Effect of Teaching Evidence Based Guidelines on Nurses' Knowledge and Performance to Prevent Ventilator-Associated Pneumonia among Children

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ABSTRACT

Ventilator-associated pneumonias (VAP) have been estimated to be the second most common nosocomial infections among children treated in intensive care units. Nurses have the most critical role in implementing most of the VAP preventive measures. **The aim of the study was** to assess the effect of teaching evidence based guidelines on nurses' knowledge and performance to prevent ventilator-associated pneumonia among children. **Quasi-experimental research design** was used in this study. Convenient sample used in this study (forty nurses) at pediatric intensive care units**.** Two standard tools were used to collect the essential data. **The main results were** the majority of the nurses (87.5%) in the pre-test had unsatisfactory knowledge. The nurses' scores of knowledge were improved in the post-test after applying the guidelines and main self reported barriers were lack of knowledge, lack of skills and lack of resources. There is a strong positive correlation between degree of knowledge and degree of application (r= 0.62). **The study concluded** that the unsatisfactory knowledge of nurses was a barrier to be well applying the evidence based guidelines. Highly statistical significant differences were found between the nurses' knowledge in the pre-post test (P-value <0.001). **The study recommended** farther educational, training program and workshop to improve nurses' level of knowledge and improve the nurses' performance as well regarding the preventive measures of VAP among children.

Keywords: Pediatric, Intensive Care Units, Nurses, Evidence based, Guidelines, Knowledge, Adherence, Barriers, Ventilator-associated pneumonia, prevention.

INTRODUCTION

Ventilation-associated pneumonia is defined as the pneumonia developed 48 to 72 hours after intubation **(Toress et al., 2010)**. Also **Centers for Disease Control and Prevention (CDC), (2012)** defined ventilation-associated pneumonia 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.

Ventilator-associated pneumonias have been estimated to be the second most common nosocomial infections among children treated in intensive care units. They occur in mechanically ventilated patients through intubation tube or tracheostomy, the inflammation usually involving the lung parenchyma. The ventilator-associated pneumonia is associated with a longer antibiotic treatment, greater duration of mechanical

ventilation (MV) and higher mortality rates in children. The condition is also associated with a higher cost of the treatment **(Yankov and Shmilev, 2012).**

Ventilation-associated pneumonia (VAP) develops when bacteria colonize the pulmonary parenchyma or lower respiratory tract of a patient receiving mechanical ventilation. Bacterial colonization of the normally sterile lower respiratory tract usually is due to aspiration of secretions, colonization of the aerodigestive tract, or the use of contaminated equipment **(Coffin et al., 2008).** Mechanical ventilation is associated with some complications mainly including ventilation-associated pneumonia (VAP), barotrauma, pneumothorax, pneumomediastinum, decreased cardiac output, nonoccurrence between the device and the patient's breathing and pulmonary emboli **(Villar et al., 2011).**

According to the **Centers for Disease Control and Prevention (CDC), (2012)** increased body temperature; leukopenia; new onset of purulent sputum; apnea; tachypnea; nasal flaring with retraction of the chest wall or grunting; wheezing, rales, or rhonchi; and cough indicate ventilation-associated pneumonia in a young infant or child.

Nurses have the most critical role in implementing most of the ventilation-associated pneumonia preventive measures, thus their knowledge about the subject is of great importance. There is no doubt that in order to improve the cares and implementing the standards, the first step is to assess the current situation to pursue evidence-based strategies for improving the practice**.** In addition, there is little data on the level of guidelines application and the compliance of the nurses with them **(Ricart et al., 2003).** So, this study was designed to assess the nurses' knowledge, application, and barriers toward evidence based guidelines for prevention of ventilator-associated pneumonia in children and to assess the effect of teaching these guidelines on their knowledge.

Significance of the study:

Ventilator-associated pneumonia (VAP) is the second most common hospital-acquired infection in pediatric intensive care units. It is linked to increased morbidity, mortality, and lengths of stay in the hospital and intensive care unit, adding tremendously to health care costs **(Cooper and Haut, 2013).**

In Eygypt, a study conducted by **Azab et al., (2015)** in the NICU of Children Hospital of Zagazig University from January 2013- March 2014 stated that, of 143 mechanically ventilated neonates, 73 patients developed VAP (51 %) throughout the study period (2500 mechanical ventilation days).

Aim of the study:

The aim of the study was to assess the effect of teaching evidence based guidelines on nurses' knowledge and performance to prevent ventilator-associated pneumonia among Children through;

- Assessing the nurses' level of knowledge and performance regarding the preventive measures of VAP among children.
- Assessing the barriers that hinder the nurses awareness about evidence based guidelines that related to prevention of VAP among children
- Implement and evaluate the effect of evidence based guidelines on nurses' knowledge and performance.

