

## Effect of Bundle of Care Guidelines on Occurrence of Ventilator-Associated Pneumonia in the Pediatric Intensive Care Unit

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### Abstract

**Background:** Ventilator-Associated Pneumonia (VAP) is a primary clinical concern associated with high incidence and mortality rates as well as health care costs worldwide. **Aim of the study:** first, it was to assess nurses' knowledge and skills regarding ventilator-associated pneumonia. Second, to examine the effect of a bundle of care guidelines on the occurrence of ventilator-associated pneumonia in the pediatric intensive care unit. **Design:** This study was quasi-experimental (Pre-/Post-test). **Setting:** This study was conducted in a pediatric intensive care unit at Shebin El Kom University Hospital, Menoufia Governorate, Egypt. **Sample:** A convenience sample of 35 nurses was recruited to achieve the first aim. A purposive sample of 194 ventilated children from patient's records six months before the intervention and 198 ventilated children six months post-intervention were included. **Tools:** A structured interview questionnaire that assesses the Sociodemographic data of children and nurses, questions to assess nurses' knowledge about ventilator-associated pneumonia. Observation checklist on ventilator-associated pneumonia prevention/management skills for nurses. Child's records to determine the previous profile of ventilated children six months of pre-intervention. **Results:** a high statistical significance difference was shown regarding nurses' knowledge and skills pre-intervention compared to post-intervention. After six months of intervention, a significant difference in lowering the percent of ventilator-associated pneumonia occurrence among ventilated children was reported post-intervention. **Conclusion:** Bundle of care guidelines related to VAP was effective in improving pediatric nurses' knowledge and skills. After the intervention, the percent of VAP occurrence among infants/children attending PICU was reduced post-intervention than in pre-intervention. **Recommendation:** Application of bundle of care guidelines is essential in maintaining the health and survival of ventilated children attending the Pediatric Intensive Care Unit.

**Keywords:** Ventilation Associated Pneumonia, Pediatric Intensive Care Unit, Bundle Guideline.



## INTRODUCTION

Ventilator-associated pneumonia (VAP) is a main health threat for hospitalized infants and children associated with high rates of incidence, mortality and costs of health care worldwide [1]. VAP is one of the most common hospital-acquired infections. [2]. VAP is a fatal complication of ventilator care and frequently encountered within pediatric intensive care units (PICUs) [3, 4]. The Centers for Disease Control and Prevention was defined VAP as pneumonia that arises in a mechanically ventilated child and develops 48 hours or more after initiation with no manifestation of lower respiratory tract infection prior intubation. Pneumonia is the leading cause of children' death worldwide [5]. The frequency of VAP in ventilated children was 17%, with a 32% mortality rate as compared with 13% in those without it [6].

World health organization (2013) stated that 8.7% of patients acquired nosocomial infection with a high mortality rate (50%), VAP was the most common beyond which. [7]. with high mortality rate (6% - 68%) and may be as high as 74% in children [8, 9]. In developing countries, the incidence of VAP is 37.2 per 1000 ventilation day, and the mortality rate for VAP patients was 80 %. VAP approximately occur in 12% of PICU ventilated children [1]. In Egypt, VAP is a significant problem with continuous increasing incidence representing a significant reason of increased morbidity and mortality. The incidence of VAP in three Universities in Egypt; Alexandria (four studies), Ain Shams (three studies) and Mansoura (one study). The VAP incidence ranged from 16% to 75% with the highest ratio in Ain Shams University and the lowest ratio in Alexandria [10].

Mechanical ventilation is a life-saving intervention, Children receiving mechanical ventilation at a higher risk than adult due to weak cough, decreased gag reflexes and using of the un-cuffed endotracheal tube resulting in decrease salivary secretions, worsens oral cavity hygiene and bacterial overgrowth [11, 12]. Mechanical ventilation raises the risk of pulmonary infection [13, 14, 15, 16]. The Center for Medicare and Medicaid Services recorded VAP as "reasonably preventable disease" and VAP reduction of is a national goal for children's safety [17, 18, 19, 20]. For the promotion of nursing care with highest standards, nursing practice must be based on a well scientific knowledge and proper practice through following evidence-based guidelines for the prevention and decreasing the incidence of VAP [21, 5]. PICU nurses should put the evidence-based guidelines into practice as they are bedside ventilated children 24 hours a day, and therefore, they play a significant role in the prevention of VAP [20, 22].



