

# Nurses Knowledge and Practice to Evidence-based Guidelines for the Prevention of Ventilator Associated Pneumonia in Pediatric Intensive Care Units

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**Abstract: Background:** Ventilator associated pneumonia is the most common hospital-acquired infection among patients receiving mechanical ventilation in pediatric intensive care unit. Using an evidence based guidelines for the prevention of ventilator associated pneumonia (VAP) are recommended. **Objectives:** to investigate nurses' knowledge and practice toward evidence-based guidelines for the prevention of ventilator associated pneumonia in pediatric intensive care units **Methods:** A quasi- experimental pre-post intervention study was done on 51 nurses of different categories working in medical, neurology and surgical ICU at Mansoura University children's Hospital, Egypt. Three tools were used; An interview questionnaire sheet was developed by the researcher in Arabic language. Nurses' knowledge of evidence-based guidelines for the prevention of VAP, multiple choice questionnaire and observational checklist for nurses' performance to ventilator bundles for VAP prevention. **Results:** mean score level of nurses general knowledge about VAP, Knowledge of Evidence-based guidelines for VAP prevention and nurses performance to ventilator bundled for VAP prevention where the mean score were  $8.6078 \pm 1.9908$ ,  $2.4706 \pm 1.3469$ ,  $2.1400 \pm 1.4287$  respectively before program implementation compared to  $12.1569 \pm 1.0464$ ,  $7.2941 \pm 1.7005$ ,  $5.5800 \pm 1.5265$  respectively after program. There is a highly significant difference between nurses knowledge and practices to Evidence-based guidelines for prevention of VAP before and after the program ( $t = -11.059$ ,  $-22.106$ ,  $-13.796$  and  $p = .000$ ,  $0.000$ ,  $0.000$  respectively). **Conclusion:** Adequate improvement in nurses' knowledge and practice after applied evidence based guidelines for prevention of ventilator associated pneumonia in pediatric intensive care unit.

**Keyword:** Evidence based guidelines; nurses knowledge and practice; pediatric intensive care; ventilator associated pneumonia.

## INTRODUCTION

Ventilator-associated pneumonia is develops later than or at 48 hours after the pneumonia in mechanically-ventilated patient has been placed on mechanical patients in intensive care units that ventilation.<sup>(1-3)</sup> VAP is the second most

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common hospital-acquired infection among pediatric intensive care unit (PICU) patients.<sup>(4)</sup> Empirical therapy for VAP accounts approximately 50% of antibiotic use in ICUs, surveillance studies of nosocomial infections in ICU patients indicate that pneumonia comprises 6.8 to 32.3% of nosocomial infections in this setting.<sup>(5,6)</sup>

The incidence of VAP attributed mortality is difficult to quantify due to the possible confounding effect of associated conditions, but VAP is thought to increase the mortality of the underlying disease by about 30%. VAP is also associated with considerable morbidity, including prolonged ICU length of stay, prolonged mechanical ventilation, and increased costs of hospitalization.<sup>(7,8)</sup>

Ventilator associated pneumonia is typically categorized as either early-onset occurring in the first 3-4 days of mechanical ventilation or late-onset, this distinction is important microbiologically.<sup>(9)</sup>

Early onset VAP is commonly caused by antibiotic-sensitive community acquired organisms, while late-onset VAP is commonly caused by antibiotic-resistant nosocomial organisms.<sup>(10)</sup> According to Centers of Disease Control and Prevention, the risk factors of VAP are thought to develop from the aspiration of oropharyngeal secretions containing potentially pathogenic organisms, aspiration of gastric secretions, supine position, and prolonged use of ventilatory support or potential exposure to contamination of ventilatory accessories, such as ventilator tubing, as well as poor infection control techniques by health care staff, and poor oral hygiene.<sup>(11, 12)</sup>

The guidelines are designed to reduce the incidence of nosocomial pneumonia and is intended for use by personnel who are responsible for surveillance and control of infection in pediatric intensive care unit. When clinicians follow the care bundle guidelines for every patient it has been

proven that this can reduce or eliminate VAP.<sup>(7)</sup> A care bundle is a cohesive set of evidence-based, well-established clinical practices that, when implemented together, achieve better patient outcomes than when implemented individually.<sup>(6)</sup> There is evidence in pediatrics that implementing a VAP prevention bundle, especially with a coordinated, multidisciplinary approach, can result in significant, sustained reduction in VAP rates, hospital length of stay, and costs.<sup>(13)</sup>