Subjects and Methods:

Research design:

The current research design was a quasi-experimental research design.

Hypothesis:

Nurses' level of knowledge and performance will be improved after implementation of the evidence based guidelines.

Setting:

The study was conducted at two pediatric intensive care units at Al-Helal Hospital and Sohag University Hospital, in Sohag City. The data was collected on October 2015.

Subjects:

Convenient sample used in this study, all nurses at the pediatric intensive care unit- Sohag University Hospital (28 nurses) and all nurses at the pediatric intensive care unit- Al-Helal Hospital (12 nurses) involved.

Tools for data collection: Two tools were used to collect the necessary data.

Tool 1: Structured interviewing questionnaire developed based on review of the related literature, it included two parts:

Part (1): Included 11 questions about the nurses' demographic characteristics and their experiences (developed by the researcher) as gender, age, level of education, years of experience at the pediatric intensive care unit, whether nurses hold a special degree in emergency and intensive care or any workshop or training related to intensive care nursing or prevention of ventilator-associated pneumonia.

Part (2): Nurses' knowledge about the evidence based guidelines for prevention of ventilator-associated pneumonia tool by **Labeau et al., (2007),** included 10 multiple-choice questions were used to assess the nurses' knowledge; each question contained one correct answer, 2 wrong answers and one option as "don't know".

Tool 2: Application of VAP prevention strategies questionnaire by **Biancofiore et al., (2007)**, included 21 questions of non pharmacologic prevention strategies (yes or no questions) were used to assess the nurses' degree of application by observation checklist regarding the preventive measures of VAP among children.

- The two tools were translated into the Arabic language by the researchers.

Scoring system:

-For each item of the knowledge tool (10 questions), the percentage of correct answers was determined as: One point being given for the right answer and zero for the wrong answer. The degree of knowledge was considered satisfactory if the percent score was 65% or more and unsatisfactory if less than 65%.

-For each item of the application tool (21 questions), the percentage was determined as: One point being given for the yes answers and zero for the no answers. The degree of application was considered applying if the percent score was 65% or more and not applying if less than 65%.

Pilot study:

A pilot study was carried out before starting of data collection on (10 %) of the participants (4 nurses) for the purpose to test the clarity, completeness, and to

determine the time involvement. The pilot study was added to the studied participants.

-The tools were tested for its validity by 5 experts (in pediatric and critical field).

-Reliability analysis, to calculate Cronbach's alpha coefficient, was also carried out using SPSS-20.0.

Tools	Reliability and Validity Statistics		
	No of Items	Cronbach's Alpha (reliability)	Validity
Knowledge tool	10	0.84	0.92
Application tool	21	0.79	0.89

Field work:

- Data collection was done by the researchers during one month on October 2015. It was done during the routine work of the hospital. The researchers interviewed the participated nurses individually to obtain the necessary information. The researchers firstly introduced them-self to them and gave them a complete back ground about the study. The researchers gave nurses the tools which translated into Arabic language by the researchers and stay with them to clarify any question vague to them. The tools required about 20-30 minutes for filling it; all nurses (40 nurses) in the pediatric intensive care units were included in the study. Each hospital was visited nine times within one month (three times in each shift), at the morning, at afternoon and at night.

Methods for data collection:

- An official permission was obtained from the director of the pediatric intensive care unit- Sohag University Hospital and Al-Halal Hospital to carry out the study after explaining the aim of the study. Explanation of the aim and methodology of the study was done to them by the researchers.

- After receiving permission from the nurses, the nurses were interviewed face to face with the researchers.

-To identify the base line of pediatric intensive care units nurses' level of knowledge towards evidence based guidelines for the prevention of ventilator-associated pneumonia a pre-test was conducted to all participants.

- Before and after teaching guidelines the researchers were visited the nurses at pediatric intensive care in each shift (at the morning, at afternoon and at night) and the study passed through three stages, each stage took about one week in which each hospital was visited three days (one day for each shift) as the following:

Stage-I: Throughout this stage the researchers collected the nurses' demographic data and assessing their level of knowledge and performance regarding the preventive measures of VAP among children (this visit took about 4 hours/day).

- The researchers distributed the tools by hand to all nurses; participants were given 20-30 minutes to complete the tool 1. Tool 2 was assessed through observation checklist.