### Significance of study

Pediatric patients getting mechanical ventilation are at risk for developing VAP leading to increased health care costs, morbidity and mortality rates [23,24,25]. PICU Nurses play an essential role in VAP prevention, as they organize care with further healthcare practitioners. [26,27]. the incidence of ventilator-Associated Pneumonia across the globe varies from 2 to 17%, with a higher incidence (38.4%) in the developing countries [2]. VAP was reported for up 20% of PICUs infections. Therefore, children who develop VAP stay almost twice as long in the PICU as those children who do not [20, 25,26]. **Deraz et al.**, (2016) applied prospective cohort study in the PICU, Ain Shams university hospital in Cairo, reported that the actual mortality rate was higher (46.7%) among the pediatric patients who acquired VAP [11]. In Egypt, The incidence of VAP was 37.56 per 1000 ventilation days of PICU patients. Implementing bundles of care in clinical practice has been widely encouraged to reduce the risk of ventilator-associated pneumonia (VAP) [27, 28]. Ventilator Bundle is a set of evidence-based interventions for mechanically ventilated pediatric patient in PICU. [29, 30, 31]. PICU nurses deal with mechanically ventilated children continually. Therefore, they are involved actively in prevention of VAP occurrence [32, 33, 34].

### Subjects and Method

#### Aim of the study

Assess nurses' knowledge and skills regarding VAP in the pediatric intensive care unit and to examine the effect of Bundle of Care Guidelines on the occurrence of VAP in PICU.

#### Research Hypothesis

- 1- Pediatric nurses who will receive Guidelines Bundle of Care on VAP will improve their knowledge post-intervention than pre-intervention.
- 2- Pediatric nurses who will receive Guidelines Bundle of Care on VAP will improve their skills post-intervention than pre-intervention.
- 3- Infants/children who will receive Guidelines Bundle of Care on VAP will have a lower percentage of occurrence post-intervention than pre-intervention



**Study Design:**

A quasi-experimental research design, one group pre-posttest, was utilized.

**Study Setting:**

This study was conducted in a pediatric intensive care unit at Shebin El Kom University Hospital, Menofia Governorate, Egypt.

**Study Sample:**

A Convenience sample of 35 nurses working in the pediatric intensive care unit (all nurses available). A purposive sample of 194 ventilated children from patient records six months before the intervention and 198 ventilated children 6 months attending PICU post-intervention (only ventilated children were included). The reason of a variation between number of children pre and post intervention was that the researcher depended on duration of intervention (6 months) not on number children.

**Data Collection Tools:**

The following tools were used:

**The tool I: A structured Interviewing questionnaire:**

A structured interview questionnaire adopted from **Said**. [7]. which assessed Sociodemographic data of nurses' understudy and nurses' knowledge on ventilator-associated pneumonia. It included the following two parts:

**Part one:** 4 questions on Sociodemographic data of nurses under study, which included gender, education level, ICU Training, and Years of work experience as a critical care nurse.

**Part two:** The close-ended knowledge assessment questionnaire consists of 20 questions that measured nurses' knowledge of evidence-based guidelines for VAP prevention. Questions included knowledge about intubation, type of humidifier, frequency of humidifier changes, suction system, rate of change, chest physiotherapy. It was used for pre-post- test.

**Scoring system of knowledge:**

The questionnaire contained items related to nurses' and children's demographic criteria, as well as 20 questions that measure Critical care nurses' knowledge of evidence-based guidelines for preventing VAP. All questions were weighted with the digits 0 and 1. Weighting (1) denoted adherence to accepted PICU nurse knowledge employed to prevent VAP. 0 denoted non-adherence to accepted PICU nurse knowledge



employed to prevent VAP. The above weight was converted into % ranging from 0 – 100 %.

**The levels of knowledge were classified as follows:**

LEVEL	PERCENTAGES
Excellent	100% - 70%
very good	69% - 60%
Good	59% - 50%
Average	49% - 40%
Poor	39% - 0%

**Validity:**

A structured Interviewing questionnaire was translated by the researcher to the Arabic language and back to English to measure its content validity by a group of six experts in pediatric medicine and nursing. The required modification was carried out accordingly.