Most of the children in the intensive care units are intubated and on ventilatory support. Intubated children are at increased risk of acquiring VAP because mechanical ventilation is the primary risk.<sup>(13)</sup> Nurses lack of knowledge may be a barrier to the adherence to evidence-based guidelines for preventing ventilator associated pneumonia.<sup>(14)</sup> As VAP is preventable and many practices have been demonstrated to reduce the incidence of VAP and its associated burden of illness,

so educating health care workers who care for children receiving mechanical ventilation about the causes, manifestation, patho-physiology, risk factors and evidence-based preventive measures of VAP would promote nurses awareness for efficient quality of care and consequently decrease morbidity of ventilator associated pneumonia in pediatric intensive care setting.

### **Aim of the study**

The aim of this study is to investigate nurses' knowledge and practice toward evidence-based guidelines for the prevention of ventilator associated pneumonia in pediatric intensive care units

### **Research Hypotheses**

1. Nurses have better knowledge about ventilator associated pneumonia and its prevention after implementation of training program regarding evidence based guidelines.
2. Nurses' practice related to ventilator bundles improved after

implementation of training program regarding evidence based guidelines.

## **SUBJECTS AND METHODS**

### **Design**

A quasi- experimental pre-post design was used.

### **Setting and target population:**

The study was conducted in Pediatric Intensive Care units (medical, neurology and surgical ICU) at Mansoura University Children's Hospital, Egypt.

Official permission was obtained from the administrator of selected intensive care units to conduct the study.

### **Sample Size:**

1. The subjects of the study were all available nurses (n= 51) of different categories working at the previously mentioned setting and who were providing care to all mechanically ventilated children over a period of three months regardless of their age, qualification or years of experience.
2. Informed consent was obtained from

each nurse for participation after explaining the aim of the study and confidentiality of data.

3. Acceptance was obtained from ethical committee from faculty of nursing at Mansoura University to carry out the research.

## **METHODOLOGY:**

### **Data collection:**

The data were collected using the following (pre/ post format).

**First: An interview questionnaire sheet** was developed by the researcher in Arabic language after reviewing the related literatures.<sup>(9,15,16)</sup> the interview questionnaire was tested for its content validity by five jury members of pediatric and critical care nursing staff. A pilot study was done on five nurses to test the clarity of the questions and any unclear question was modified. The questionnaire comprised the following two parts

**Part I:** Sociodemographic data of the nursing staff such as age, years of

experience, level of education, working hours, previous training program about VAP prevention.

**Part II:** This part concerned nurses' knowledge regarding ventilator associated pneumonia such as knowledge about the definition, risk factors, causes, manifestations and diagnostic criteria.

**Second: Nurses' knowledge of evidence-based guidelines for the prevention of VAP Questionnaire:**

Validated multiple choice questionnaire adopted from Labeau *et al.* (2007) <sup>(17)</sup> that included questions about :

Oral vs. nasal route for endotracheal intubation, frequency of ventilator circuits changes, types of airway humidifier, frequency of humidifier changes, open vs. closed suction system, frequency of change in suction system, endotracheal tubes with extra lumen for drainage of subglottic secretion, kinetic vs. standard beds and Patient positioning. The nurses were interviewed individually to assess

their knowledge (pre-test). A scoring system was applied to knowledge questions. The maximum score for the knowledge questions was 25. A score 0 was given for each incorrect answer and a score 1 for each correct answer.

**Third: Observational checklist for nurses' performance to ventilator bundles for VAP prevention:**

Adopted from Arlene *et al.* (2007) <sup>(18)</sup> that measures the compliance of nursing staff to ventilator bundle that was recommended as evidence based guidelines for the prevention of VAP such as the following items: frequent hand washing by all care providers and careful infection control practice, elevating head of bed 30- 45 degrees, unless contraindicated, monitoring gastric residuals every 4 hours in enterally fed patients to prevent aspiration, performing oral care using oral swab and chloroxideine every 2 hours, using separate suction catheter for tubing