-The nurses were asked to mark which interventions listed on the tools were recommended in the evidence based guidelines for prevention of ventilator-associated pneumonia.

Stage-II: Throughout this stage the researchers teaching and discussed with nurses the content of guidelines (this visit took about two hours/day). The contents of the guidelines were covered through one session in each shift because it was

difficult to collect all nurses of intensive care unit at the same time.

Stage-III: was to assess the nurses' level of knowledge after teaching the guidelines and assessing the barriers that hinder the nurses' awareness about evidence based guidelines that related to prevention of VAP among children (this visit took about two hours/day). Post-test conducted immediately (within three days) after teaching the guidelines. All the 40 nurses attempted the post-test in Stage-III.

Objective of the guidelines: The guidelines will improve the nurses' knowledge and performance toward prevention of ventilator-associated pneumonia among children.

The content of the guidelines:

According to **American Association of Critical-Care Nurses (AACN), (2008); The Canadian Critical Care Trials group (Muscedere et al., 2008); and Institute for Clinical Systems Improvement (ICSI), (2011)** the content of the guidelines was includes interventions as: Elevation of the head of the bed, maintaining cuff pressure in the endotracheal tube between 20-25 mmHg, circuit changes, use of heated humidifiers and heat and moisture exchangers, providing oral care with chlorhexidine and water-soluble mouth moisturizer, secretion removal with specially designed endotracheal tubes, closed, in-line suctioning, oral vs. nasal route for endotracheal intubation, frequency of humidifier changes, frequency of change in suction systems and patient positioning.

- Teaching the guidelines was implemented through lecture and discussion.

- Arabic handout about the evidence based guidelines for the prevention of ventilator-associated pneumonia among children was given to the nurses after teaching it.

- Evaluation was done through assessing the knowledge level of the nurses in the pre-test compared to their knowledge in the post test to assess the effect of teaching the guidelines on their knowledge.

- Also person correlation between degree of knowledge and degree of application among nurses was evaluated.

Ethical consideration:

Confidentiality of the researchers was asserted. Explanation of the aim and methodology of the study was done to nurses by the researchers. The right to refuse to participate in the study was emphasized to the nurses.

- In order to increase the compliance, all nurses where personally informed by the researchers about the study and its importance.

Statistical analysis:

The data were tested for normality using the Anderson-Darling test and for homogeneity variances prior to further statistical analysis. Categorical variables were described by number and percent (N, %), where continuous variables described by mean and standard deviation (Mean, SD). Chi-square test and fisher exact test used to compare between categorical variables. Person correlation coefficient used to assess the association between knowledge and application. A two-tailed $p < 0.05$ was considered statistically significant. All analyses were performed with the IBM SPSS 20.0 software.

Results:

Table (1) showed percentage distribution of the nurses according to their

demographic characteristics and their experiences, as shown in this table, all participating nurses were female, had diploma qualification, and permanent employment, (100%) respectively. Half of them (50.0%) were between 18 to 22 years old. 35.0% had more than 10 years work experience as an intensive care nurse, followed by 32.5% experience 1-5 years. Only one nurse (2.5%) had a special degree in intensive care, majority of them (95.0%) were registered nurse. Majority of the nurses (85.0%) not attended any workshop related to intensive care nursing or prevention ventilator associated pneumonia, and majority of them (87.5%) think that they did not have sufficient information about the prevention of pneumonia in artificially ventilated patients.

Table 2: Illustrated percentage distribution of nurses' knowledge regarding evidence based guidelines for preventing ventilator associated pneumonia in pre and post test, as shown in this table, the ranking items with the lowest scores of knowledge in the pre-test were related to, open vs. closed suction systems (2.5.0%), frequency of change in suction systems (10.0%), the type of airway humidifier (10.0%), use of 0.12% chlorhexidine gluconate antiseptic oral rinse (15.0%), endotracheal tubes with extra lumen for drainage of subglottic secretions (20.0%), and kinetic vs. standard beds (27.5%), while in post-test the scores of knowledge were increased to (97.5%), (82.5%), (100%), (95.0%), (100%) and (97.5%) respectively in these items.

Table 3: Presented the relation between nurses' knowledge regarding evidence based guidelines for preventing ventilator associated pneumonia in the pre and post test. As shown in this table, highly statistical significant differences were found between the nurses' knowledge in the pre-test and post- test in all items (P-value <0.001) except in the item related to oral vs. nasal route for endotracheal intubation, no statistical significant differences was detected (P-value <0.090)**.**

Figure 1: Showed the level of nurses' knowledge in the pre and post- test regarding evidence based guidelines for preventing ventilator associated pneumonia. As presented in this figure, the level of nurses' knowledge in the pre-test was unsatisfactory (87.5%) and the satisfactory knowledge was (12.5%) while in the post-test the level of nurses' knowledge improved to be unsatisfactory (5.0%) and satisfactory (95.0%) respectively.