**Reliability:**

The reliability of the tools was done by test-retest for measuring internal consistency with a period of two-week intervals. The Cronbach's alpha for the observation checklist tool was 0.9 indicate excellent reliability.

**Tool II: Observation checklist on ventilator-associated pneumonia prevention/ management skills for nurses.**

Newhouse et al. developed **this scale., [35]**. It was used to monitor VAP prevention/management skills for nurses during childcare on a ventilator, which included 16 skills about hand hygiene, isolation/standard precautions, Oral care, Suction, infection control. It was used for pre-post- test.

**Scoring system for nurses' skills checklist:-**

All skills were weighted with the digits 0 and 1. Weighting (1) for each correct action represented adherence to accepted ICU prevention/management skills of VAP. 0 for the wrong action represented non-adherence to accepted ICU prevention/management skills of VAP. The above weight was converted into % ranging from 0 – 100 %.

**The levels of skills were classified as follows:**

PASS: score 14 (87%) and above skill/competency

FAIL: score less than 14 out of 16: Needs Retraining



### **Content validity of Observation checklist**

An observation checklist was translated by the researcher to the Arabic language and back to the English form. It was tested for its content validity by a group of five experts in pediatric medicine and pediatric nursing, Menofia University. The corrections were done accordingly based on their responses.

### **Reliability of Observation checklist**

Test-retest reliability was applied using a group of four nurses who were not included in the study. The tool was presented to them twice- two weeks apart. The tool proved to be solidly reliable ( $r = 0.83$ ).

### **Tool III: child records**

Child records were used to collect the following data:-

- A- Child necessary data:** questions on data of children under study, which included age, gender.
- B- Past and present medical history: included** diagnosis and occurrence of VAP.

### **Approval:**

The official permission was obtained from the hospital directors for conducting the study. An exploratory stage was conducted before starting the study to determine the feasibility of accomplishing this study.

### **Ethical considerations and human rights**

During the initial interview, the purpose of the study and the procedures were explained to all participants; nurses, the pediatric patient, and their caregivers and the oral consent were obtained from them.

They were assured that all information would be confidential to ensure the confidentiality of the participants. Participants were assured that their participation in the study was voluntary and that they could withdraw from the study at any time and can refuse to participate in the study.

### **Method**

#### **I: Preparatory phase:**

This study was preceded by a preparatory phase in which the following activities were performed.

- 1- The investigators did a computer search about the study topic, then reviewing past and current literature covering the various aspects of the problem using books, articles periodicals, magazines,



and studies related to the research study. They have then constructed the tools, questionnaires, and mental materials from the previous literature.

- 2- The nurses were contacted separately in order to explain the purpose and the nature of the study and obtain approval for participation in addition to the time planning for the delivery of training sessions.

#### **Pilot study:**

The study was done to test the practicality and applicability of the two tools to identify the obstacles and difficulties that may be encountered during data collection. It also helped to estimate the time desired to fill in the tools.

It was conducted to include five nurses in PICU. Then, the pilot sample was excluded from the total sample.

**Study Period:** The duration of the study was eight months from July 2018 to the end of February 2019. The study intervention lasts for two months from July 2018 to the end of August 2018. Child's records of all children on mechanical ventilation (MV) were retrospectively reviewed to collect data about socio-demographic data and their diagnosis and occurrence of VAP from the previous profile of ventilated children who admitted to PICU 6 months pre-intervention from January 2018 to the end of June 2018 to compare pediatric patient file with all children who admitted to PICU 6 months post-intervention were on mechanical ventilation from August 2018 to the end of February 2019.

#### **II: Fieldwork**

- Each PICU nurse was interviewed individually after a simple conversation followed by an explanation of the objectives intervention, which was established in a clear Arabic statement.
- Conduct a pre-test to determine the necessary data of knowledge and skills of nurses.
- A pre-intervention data using A structured interview questionnaire for all participants nurses were interviewed to assess Sociodemographic and nurses' knowledge on ventilator-associated pneumonia. Fill the questionnaire sheet individually; the interview period was 25- 30 minutes in length.
- A pre-intervention data was collected included skills assessment data by using the Observation checklist on VAP prevention/management skills for all participant nurses. Note the skills of nurses during their work. The observation period was 3 hours in length to conduct the pre-test.

