering nurses with knowledge and skills is very important to increase their decision making ability in their workplace and enables them to provide the best standard of care for sick children⁽¹⁰⁾.

Nurses' lack of knowledge may be a barrier to adhere to evidenced based guidelines for preventing ventilator-associated pneumonia and translating evidence based findings into consistent delivered care at the bedside remains a challenge. However, many studies have shown that, educational interventions staff development programs and multi-module programs led to a substantial reduction of ventilator associated pneumonia⁽⁸⁾.

Aim of the study:

The aim of the study was to evaluate the effect of implementing training program for nurses on prevention of pediatric ventilator-associated pneumonia.

Research hypothesis:

Nurses will have better knowledge & practice about prevention of pediatric ventilator-associated pneumonia after implementation of training program.

Materials and Methods

I- Materials:

Design:

A quasi-experimental research design was utilized in this study.

Setting:

This study was carried out at the Pediatric Medical Intensive Care Unit at

Mansoura University Children's Hospital (MUCH).

Subjects:

The subjects of the study included all nurses (40) working at the above mentioned study setting and were providing care for children receiving mechanical ventilation regardless of their age and qualification or years of experience.

Tools:

Tool 1: questionnaire to assess the nurses' knowledge about Pediatric ventilator-associated pneumonia and its prevention, 2010; this tool was developed by the researcher in the light of **Biancofiore, (2007); Labeau, (2007) and Gomes, (2010)** ^(11, 12, 13); this tool was used to assess the nurses' knowledge about pediatric ventilator-associated pneumonia and its prevention in PICU. Questions were in the form of multiple choice questions. This tool was used pre and post program implementation. Answers were checked with a model answer. The tool was tested for its content validity and reliability by a jury before its implementation. It included two parts as the following:

Part I: Socio-demographic data of nurses including: age, level of education, years of experience and previous attendance of training program about prevention of pediatric ventilator-associated pneumonia.

Part II: It included 17 questions about pediatric ventilator-associated pneumonia and its prevention in PICU. 3 questions covered definition, risk factors, signs and symptoms and 14 questions covered nursing intervention for prevention of VAP, 4 questions about mechanical ventilator equipment care, 2 questions about endotracheal tube care, 2 questions about suctioning, 3 question about patients positioning and 3 questions about nasogastric feeding. The scoring system for the questionnaire was developed; the

correct answer was given the score (1) the wrong answer was given score (zero). Based upon the scoring system utilized, the knowledge was considered good if the percent score was 70% and more, average knowledge from 65 % -< 70% and poor if the percent score was < 65%.

Tool II: Pediatric ventilator-associated pneumonia prevention observation Checklist.

This tool was developed by the researcher in the light of **CDC, (2003); World Health Organization, (2009); Institute for Clinical Systems Improvement, (2011) and Bowden & Greenberg, (2012)** ^(14, 15, 16, and 17). The observation checklists were used to assess and evaluate the pediatric nurses' practice about prevention of pediatric ventilator-associated pneumonia in PICU. This tool was used to assess the actual nurses' practice of hand washing, mouth care, suctioning technique & nasogastric feeding. It was tested for its content validity and reliability. The scoring system for the observation checklist was developed; each correct step of the procedure scored on the bases of "Done" scored (1), or "Not done", scored (0). The level of practice was considered satisfactory practice if the percent score was 70% and more, partially satisfactory practice from 65 % -< 70% and unsatisfactory practice if the percent score was < 65%.

The training program for prevention of pediatric ventilator-associated pneumonia

The investigator designed the training program based on the actual need assessment of the studied nurses through reviewing the related literature. The training program was containing the theoretical and practical skills related to VAP and its prevention. The training program aims to improve the nurses' knowledge and practices about prevention of pediatric ventilator-associated

pneumonia in Pediatric Intensive Care Unit (PICU).

Nurses were divided into small groups; (8 in each group). The program was given in four sessions; two theoretical and two practical sessions (around 45-60 minutes for each). The program was given over a period of 8 weeks. Various teaching methods were used in the form of lectures, group discussion, demonstration and re-demonstrations. Various teaching media were used, such as colored posters, power point, video and hand out. The program was carried out in the Pediatric Intensive Care Nursing Unit.

Nurses' knowledge and practice were evaluated three times pre / immediate post and three months later after implementation of the training program using the previously mentioned study tools.

Method:

An official permission was obtained by submission of an official letter to the director of the hospital and the head of Pediatric medical Intensive Care Unit to conduct the study after explaining the aim of the study. The tools were developed by the researcher, after reviewing of the related literature.