Table 4: Illustrated the relation between nurses' socio-demographic characteristics, experiences and their baseline level of knowledge regarding evidence based guidelines. As illustrated in this table, no statistical significance differences were found between the nurses' baseline level of knowledge and age, years of experience as a nurse, years of work experience in intensive care unit, and their education. A highly statistical significance differences were found between the nurses' baseline level of knowledge and the attending workshop related to intensive care nursing or prevention of ventilator associated pneumonia with higher prevalence among nurses who were attended.

Table 5: Illustrated nurses' degree of application of VAP prevention strategies among children. As shown in this table, all nurses (100%) were applying the items related to use of protective gloves, adequate nutrition, periodic changes in patient posture, Patient in semi-seated position, use of a nosocomial infection control program. lowest application items were from use of special beds (e.g. Respicare) (10.0%), use of antibacterial filters in ventilator circuit (17.5%), use of subglottal aspiration devices (20.0%), routine replacement of ventilator circuit (25.0%), and hourly removal of

condensation from ventilator circuits (35.0%). Mean score of application was14.7+3.1.

Figure 2: Presented the Percentage of the nurses' application of evidence based guidelines for preventing ventilator associated pneumonia in children. As illustrated in this figure, (80.0%) of the nurses were applying the evidence based guidelines for preventing ventilator associated pneumonia while (20.0%) were not applying.

Figure 3: Illustrated person correlation between degree of knowledge and degree of application among nurses, as shown in this figure there is a strong positive correlation between degree of knowledge and degree of application (r= 0.62), and highly statistical significance difference were also found (P < 0.001).

Figure 4: Showed self reported nurses' barriers related to the reason of not applying the evidence based guidelines for preventing ventilator associated pneumonia. As presented in this figure**,** the main barriers were lack of knowledge (97.5%), lack of skills (95.0%), Lack of staff nurses (90.0%), Work load (87.5%), inadequate resources, (85.0%), forgetfulness (40.0%) and doctor order (20.0%).

Table 1: Percentage distribution of nurses according to their socio-demographic characteristics and their experiences (n=40).

Socio-demographic characteristics of nurses	No.	%
Gender: Female	40	100.0
Age/years:		
<18	3	7.5
18-	20	50.0
22-	11	27.5
>30 years	6	15.0
Years of experience as a nurse		
<1 year	4	10.0
1-5 years	14	35.0
6-10 years	12	30.0
>10 years	10	25.0
Years of work experience do you have as an Intensive care nurse		
<1 year	5	12.5
1-5 years	13	32.5
6-10 years	8	20.0
>10 years	14	35.0
Obtained special degree in intensive care		
Yes	1	2.5
No	39	97.5
Highest level of professional qualification:		
Diploma	40	100.0
Education:		
Registered nurse	38	95.0
Nursing assistant	2	5.0
Employment: Permanent	40	100.0
Workshop or training attended related to prevention of ventilator-associated pneumonia		
No	34	85.0
Yes	6	15.0
Years when course/session attended:		
6 months	4	11.8
2 years back	2	5.9
Think that you are sufficiently informed about the prevention of pneumonia in artificially ventilated patients		
Yes (from clinical practices and doctor round)	5	12.5
No	35	87.5

Table 2: Nurses' knowledge regarding evidence based guidelines for preventing ventilator associated pneumonia in pre and post test (n=40).