Pediatric patients' records of all children who admitted to PICU 6 months pre-intervention and were on mechanical ventilation (MV) from January 2018 to the end of June 2018 were retrospectively reviewed to collect data about socio-demographic data and their diagnosis and occurrence of VAP.

- The study group was divided into groups of 5 each to receive the designed educational components



that conducted at a separate room in PICU.

- The researcher distributed the designed illustrated booklet for the study groups; the study group was followed up weekly to fix the guidelines and instructions related to VAP.

**Study Intervention:-**

**Objective:** Upon completion of the intervention, the nurse will provide standardized Ventilator-Associated Pneumonia (VAP) Prevention/Management Knowledge/Skills.

**Date:** The sessions begin on 1-7-2018 and ends on 30-8-2018.

Initiation of sessions includes the classification of nurses studied into five groups, and then guidance nurses on the objectives of the intervention and its contents and timetable and expected results.

**VAP Bundle of Care Guidelines for nurses**

Guidelines for VAP prevention have been published by the Centers for Disease Control and Prevention CDC [26], the Institution for Healthcare Improvement (IHI) [36].

**The intervention Sessions:**

**To improve Knowledge:-**

Timing: Presented within three weeks (1 sessions/week per group) 20-30 minutes per session.

Teaching methods: Interactive session used to lecture, small group discussion, and.

Audiovisual aids, PowerPoint slides, graphics diagrams, booklets to clarify the education guidelines.

Theoretical contents topics include:-

Session I: - provide knowledge regarding Anatomy & physiology of child respiratory system

Session II: Mechanical ventilation including, indication, Moods of the ventilator, Weaning technique of the child from the ventilator Nursing role as regards to pediatric patients on the ventilator

Session III:- Risk factors, Clinical manifestations, the diagnosis and treatment of VAP. The Prophylactic pharmacological strategies are: aerosolized, nasal, intravenous and topical/topical plus antibiotics, oral decontamination and prevention of maxillary sinusitis

**VAP Bundle of Care Guidelines for nurses**

Such as:-Make hand hygiene before and after dealings with ventilator circuit, before and after oral care, before and after suctioning, ETT and after touching potentially contaminated objects, after contact with any source of microorganisms and after removing gloves, wear a gown before given care to patient when





soiling from respiratory secretions is expected, elevate the head of the bed 30°-45° and change ventilator circuits when they are obviously soiled or malfunctioning

## 2- To improve skills

Timing: 4 weeks (1 sessions/week per group). The researcher was available for one day per week in the pediatric intensive care unit on the morning shifts for 20 minutes per session minutes / each group.

Teaching methods: demonstration and re demonstration -individually and revision of each session before demonstrating another session to clarify the education guidelines skills.

### Practical sessions:-

Session I: standard precautions such as hand hygiene, gloving, and gowning procedures, Sterilization or disinfection to prevent transmission of infection and maintenance of ventilator equipment and device

Session II: ventilator care and airway humidification: type of humidifier, frequency of humidifier changes

Session III: Oral care, ventilator circuit changes

Session IV: Suction guidelines

### III: Evaluation phase:

- Evaluation nurses ' knowledge was immediately after receiving a bundle of care guidelines knowledge sessions for nurses and before starting skills sessions using a **structured Interviewing questionnaire**.
- Evaluation of Prevention/Management Skills of VAP at the following week after receiving a Bundle of Care Guidelines practical sessions for nurses using the Observation checklist on ventilator-associated pneumonia prevention/management skills for nurses.
- Child's records of ventilated children who admitted to PICU were used six months pre and six months post-intervention; the researcher compares socio-demographic data, their diagnosis, and the occurrence of VAP. The results of this comparison represent the effect of the bundle on the VAP occurrence title was reported.

### Statistical analysis:

In the present study, results were collected, tabulated, and statistically analyzed by an IBM compatible personal computer with SPSS statistical package version 20. Two types of statistics were done, **descriptive statistics included the number (No)** and percent (%) for qualitative data, mean ( $\bar{x}$ ), standard deviation (SD), and range for quantitative data and **analytic statistics included student's t-test** was a test used for comparison between groups having quantitative variables.



One way Anova test is a test used for comparison between more than two groups having quantitative variables.

Paired samples t-test was applied for comparison between the customarily distributed quantitative data at an interval for the same group. Chi-squared test ( $\chi^2$ ) was used to study the association between two qualitative variables.