The developed tool was submitted to a jury of five experts in the pediatric nursing field for its content validity. Based on their comments; necessary modifications were done. The reliability of the tool was done by measuring the internal consistency of its items using the Alpha Cronbach's coefficient. The alpha reliability for tool 1 was (0 .676) and tool 2 was (0.976).

Data collection of this study was carried out over six months in the period from the beginning of October 2013 to April 2014. A pilot study was carried out on 4 nurses (10% of the total sample size, to ascertain the feasibility, applicability and clarity of the tool and some modifications were made consequently.

Ethical Considerations

Ethical approval was obtained from Research Ethics Committee at the Faculty of Nursing - Mansoura University. Informed written consent was obtained from every nurse after explaining the aim of the study. Confidentiality of data and anonymity as well as nurses' right to withdraw from the study at any time was ascertained.

Data Analysis

The collected data were coded and entered in a data based file using the excel program for windows. Frequency analysis and manual revision were used to detect any error. After complete entry, data were transformed to the statistical package of social sciences (SPSS) version 16.0 by which the analysis was conducted applying frequency tables with percentages. Data were revised, coded and analyzed. All tests were performed at a level of significance of 5% ($P < 0.05$).

Results:

It was observed from table (1) that, more than half of nurses (57.5%) were in the age group from 30 to less than 35 years while, the minority of them (10.0%) was in the age group from 35 to less than 40 years. Regarding nurses' educational level, the current study revealed that, less than two third of nurses (60%) were Bachelor degree of nursing while, more than one third (35%) of them were diploma.

Concerning the years of experience, the current study showed that, two fifth of nurses (40%) were had 5 to less than 10 years of experience while, approximately one quarter (22.5%) of them had less than 5 years experience. In addition, less than two third (60%) of studied nurses' didn't receive training program about infection control.

Table (2), illustrates level of nurses' knowledge about VAP and its prevention. It is clear from this table that, only 7.5% of the nurses had "good" knowledge score before the program implementation.

While, immediately after the program, the percentage improved to 100% and after 3 months declined to 92.5%. Statistical significant differences were found between nurses' knowledge before and immediately after the program and between before and after 3 months.

Mean scores of nurses' Practices about prevention of VAP were illustrated in **table (3)**. It is revealed from this table that, the mean score of nurse's practices before the program was 33.62. But, immediately after the program implementation the mean was improved to 73.45. Also, three months later, the nurses' mean practices score was 60.85. The difference was statistically significant between pre, post & after 3 months.

Level of nurses' practice about VAP prevention was represented in **table (4)**. It is revealed from the table that, before the program implementation, none of the nurses had "satisfactory" practices score. But immediately after the program and after 3 months, the percentage increased to (100%). Statistical significant differences were found between nurses' knowledge before and immediately after the program and between before and after 3 months.

Table (5); showed that there was an extremely statistical significant difference between the degree of the studied nurses' total knowledge score and their total practice score.

Table (1); Socio-demographic characteristics of the nurses in PICU

Characteristics	NO (n=40)	%
Age in years		
20 < 25	5	12.5
25 < 30	8	20.0
30 < 35	23	57.5
35 ≥ 40	4	10.0
Educational level		
Diploma	14	35.0
Technical institute of nursing	2	5.0
Bachelor degree of nursing	24	60.0
Years of experience		
< 5	9	22.5
From 5 to less than 10	16	40.0
From 10 to less than 15	6	15.0
From 15 to less than 20	7	17.5
20 & more	2	5.0
Attending of training programs		
Yes	16	40.0
No	24	60.0

Table (2); level of nurse's total knowledge about pediatric VAP and its prevention

Item	pre		post		After 3m		P1	P2	P3
	No	%	No	%	No	%			
Good knowledge	3	7.5	40	100	37	92.5	$\chi^2=68.84$ $\leq 0.001^{**}$	$\chi^2=62.9$ $\leq 0.001^{**}$	FET 0.241
Average knowledge	3	7.5	0	0	3	7.5			
Poor knowledge	34	85.0	0	0	0	0.0			

P1: comparison between pre & post

P2: comparison between pre & after3m

P3: comparison between post & after3m

t: Paired t test used

(*) statistically significant at $p < 0.05$ (**) extremely statistical significance at $p < 0.001$