catheter and for oral suctioning, suction hypopharynx before endotracheal(ET), repositioning patient or repositioning ET tube and deflating cuff, using in – line ET tube suction system, keeping end of ventilator circuit, suction devices, manual ventilation bag and mask off the bed, draining ventilator condensate frequently without opening the circuit. Each nurse was observed by the researcher while performing the procedure of enteral feeding, suctioning, oral care, hand washing, bed positioning, and change of ventilator circuit from initiation of the procedure till termination to assess implementation of ventilator bundle as a clinical guidelines for prevention of ventilator associated pneumonia ( pre-test) during morning and afternoon shifts. Time consumed for assessing each procedure took 10-20 minutes. The maximum score for practice questions was 11. A score 0 was given for each skill that was not accomplished and a score 1 for each skill

that was accomplished by the nurses.

### **Educational program**

After assessing the nurses' baseline knowledge, they received an educational program that was designed and developed by the researcher according to the deficits and shortcomings in nurses' knowledge and performance that were identified in the pre-test.

Health education program was conducted in selected pediatric intensive care units, three sessions for each group were applied with total fifteen sessions in the form of face to face large group discussion. Each session covered about one hour. Several audiovisual aids were used such as flip charts, pictures, posters, handouts and data show for more clarifications. Applying practical procedure on patient inside intensive care unit was done first by the researcher followed by nurses' demonstration in front of researcher. This program was conducted over a period of two and half months.

Practical sessions covered the following items, hand washing and careful infection control practice, suctioning, positioning of bed, oral care using oral swab and chlorhexidine, care of ventilator equipment, and change of ventilator circuit.

Nurses' knowledge and practice were assessed after implementation of the program by using the same test format and observational checklist as during the pretest to determine the retained knowledge and practice of the nurses. Data were collected during six months starting from January to the end of June 2009.

#### **Statistical analysis:**

Data were analyzed using SPSS (Statistical Package for Social Sciences) version. The results of the pre-post test were compared using Wilcoxon Signed Ranks test (Z), t- test (Paired t-test), ANOVA test .A p-value  $\leq 0.05$  was considered as statistically significant. Means and standard deviations were reported as appropriate.

## **RESULTS**

Table (1) shows percentage distribution of the sample according to their sociodemographic data and general characteristics. It is found that 64.7% of nurses age ranged between 20 to less than 30 years and most of them 66.7% were working in general ICU (medical, neurological) while 33.3% of them were working in surgical ICU. Regarding their qualification more than half 56.9% had Bacaloryes, 37.3% had Diploma and only 5.8% had Technical Institute. In relation to nurses' experience in ICU, it was found that more than half of them 52.9% had experience from one to five years and only 15.7% had more than ten years experience. Also 51% of nurses their job title was Hakima, 29.4% were head nurses and 19.6% were sisters. More than half of nurses spent six hours work in ICU, 29.4% spent twelve hours and 15.7% of them spent eight hours. The majority of nurses

did not have previous training program on VAP prevention.

Table (2) shows percentage distribution of nurses general knowledge about VAP before and after educational program implementation. It is found that there is a significant difference in nurses general knowledge about ventilator associated pneumonia after the program than before the program regarding definition, causes, risk factors and causative organisms of VAP ( $z = 5.60, 6.52$  respectively,  $p\text{-value} = 0.000$ ). Also regarding nurses knowledge about the importance of performing hand washing, elevating head of bed to 30-45, times of suctioning per day, oral care to child connected to ventilator, the results reveal significant difference in nurses knowledge after the program compared to before ( $z = 3.19, 5.099, 5.76, 4.243, 4.359, 3.317, 2.83$ ) respectively and  $p$  value 0.0014, 0.000, 0.001, 0.0044). No significant difference in nurses knowledge before and after the program was found

regarding diagnostic criteria of VAP, and the use of anti acid for children connected to ventilator.

Table (3) shows that there was a highly significant difference in nurses knowledge after program implementation than before regarding items of evidence –based guidelines for VAP prevention such as oral vs. nasal route for endotracheal intubation, frequency of ventilator circuits changes, types of airway humidifier, frequency of humidifier changes, open vs closed suction systems, frequency of change in suction system, endotracheal tubes with extra lumen for drainage of subglottic secretion, kinetic vs standard beds and patient positioning ( $z = 4.48, 3.14, 7.10, 7.37, 6.82, 3.48, 5.22, 6.93, 4.48$  and  $p$  value 0.00008, 0.001692, 0.000497, 0.000 respectively).