Pearson correlation coefficient test (r-test) is a test of significance used to study the correlation between parametric quantitative variables and Correlation coefficient test (r-test) results may be positive (+) correlation or negative (-) correlation. It is used to quantify the strength of the linear relationship between two variables.

P-value of ( $>0.05$ ) was considered statistically insignificant; the P-value of ( $\leq 0.05$ ) was considered statistically significant.

P-value of ( $\leq 0.001$ ) was considered statistically highly significant.

## Results

**Table 1:** Distribution of socio-demographic characteristics of studied nurses working in PICU (n= 35)

Socio-Demographic characteristics for nurses	No. (n= 35)	%
<b>Age(years):</b>		
18- <26 Yrs.	17	48.6
26-30Yrs	10	28.6
More than 30Yrs	8	22.8
<b>Level of education:</b>		
Nursing diploma	7	20.0
Technical institute	12	34.3
Bachelorette	16	45.7
<b>Years of experience</b>		
1- 4 Yrs.	17	48.6
5-9Yrs	11	31.4
10 Yrs. or more	7	20.0
<b>PICU training</b>		
Yes	12	34.3
No	23	65.7

**Table 1.** Illustrated distribution of socio-demographic characteristics of studied nurses working in PICU (n= 35). The table revealed that (48.6 %) of nurses their age were ranged from 18- <26 years. Concerning



the level of education, 45.7% of studied nurses had completed their bachelorette degrees in education. Also, (48.6 %) of studied nurses had (1-4 ) years of experience in PICU. On the other hand, only 34.3% were received PICU training.

**Table 2:** Clinical Characteristics of mechanically ventilated children in PICU pre and post-intervention

Clinical characteristics	Time of assessment				$\chi^2$ test	P-value
	Pre-test (n=194)		Post test (n=198)			
	No.	%	No.	%		
<b>Age (years):</b>						
< 1 year	90	46.4	93	47.0	2.44	0.48 NS
1-< 5	59	30.4	62	31.3		
5-10	34	17.5	26	13.1		
>10 years	11	5.7	17	8.6		
<b>Gender :</b>					2.26	0.13 NS
Male	103	53.1	120	60.6		
Female	91	46.9	78	39.4		
<b>If catching VA P diagnosis was :</b>	N=53		N=37		3.03	0.69 NS
Convulsions	16	30.2	11	29.7		
Cerebral palsy	11	20.8	7	18.9		
Head trauma	9	17.0	5	13.5		
Chronic kidney disease	6	11.3	4	10.8		
Chronic heart disease	4	7.5	7	19.0		
Failure to thrive	7	13.2	3	8.1		

\*significant

\*\*highly significant

Table (2): Represented the Clinical characteristics of ventilated children in PICU pre and post-intervention. It revealed that 46.4% and 47.0% of children were in the age group < 1 year, 30.4 % and 31.3% were 1-< 5 Years, 17.5% and 13.1% were 5-10 Years, 5.7% and 8.6% were >10 years on pre-intervention and post-intervention respectively. Also, most of the children (53.1%and 60.6%) were hospitalized pediatric males on pre-intervention and post-intervention, respectively.

The present study also showed that the diagnosis of ventilated children whose catching VAP were convulsions (30.2 % vs. 29.7 %), followed by children with Cerebral palsy (20.8%vs. 18.9 %), Children



with Failure to thrive were (17.0% vs. 13.5 %)Head trauma(13.2% vs. 8.1%), Chronic kidney disease(11.3% vs. 10.8 %), And Chronic heart disease(7.5% vs. 19.0 %) on pretest and posttest respectively. For these reasons, there was a statistically significant difference at 5% level of significance between children on pre-intervention and children on post-intervention concerning the occurrence of VAP.