Table (3); Mean scores of nurses' practice about prevention of pediatric VAP

Item	Maximum score	Pre Mean \pm SD	Post Mean \pm SD	After 3m Mean \pm SD	P1	P2	P3
Hand washing	13	6.125 \pm .965	12.20 \pm .791	9.35 \pm 1.144	t=30.778 P= \leq 0.001**	t=18.585 P= \leq 0.001**	t=13.951 P= \leq 0.001**
Nasogastric feeding	22	13.375 \pm 1.408	21.75 \pm .438	19.85 \pm .975	t=31.922 P= \leq 0.001**	t=31.019 P= \leq 0.001**	t=10.064 P= \leq 0.001**
Tracheal suctioning	24	8.55 \pm 2.194	22.375 \pm .774	20.50 \pm 1.585	t=35.264 P= \leq 0.001**	t=30.861 P= \leq 0.001**	t=7.467 P= \leq 0.001**
Oral care	17	5.575 \pm 1.599	16.875 \pm .334	11.875 \pm 1.522	t=40.675 P= \leq 0.001**	t=22.310 P= \leq 0.001**	t=18.661 P= \leq 0.001**
Total practice	76	33.62 \pm 4.71	73.45 \pm 1.5	60.85 \pm 2.96	t=45.95 P= \leq 0.001**	t=44.46 P= \leq 0.001**	t=22.58 P= \leq 0.001**

Table (4); level of nurses' practice about VAP prevention

Item	Pre		Post		After 3m		P1	P2
	No	%	No	%	No	%		
Satisfactory practice	0	0.0	40	100	40	100	$\chi^2=80$ $\leq 0.001^{**}$	$\chi^2=80$ $\leq 0.001^{**}$
Partial satisfactory practice	0	0.0	0	0.0	0	0.0		
Unsatisfactory practice	40	100	0	0.0	0	0.0		

Table (5); Correlation between total nurses' knowledge scores about pediatric VAP and its prevention and total practice scores

Total knowledge score	r	p
Total practice score	0.861	$\leq 0.001^{**}$
Total knowledge and practice scores		

Discussion:

Ventilator-associated pneumonia is defined as pneumonia that occurs in 48 hour or more after endotracheal intubation or tracheostomy, caused by infectious agents not present or incubating at the time of mechanical ventilation was started⁽¹⁸⁾. Prevention and control of healthcare-associated infection is one of the greatest challenges confronting health care providers around the world⁽¹⁹⁾.

Education and training of all hospital staff is essential to increase their awareness about the importance of infection control⁽²⁰⁾. The findings of the current study showed that, approximately two thirds of the studied nurses did not receive training program about infection control as in (Table 1). This result was in an agreement with **Rosenthal et al., (2003)**; **Ebrahim, (2012)** & **Ismail, (2013)**^(21, 22 &23) who cited that, the majority of nurses did not attended any training program about infection control or in VAP prevention.

Knowledge is considered the backbone of the prevention of nosocomial infections especially VAP. The goal of continuous education in nursing is to enhance knowledge to promote the quality of health care delivery to the children^(24 &25). The present study findings revealed that, all pediatric critical care nurses with different educational levels, irrespective of their years of experience or age had unexpectedly poor knowledge scores about VAP and its preventive measure before program implementation as presented in **Table (2)**. It has been suggested that, the majority of the nurses in this part acquire their knowledge of taking care of critically ill pediatric patients from their basic educational programs, or from hospital policies and procedures.

The present study finding is consistent with **Blot et al., (2007)**; **Alhirish, (2010)**; **Gomes (2010)** & **Ali,**

(2013)^(26, 27, 13 &28) who conducted a study about knowledge among intensive care nurses on Evidence-based guidelines for the prevention of ventilator-associated pneumonia and their overall knowledge results were poor. These results may be due to lack of training courses, lack of equipment and work overload which in turn affect nurses' knowledge and practice.

Educational programs are important for refreshing and updating nurses' information. They may also play a role in retaining knowledge. It has been reported that, knowledge retention generally falls to 75–89% of its original level after a relatively short 2–3 weeks' time⁽¹⁰⁾. In the current study, the interval for testing knowledge after program application was three months, where the 2nd post-test was conducted three months after the first one. So, the overall positive change in the nurses' knowledge about VAP preventive measures after implementing the educational program reflected that education can bring about changes in their level of knowledge (**Table 2**). These findings are consistent with **Meherali et al., (2011)**⁽²⁹⁾; who demonstrated that, a five hour teaching module significantly enhanced nurses' knowledge towards evidence based guidelines for the prevention of VAP.

Unfortunately, in the current study, nurses did not pay attention to many steps of hand washing before program application as clarified in (**Table 3**). Similarly, **Ricart et al., (2003)** and **Tablan et al., (2004)**^(30 &31) reported that, nurses knew the importance of hand washing as VAP preventive measures yet they did not apply it. The finding of the current study may be due to absence of supervision as well as lack of role model may contribute to lack of compliance to hand washing and lack of training program which was documented by the fact that, the high percentage of the studied nurses did not

receive training about infection control. On the other hand, significant changes were noted regarding nurses' hand washing practices, shortly after program application and three months later. This could be attributed to the effect of program application. In addition, the presence of hand washing technique poster hanged on the PICU wall acts as a reminder for them. This is in harmony with **Diaz, (2010)** who emphasized that, hand washing before and after patient care, is considered one of the basic elements in prevention of VAP.