Items	Pre		Post	
	No	%	No	%
1. Oral vs. nasal route for endotracheal intubation				
Oral intubation is recommended*	35	87.5	39	97.5
Nasal intubation is recommended	-	-	-	-
Both routes of intubation can be recommended	3	7.5	1	2.5
Do not know	2	5.0	-	-
2. Frequency of ventilator circuits changes				
It is recommended to change circuits every 48 hrs (or when clinically indicated)	13	32.5	2	5.0
It is recommended to change circuits every week (or when clinically indicated)	1	2.5	-	-
It is recommended to change circuits for every new patient (or when clinically indicated)*	23	57.5	38	95.0
Do not know	3	7.5	-	-
3. Type of airway humidifier				
Heated humidifiers are recommended	32	80.0	-	-
Heat and moisture exchangers are recommended*	4	10.0	40	100.0
Both types of humidifiers can be recommended	1	2.5	-	-
Do not know	3	7.5	-	-
4. Frequency of humidifier changes				
It is recommended to change humidifiers every 48 hrs (or when clinically indicated)	6	15.0	1	2.5
It is recommended to change humidifiers every 72 hrs (or when clinically indicated)	6	15.0	9	22.5
It is recommended to change humidifiers every week (or when clinically indicated)*	22	55.0	30	75.0
Do not know	6	15.0	-	-
5. Open vs. closed suction systems				
Open suction systems are recommended	19	47.5	-	-
Closed suction systems are recommended*****	1	2.5	39	97.5
Both systems can be recommended	18	45.0	1	2.5
Do not know	2	5.0	-	-
6. Frequency of change in suction systems				
Daily changes are recommended (or when clinically indicated)	34	85.0	1	2.5
Weekly changes are recommended (or when clinically indicated)	2	5.0	6	15.0
It is recommended to change systems for every new patient (or when clinically indicated)*****	4	10.0	33	82.5
Do not know	-	-	-	-
7. Endotracheal tubes with extra lumen for drainage of subglottic secretions				
These endotracheal tubes reduce the risk of VAP*****	8	20.0	40	100.0
These endotracheal tubes increase the risk of VAP	-	-	-	-
These endotracheal tubes do not influence the risk of VAP	21	52.5	-	-
Do not know	11	27.5	-	-
8. Kinetic vs. standard beds				
Kinetic beds increase the risk of VAP	-	-	-	-
Kinetic beds reduce the risk of VAP*	11	27.5	39	97.5
The use of kinetic beds does not influence the risk of VAP	23	57.5	1	2.5
Do not know	6	15.0	-	-
9. Patient positioning				
Supine positioning is recommended	4	10.0	-	-
Semi-recumbent positioning is recommended*****	26	65.0	40	100.0
The position of the patient does not influence the risk of VAP	10	25.0	-	-
Do not know	-	-	-	-
10. Use of 0.12% chlorhexidine gluconate antiseptic oral rinse				
0.12% chlorhexidine gluconate antiseptic oral rinse reduce the risk of VAP*	6	15.0	38	95.0
0.12% chlorhexidine gluconate antiseptic oral rinse increase the risk of VAP	1	2.5	2	5.0
0.12% chlorhexidine gluconate antiseptic oral rinse does not influence the risk of VAP	-	-	-	-
Do not know	33	82.5	-	-

* = correct answer-

Table 3: The relation between nurses' knowledge regarding evidence based guidelines for preventing ventilator associated pneumonia in the pre and post test (n=40).

Items of nurses' knowledge	Pre				Post				P. value
	Correct		Incorrect		Correct		Incorrect		
	No.	%	No.	%	No.	%	No.	%	
1. Oral vs. nasal route for endotracheal intubation	35	87.5	5	12.5	39	97.5	1	2.5	0.090
2. Frequency of ventilator circuits changes	23	57.5	17	42.5	38	95	2	5	<0.001**
3. Type of airway humidifier	4	10	36	90	40	100	-	-	<0.001**
4. Frequency of humidifier changes	22	55	34	85	30	75	10	25	0.061
5. Open vs. closed suction systems	1	2.5	39	97.5	39	97.5	1	2.5	<0.001**
6. Frequency of change in suction systems	4	10	6	15	33	82.5	7	17.5	<0.001**
7. Endotracheal tubes with extra lumen for drainage of subglottic secretions	8	20	32	80	40	100	-	-	<0.001**
8. Kinetic vs. standard beds	11	27.5	29	72.5	39	97.5	1	2.5	<0.001**
9. Patient positioning	26	65	14	35	40	100	-	-	<0.001**
10. Use of 0.12% chlorhexidine gluconate antiseptic oral rinse	6	15	34	85	38	95	2	5	<0.001**

** = highly statistical significant

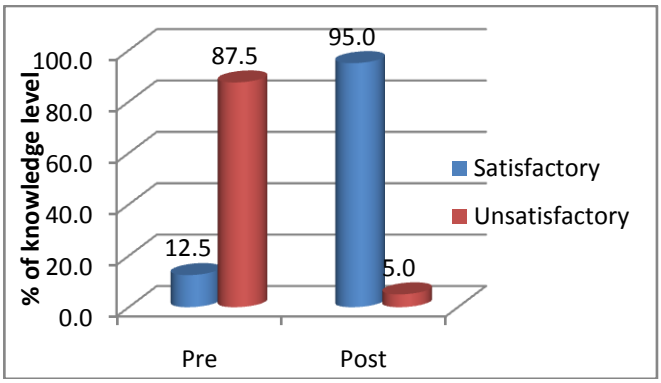

Figure (1): The level of nurses' knowledge in pre and the post- test regarding evidence based guidelines for preventing ventilator associated pneumonia.