**Table 3: Distribution of pediatric nurses' knowledge regarding VAP pre and post-intervention**

Nurses' knowledge	Time of assessment				$\chi^2$ test	P-value
	Pre-test (n=35)		Post test (n=35)			
	No.	%	No.	%		
<b>Knowledge category</b>						
Poor39% - 0%	17	48.6	4	11.4	22.79	<0.001 **HS
Average 49% - 40%	11	31.4	6	17.2		
Good 59% - 50%	5	14.3	12	34.3		
Very good 69% - 60%	2	5.7	9	25.7		
Excellent100% - 70%	0	0.0	4	11.4		
<b>Score:</b>						
Mean±SD	5.68±1.39		16.11±1.71		Paired t=	<0.001
Range	4.00–13.00		5.00–19.00		27.99	**HS

\*significant

\*\*highly significant

Table 3: Showed Distribution of pediatric nurses' knowledge regarding VAP pre and post-intervention. It was obvious that (48.6%) and (31.4) of nurses have a poor or average level of knowledge about ventilator-associated pneumonia questions on pre-intervention compared to only 11.4 and 17.2 on post-intervention, respectively. On the other hand, nurses had improved their excellent, very good, good, Average and Poor knowledge level on posttest from 0.0%, 5.7%,14.3%,31.4 %, and 48.6% pre-intervention to11.4%,25.7 %,34.3 %,17.2 % and 11.4% post-intervention respectively. Therefore, there were statistically significant differences between nurses' knowledge about ventilator-associated pneumonia on pre and post-intervention at a 1% level of significance.



**Table 4: Distribution of pediatric nurses' skills pre and post-intervention regarding VAP.**

nurses' skills	Time of assessment				$\chi^2$ test	P-value
	Pre-test (n=35)		Post test (n=35)			
	No.	%	No.	%		
<b>nurses' skills Level:</b>						
Poor (score <14 (87%))	28	80.0	11	31.4	14.82	<0.001 HS**
Good (score $\geq$ 14 (87%))	7	20.0	24	68.6		
<b>Score:</b>						
Mean $\pm$ SD	12.91 $\pm$ 1.99		15.14 $\pm$ 1.57		Paired	<0.001
Range	8.00–16.00		12.00–16.00		t=5.20	HS**

\*significant

\*\*highly significant

**Table 4:** showed the distribution of pediatric nurses' skills pre and post-intervention regarding VAP

The findings illustrated that nurses' skills were improved after intervention, in which nurses (68.6%) had more satisfactory excellent skills toward ventilator-associated pneumonia post-intervention than pre-intervention (20.0%). For these reasons, there were statistical and highly statistically significant differences at 5% and 1% levels of statistical significance.



**Figure 1: Percent distribution of VAP occurrence of children in PICU pre and post-intervention**

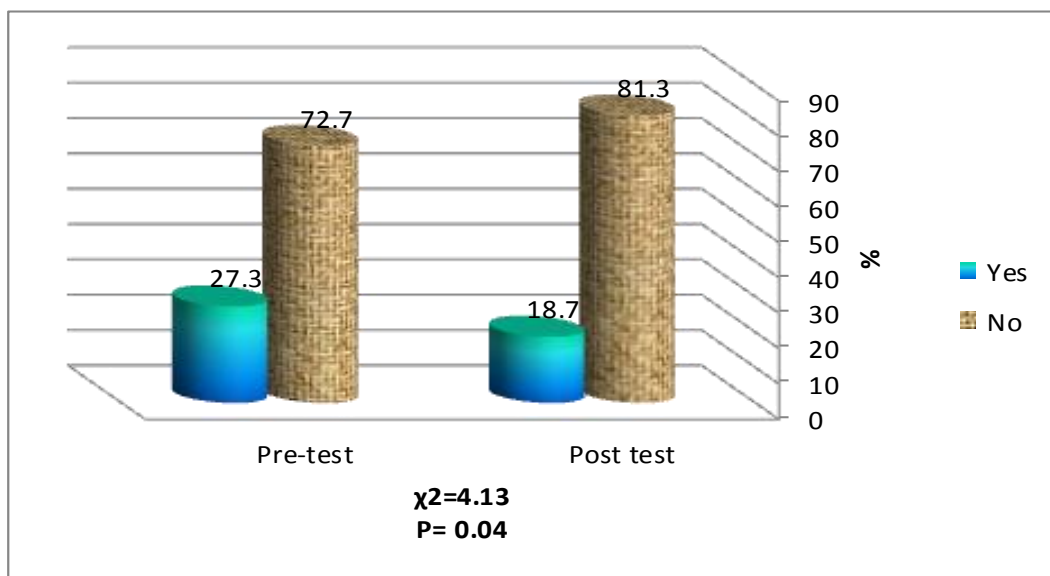


Figure 1: Represented a comparison of mean score between pre and post-intervention regarding Catching VAP. It was evident that the percent of pediatric catching VAP was reduced from 27.3% to 18.7% after the intervention. Therefore, there were statistically significant differences between the percent of children who were catching VAP on pre and post intervention at a 5% level of significance.