Also, in **Table (2)**, the current study revealed unsatisfactory nursing practices regarding prevention of VAP and enteral feeding (EF) management in the intended PICUs. The result of the current study was in agreement with **Seliman et al., (2011)**⁽³²⁾ who reported in his study that, nursing practices regarding prevention of aspiration and enteral feeding was unsatisfactory. This may be due to shortage of nursing staff to provide high quality nursing care for critically ill pediatric patients. In addition, the nursing practice was based primarily on individual past experience and tradition, with senior nurses teaching procedures to the junior nurses. Evidence-based nursing practice was not the standard for care. Therefore, the unsatisfactory EF practices predispose the patients to numerous complications.

Observation of endo-tracheal suction (ETS) revealed that, nurses didn't comply with the guidelines when suctioning as they neglected applied few items from this procedure related to hyper oxygenation before and after suctioning, assessment of child need for suctioning and assessment of cardiopulmonary status during and after suctioning. These findings are supported by **Kelleher & Andrews, (2008)**⁽³³⁾ who reported in his study that, the nurses varied in their ETS practices; did not adhere to best practice suctioning recommendations; and consequently

provided lower-quality ETS than expected. Significant discrepancies were observed in the nurses' respiratory assessment techniques, hyper oxygenation and infection control practices, patient reassurance and the level of negative pressure used to clear secretions. In addition, in the current study, nurses' practice regarding tracheal suction was enhanced immediately post program implementation and three months later. This result was in harmony with **Chau et al., (2007)**⁽³⁴⁾ who reported that, nurses demonstrated a good endotracheal suctioning technique with 91% scoring when they performed the skills in accord with the best practice guideline.

Statistical significance difference was found between nurses' practice regarding oral care technique and phases of the present study, not all nurses paid attention to oral care for ventilated children as in **(Table 3)**. Also, this could be interpreted in the light of the fact that, nurses may be hesitant to provide oral care or use toothbrush for intubated infants and children because endotracheal tubes may limit access to their oral cavities. They may also be afraid of dislodging the endotracheal tube. Another reason behind not using toothbrushes could be nurses' lack of knowledge regarding up-to date research findings. In addition, absence of oral assessment sheet, oral care protocol and the unavailability of supplies and equipment for oral care can greatly affect the quality of oral hygiene given by the nurses. These results are in harmony with **Soh et al., (2012)**⁽³⁵⁾ who studied the oral care practice for ventilated children in intensive care units. He indicated the need for standardized oral care protocols in ICUs to improve quality of oral care. Also, **Berry & Davidson, (2006)**⁽³⁶⁾ reported that, the provision of effective oral care is

an important strategy in reducing nosocomial pneumonia.

It was concluded by **Chan & Hui-Ling, (2012)** and **Ganz et al., (2009)**^(37 &38) that, most nurses believed that good oral hygiene is important for patients on mechanical ventilator (MV). However, they found that performing oral hygiene to be an unpleasant task. There was a lack of standard practice among nurses in performing oral hygiene. Practices varied with regard to the frequency, methods, and requisites used for oral care.

Training activities and evidence-based protocols aimed to improve PICU nurses' quality of care and narrow the gap between scientific knowledge and actual performance (**DelosReyes et al., 2007 & Fahimi et al., 2010**)^(39 &40). This was apparent in (**Tables 4 & 5**) where improvement of nurses' practice and adherence to VAP preventive measures were recognized. These results was in harmony with **Gatell, (2012)**⁽⁴¹⁾ whose results showed that, implementation of training program improved nurses' knowledge and clinical practice regarding VAP preventive strategies. This may clarify that, knowledge of recommended guidelines necessarily reflect appropriate practice and still it remains the first step toward the implementation of evidence-based guidelines for the prevention of VAP.

Conclusion:

Based on the findings of the current study, it was concluded that nurses' knowledge and practices of ventilator-associated pneumonia and its prevention in PICU was improved after the implementation of the training program either immediately or 3 months later than before its implementation.

Recommendations:

1. Periodic refreshing in-service training program should be provided to nurses' in PICU in order to improve their

knowledge and practices regarding VAP prevention.

2. Strict supervision of nurses' practices of infection control precautions in the unit is mandatory.
3. Hospital policy should include guidelines for the application of VAP prevention protocols in PICU.

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