Table 4: Relation between nurses' socio-demographic characteristics, experiences and their baseline level of knowledge regarding evidence based guidelines (n=40).

Variables	Levels of knowledge				P-value
	Satisfactory		Un-satisfactory		
	No.	%	No.	%	
Age/years:					
<18	-	-	3	8.3	0.611
18-	2	50.0	18	50.0	
22-	2	50.0	9	25.0	
>30	-	-	6	16.7	
Years of experience as a nurse					
<1year	-	-	4	11.1	0.295
1-5 years	-	-	14	38.9	
6-10 years	2	50.0	10	27.8	
>10 years	2	50.0	8	22.2	
years of work experience in intensive care unit					
<1year	-	-	5	13.9	0.232
1-5 years	-	-	13	36.1	
6-10 years	2	50.0	6	16.7	
>10 years	2	50.0	12	33.3	
Education					
Registered nurse	4	100.0	34	94.4	0.629
Nursing assistant	-	-	2	5.6	
Any workshop attended related to pediatric intensive care nursing or prevention of VAP.					
None	-	-	34	94.4	<0.001**
Attended	4	100.0	2	5.6	

** = highly statistical significant

Table 5: Nurses' degree of application of VAP prevention strategies among children (n=40).

Application items	Apply		Not apply	
	No.	%	No.	%
1-Use of protective gloves	40	100.0	-	-
2-Hand-washing with soap and water between patients	15	37.5	25	62.5
3-Hand-washing with alcoholic antiseptic solution	39	97.5	1	2.5
4-Adequate nutrition	40	100.0	-	-
5-Bronchoaspiration using a sterile technique	38	95.0	2	5
6-Bronchoaspiration using closed-circuit systems	31	77.5	9	22.5
7-Maintaining adequate tracheal tube cuff pressure	26	65.0	14	35
8-Respiratory physiotherapy	32	80.0	8	20
9-Avoiding gastric distension	32	80.0	8	20
10-Removing NGT as soon as clinical conditions allow	35	87.5	5	12.5
11-Humidification of respiratory circuit using heat exchange filter	34	85.0	6	15
12-Routine replacement of ventilator circuit	10	25.0	30	75
13-Periodic changes in patient posture	40	100.0	-	-
14-Use of antibacterial filters in ventilator circuit	7	17.5	33	82.5
15-Patient in semi-seated position	40	100.0	-	-
16-Oral hygiene with antiseptic mouthwash	35	87.5	5	12.5
17-Use of a nosocomial infection control programme	40	100.0	-	-
18-Hourly removal of condensation from ventilator circuits	14	35.0	26	65
19-Use of subglottal aspiration devices	8	20.0	32	80
20-Use of heated ventilator circuits	29	72.5	11	27.5
21-Use of special beds (*e.g.* Respicare)	4	10.0	36	90

The main score of application was 14±3.1

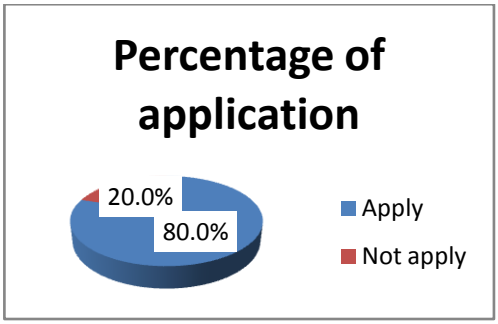

Fig., (2): Percentage of the nurses' application of evidence based guidelines for preventing ventilator associated pneumonia in children.

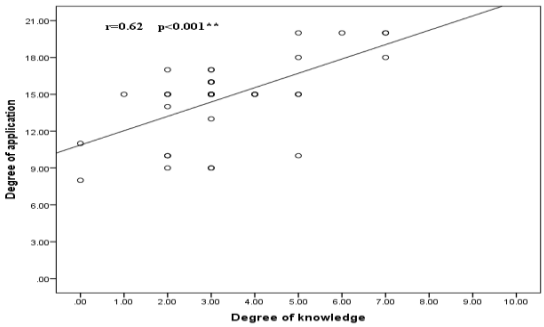

Fig., (3): Person correlation between degree of knowledge and degree of application among nurses.