### Discussion

VAP is the most frequent nosocomial infection in mechanically ventilated children. It is also associated with significant morbidity, increased ventilator days and higher medical cost that leads to a high mortality rate in PICU [37; 38]. VAP is a marked health hazard for mechanically ventilated infants and children. [39; 40;41]

### Socio-demographic characteristics of studied nurses working in PICU:

The present study revealed that 48.6 % of studied pediatric nurses their age from 18- <26 years, this result was similar to the previous study with Al-Shameri [4]. Concerning total clinical experience in PIC about 48.6 % of pediatric nurses in the present study had 1-4 years of experience in PICU, whereas,



the present study was similar with **Badawy [42]**, who studied the Impact of a Structured Teaching Program for Prevention of VAP on Knowledge and Practices of Intensive Care Nurses at Central Quwesna Hospital, Egypt. And **Dana [43]** who found that 43.3% of the nurses had 1-5 years of clinical experience in PICU. Regarding PICU training, the present study finding revealed that 34.3% were received PICU training. This result was inconsistent previous finding by **Said A. [7]** reported that 90% had no ICU training.

### Characteristics of mechanically ventilated children in PICU

Descriptive statistics of the present study analyzed that 46.4% and 47.0% of ventilated children in PICU were in the age group < 1 year, 30.4 % and 31.3% were 1-< 5 Years, 17.5% and 13.1% were 5-10 Years, 5.7% and 8.6% were >10 years on pre-intervention and post-intervention respectively. And most children were hospitalized pediatric were male. This study was approximately convenient to study by **Haque et al., [44]**, who studied "Implementation of ventilator bundle in PICU of a developing country" who found that (69%) of the PICU was male.

Concerning diagnosis, the present study results revealed that (30.2 % vs. 29.7 %) of ventilated children whose catching VAP have diagnosed with convulsions followed by Cerebral palsy (20.8% vs. 18.9 %), Failure to thrive (17.0% vs. 13.5 %) Head trauma (13.2% vs. 8.1%), Chronic kidney disease(11.3% vs. 10.8 %), And Chronic heart disease (7.5% vs. 19.0 %) on pre-intervention and post-intervention respectively. This result was approximately similar to the previous prospective cohort study was conducted in PICU, Ain Shams university hospital in Cairo, Egypt, by **Deraz et al. [11]**. They reported that patient groups who developed VAP showed significantly higher emergency admission to PICU and highly significant underlying medical emergency or conditions compared to surgical conditions. They analyzing causes of admission of o studied group to the PICU; it was found that chest diseases were the most common illness admitted to PICU among the studied group (28%), followed by CVS diseases and CNS diseases (20%) each, blood diseases16%, (12%) abdominal diseases and (4%) endocrinal diseases [11]. In contrast to our study, **Joseph and coworkers [45]** and **Maher and Bateman, [46]** found that, the most common primary PICU admitting diagnostic classification was the cardiovascular system (75%).

### Effect of the bundle of care guidelines intervention on nurses' knowledge

The present study showed a Significantly improvement for studied pediatric nurse's knowledge in post-intervention than pretest , nurses had improved their excellent ,very good , good, Average and Poor knowledge level on posttest from 0.0%,5.7%,14.3%,31.4 %, and 48.6% pre-intervention to11.4%,25.7 %,34.3 %,17.2 % and 11.4% post-intervention respectively. The present study results were in line with **Said [7]**.Who studied Knowledge and Practice of Intensive Care Nurses on Prevention of



Ventilator-Associated Pneumonia at Muhimbili National Hospital, Dar El Salaam, Tanzania. They reported that knowledge levels were scored as follows: (54.2%) excellent, (16.1%) very good, (19.5%) good, (8.5%) average, and (1.7) poor post-intervention (1). Also, the present study result was consistent with **Feria, [32]** who studied "VAP Bundle Prevention Strategies in PICU" they reported that most of the nurses had adequate Knowledge post-intervention.

Also, the present study showed a statistically significant improvement Score of total Mean of nurse's knowledge in post-intervention  $16.11 \pm 1.71$  than pre-intervention  $5.68 \pm 1.39$ . The present study results were consistent with, **[42,46]** they reported increased total knowledge score immediately after the VAP prevention program.