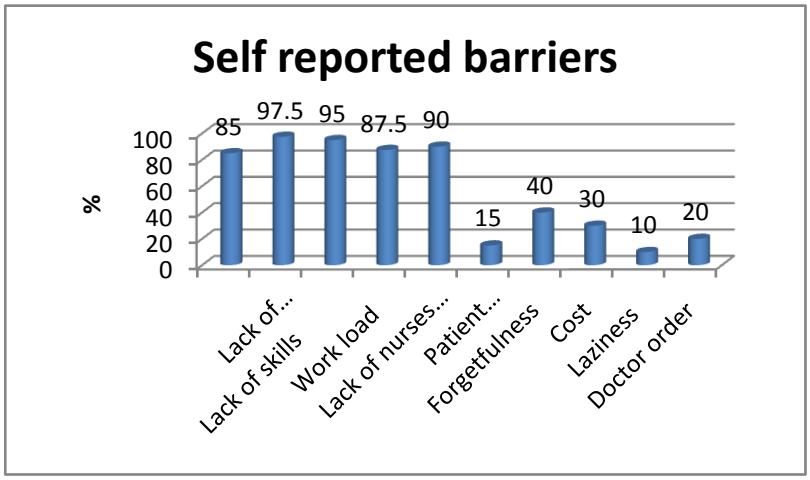

Fig., (4): Self reported nurses' barriers among nurses related to reasons of not applying the evidence based guidelines for preventing ventilator associated pneumonia (n=40).

Discussion:

Ventilator-associated pneumonia (VAP) is a serious health care- associated infection, resulting in high morbidity and mortality. It also prolongs hospital stay and drives up hospital costs. Measures employed in preventing ventilator-associated pneumonia in developing countries are rarely reported. This study tried to assess the effect of teaching evidence based guidelines on nurses' knowledge and performance to prevent ventilator-associated pneumonia among children **(Azab et al., 2015).**

As regard to the socio-demographic characteristics of the nurses, the present study mentioned that all participating nurses were female, had diploma qualification, and permanent employment. More than one third of them had more than 10 years of ICU experience. Only one nurse had a special degree in intensive care, majority of them were registered nurse **(table 1)**. These results are in line of other study in Riyadh, Saudi Arabia by **Meherali et al., (2011) who stated that,** majority of study subjects were female (80%), and majority (85%) having diplomas in nursing. Also the result of **Jansson et al., (2013)** reported that, the majority of participants (89.1%) were registered nurses, often with >10 yrs ICU experience (40.6%) and 68.3% were permanent employment.

Majority of the nurses not attended any workshop or training related to prevention of ventilator-associated pneumonia Only (12.5%) of the studied nurses reported that they are sufficiently informed about the prevention of pneumonia in artificially ventilated patients, nurses reported that they acquire their knowledge from the doctor round or from their practical experts **(table 1)**. These results are in agreement with **Said, (2012)** who found that the majority of nurses had no ICU training.

The results of the pre-test highlighted that majority of the nurses in the pre-test had unsatisfactory level of knowledge regarding evidence based guideline for the prevention of VAP (**figure 1).** Also the findings of **Nesami and Amiri**, **(2014)** demonstrated that, nurses' knowledge about VAP guidelines is not good. Also **Javed, (2011)** stated that nurse working at critical unit are having knowledge gap to be able to prevent incidence of VAP among ventilated patients.

The current study also presented in **figure 1** that the nurses' scores of knowledge regarding evidence based guidelines for VAP prevention in post-test were better than the scores of knowledge in the pre-test. The effectiveness of teaching guidelines in increasing knowledge of the nurses is supported with other studies by **Babcock et al., (2004) and Meherali et al., (2011) who stated that,** Knowledge scores of participants increased significantly after the educational intervention in the first post-test regarding evidence based guidelines for VAP prevention. Also the result of **Soh et al., (2007)** revealed a significant difference in the nurses' knowledge before and after the teaching.

The items with the lowest scores of knowledge in the pre-test were related to, open vs. closed suction systems, endotracheal tubes with extra lumen for drainage of subglottic secretions, frequency of change in suction systems, the type of airway humidifier, use of 0.12% chlorhexidine gluconate antiseptic oral rinse, and kinetic vs. standard beds, while in post-test the scores of knowledge in these items were increased. This is presented in **(table 2).** This result is congruent with other study by **Nesami and Amiri**, **(2014)** who stated that, the items with the lowest scores were the frequency of changing ventilator circuits (17.3%), humidifirs (3.8%) and suction systems (13.5%). Also a study by **Gatell et al.,**

(2012) reported that**,** Nurses answered more questions correctly on the post-intervention questionnaire than on the pre-intervention.

The reason of unsatisfactory level of nurses' knowledge in the pre-test could be related to the majority of the nurses in this study not attended any workshop or previous training about guidelines for prevention of VAP.

Regarding the relation between nurses' socio-demographic characteristics and their level of knowledge regarding evidence based guidelines for preventing ventilator associated pneumonia **(table 4)** the results of the present study showed that, A highly statistical significance differences were found between the nurses' level of knowledge and the attending workshop related to prevention of ventilator associated pneumonia with higher prevalence among nurses who were attended. This result is congruent with **Ahmed and Abosamra, (2015)** who found that, there is significant relation the nurses' level of knowledge and previous training on guidelines of prevention of VAP.

Also **table 4)**in the present study showed no statistical significance differences were found between the nurses' level of knowledge and their age, years of experience as a nurse, years of work experience in intensive care unit, and their education. This result is line with **Gomes, (2010)** who found no correlation between age and knowledge of nurses on the evidence based guidelines for prevention of VAP and there is a weak correlation between years of experience and knowledge levels of nurses.

The degree of application of VAP prevention strategies among children were presented in **table 5**. As shown in this table, all nurses were well applying the items related to use of protective gloves, adequate nutrition, periodic changes in patient posture, Patient in semi-seated position, use of a nosocomial infection control program. This result is correspondent with **Institute of Health care Improvement (IHI), (2006) and Rello et al., (2010),** who stated that the most common self-reported adherences were related to VB including semi-recumbent positioning adequate hand hygiene and formal infection control programs.

The lowest items of application were from use of special beds (*e.g.* Respicare), use of antibacterial filters in ventilator circuit, use of subglottal aspiration devices, routine replacement of ventilator circuit, and removal of condensation from ventilator circuits **(table 5).** This result is in agreement with other study by **Ahmed and Abosamra, (2015) and Muscadere et al., (2008) who stated that,** the highest percent of studied sample reported incorrect answer regarding frequency of ventilator circuit replacement, condensation in the ventilator circuit, ventilator and bed side maintenance, and type of suction system.

In this study the mean score of application was14.7+3.1. The percentage of nurses' application of the evidence based guidelines for prevention of VAP was 80%. This is in line with previous studies by **Kaynar et al., (2007) and Ricart et al., (2003)** who reported the adherence was between 77.7 and 83.0% Also in line with **Jansson et al., (2013)** who reported the self-reported adherence to evidence based guidelines for prevention of VAP was 84%.

Figure (3): Illustrated person correlation between degree of knowledge and degree of application among nurses, this figure showed, although the majority of the nurses their percentage of knowledge not exceed 65% (unsatisfactory level of knowledge) the majority of them had more than 65% degree of application. However,

the result found that the greater degree of the nurses' knowledge the greater degree of their application. Also this figure showed, there was a strong positive correlation between degree of knowledge and degree of application (r= 0.62), and statistical significance difference were found (P < 0.001). This is reflecting that when the nurses' knowledge increase and improve regarding the evidence base guidelines for prevention of ventilator associated pneumonia in children, the degree of nurses' application of the guidelines will increase and improve as well. This result supported by the result of **Zack, (2002)** who found that, lack of knowledge of evidence based practice guidelines is a barrier for non adherence to evidence based guidelines for the prevention of VAP.

The main self reported nurses' barriers related to the reason of not applying the evidence based guidelines for preventing ventilator associated pneumonia were lack of knowledge, lack of skills, Lack of staff nurses, Work load, inadequate resources, forgetfulness and doctor order **(figure 4).** This result supported by the result of **El-Khatib et al., (2010)** who found that the main barriers were lack of knowledge and skills and forgetfulness.

Conclusion:

Based on the study finding and research hypothesis, the study concluded that, the unsatisfactory knowledge of nurses was a barrier to be well applying the evidence based guidelines. The nurses' level of knowledge improved after teaching the guidelines for prevention of ventilator-associated pneumonia. Highly statistical significant differences were found between the nurses' knowledge in the pre-post test (P-value <0.001). There was a strong positive correlation between degree of knowledge and degree of application (r= 0.62) which reflecting that when the nurses' knowledge increase and improve, the degree of nurses' application of the guidelines will increase and their performance will improve as well.

Recommendations:

-The nurses need farther educational, training program and workshop about the evidence based guidelines to prevent ventilator-associated pneumonia targeting all nurses in all intensive care units in other hospitals.

-Written protocol should be present and reviewed regularly and updates in the intensive care units about the evidence based guidelines for the prevention of ventilator-associated pneumonia and learned to all nurses in ICUs.

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