#### **Effect of the bundle of care guidelines intervention on nurses' VAP Prevention/management kills in PICU**

Also, the present study showed a statistically significant improvement for pediatric nurses' skills after application of the bundle of care guidelines for VAP, 68.6% of nurses had more satisfactory excellent skills toward ventilator-associated pneumonia post-intervention compared to 20.0% on pre-intervention. This study was approximately similar to **Said. [7]; Mbithe [47]** who found inadequate skills of the PICU nurses on VAP preventive strategies. These findings support earlier study **Polit et al., [48]** that reported low and moderate levels of adherence to recommended skills. Also the present study results were consistent with **Badawy, A. [42]; Rello et al., [45]; Mbithe [47]; Morrow et al., [49]** They stated that total skills score increased immediately after the intervention of a care bundle approach for VAP prevention. Moreover, these present findings agree with previous researches were implemented by **Azab, [50]** who studied "Reducing VAP in a neonatal intensive care unit using "VAP prevention Bundle".

Regarding performing our study reported statistical and highly statistically significant differences in VAP skills on posttest (74.3%) were Observed/verbalized compared to 28.6% on pretest. These present findings assure the findings of **Koff et al. (51)**, who studied "Reduction in VAP in a mixed intensive care unit after initiation of a new hand hygiene program.", **Johnston, et al., [38]**, and **Sebastian, et al., [52]** who proceed their study on "Oral mucosal decontamination with chlorhexidine for the prevention of VAP in children".

#### **Effect of the bundle of care guidelines intervention on VAP occurrence of children in PICU**

The current study, a statistically significant difference between children pre and post-intervention of VAP bundle implementation concerning the reduction of VAP occurrence was reported. This result was in line with **Rello [53]**, who reported that the incidence of VAP decreased from 15.5% to 11.7%, post application of bundle of care approach for prevention of VAP. **Brilli et al. [47]** reported that VAP rates decreased from 7.8 to 0.5 cases per 1,000 ventilator days after the implementation of VAP





bundle guidelines prevention. Also, the implementation of ventilator bundle for mechanically ventilated children can significantly decreasing VAP even in the countries with limited resource [44, 48]. These findings also matched with Al Khader [49], Osman [50], and Charles, et al. [51]. Esteban et al. [25] reported decreased VAP rates from 28.3 to 10.6 As evaluation of the long-term outcomes of a VAP bundle prevention project(period of 12-month post-intervention)

Similarly, Perugini et al., [54] and Rosenthal et al., [9] were conducted study in several countries, including Philippines, Columbia, India, Turkey and El Salvador. They implemented the VAP bundle and reported that the VAP rate was reduced from 11.7 cases to 8.1 cases for every 1,000 ventilator days. One noteworthy VAP bundle prevention study by Brillì et al. [55] reported that VAP rates decreased from 7.8 to 0.5 cases per 1,000 ventilator days. These similar findings between the present study results and those later authors were attributed to similarities in the effect of the bundle of care guidelines on the occurrence of VAP in the pediatric intensive care unit [56]. these findings also coordinated with Al Khader [57], Osman [58], and Charles, et al. [59] and Alsoda et al., 2020 [60] who study Implementation of ventilator bundle for prevention of VAP in PICU. They reported that The VAP rate decreased from 50 to 14% through compliance with the ventilator bundle

#### **Conclusion:**

Application of Bundle of care guidelines related to VAP was effective in improving pediatric nurses ' knowledge and skills related to VAP. After the intervention, the percent of VAP occurrence among infants/children attending PICU was reduced post-intervention than in pre-intervention.

#### **Recommendations:**

- 1- Application of bundle of care guidelines related to VAP essential to maintain optimal health and survival of ventilated children attending PICU.
- 2- There are establishing nurses in-service training programs for enhancing knowledge and practice leveling of about infection control issues, especially bundle of care guidelines related to VAP in PICU.
- 3- For the faculties of nursing: care of mechanical ventilation and the preventing guidelines for VAP should be involved in the nursing curriculum to have adequate basic knowledge and skills for students.
- 4- Further studies in a large number of children in PICU related VAP to highlight the role of the pediatric nurse in enhancing the quality of care.



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