Regarding percentage distribution of nurses practices to ventilator bundles as evidence-based practices for the prevention of VAP before and after the



program in Table (4) there is a highly significant difference in nurses practice before and after the program regarding to frequent hand washing and using infection precaution devices, elevating head of bed 30-45 degree unless contraindicated, monitoring gastric residuals every 4 hours in enterally fed patients, performing oral care every 2 hours and suction of hypopharynx before repositioning patient, repositioning endotracheal tube and deflating cuff, using in-line ET tube suction system, keeping end of ventilator circuit, suction devices, manual ventilation bag and mask off the bed (  $z= 5.83, 7.55, 6.60, 3.35, 6.34, 4.359, 4.899, 2.18$  respectively  $p= 0.000000, 0.000802, 0.029$  ). Meanwhile, no significant difference regarding using separate suction catheter for tubing catheter for oral suctioning, suction hypopharynx before endotracheal insertion and draining ventilator condensate frequently without opening circuit.

Table (5) shows mean score level of nurses general knowledge about VAP, knowledge of evidence-based guideline for VAP prevention and nurses practices to ventilator bundles for VAP prevention where the mean score was  $8.6078 \pm 1.9908$ ,  $2.4706 \pm 1.3469$  and  $2.1400 \pm 1.4287$  respectively before program implementation compared to  $12.1569 \pm 1.0464$ ,  $7.2941 \pm 1.7005$  and  $5.5800 \pm 1.5265$  respectively after the program.

## DISCUSSION

Educating health care workers who care for patients receiving mechanical ventilation can decrease the rate of ventilator associated pneumonia.<sup>(19)</sup> In times of limited resources, focusing health care workers efforts on the prevention of ventilator associated pneumonia is important.<sup>(20)</sup> The results of this study reveal that 52.9% of the sample had one to five years experience in intensive care units that may be the cause of decreasing

knowledge about the risk factors for developing VAP. This is corresponding with Ricart et al.,(2003)<sup>(21)</sup> who clarified that nurses with < 1 year experience had less knowledge and performed worse than nurses with many years of experience.

This study demonstrated that an educational program was associated with improvement in nurses' knowledge about the problems of ventilator associated pneumonia in pediatric settings (table 2) especially for the definition, causes, risk factors and prevention of VAP. While their knowledge about diagnostic criteria of VAP and use of antacid for children connected to ventilator were positive and stable before and after implementation of educational program. This finding is supported by Babcock et al.,(2007)<sup>(22)</sup> who stated that upgrading and improving nurses knowledge about VAP can be associated with efficient care and consequently decrease morbidity of the disease.

Study made by El-khatib et al.(2009)<sup>(23)</sup>

illustrated that educational program can have positive effects on nurses' knowledge and play a vital role in influencing clinical practice especially in prevention of ventilator associated pneumonia. Mentioned study insists on an adequate level of nurse staffing information must be maintained to get better results with their patients. The above findings find supporting the present study as nurses knowledge was found to be poor before giving educational program compared to after program implementation especially regarding frequency of humidifier changes, open vs closed suction system, endotracheal tubes with extra lumen for drainage of subglottic secretions and kinetic vs standard beds( table 3).

Regarding to nurses knowledge about route of endotracheal intubation most of them mentioned that oral route is used by doctors and sometimes both routes were used according to doctors decision without knowing the reason and which is the best

way for prevention of VAP, but after the program 90.2% of them know that oral route is recommended than nasal route. Invasive procedure as intubation for more than 72 hours is considered one risk factor of nosocomial infection including ventilator associated pneumonia because mechanical ventilator support cannot be performed without the endotracheal tube.<sup>(24,25)</sup>

Gauvian *et al.*,<sup>(26)</sup> (2003) and Dodek *et al.*,<sup>(27)</sup> (2004). Other studies concluded that oral intubation is associated with a lower incidence of VAP compared with nasotracheal intubation that prevents drainage of the sinuses and might increase the risk of sinusitis and VAP.

A study made by Almuneef *et al.*,<sup>(28)</sup> (2004) stated that the risk factors associated with ventilator associated pneumonia in pediatric intensive care units in Saudi Arabia were aspiration of oral and/or gastric secretions which is the primary route of bacterial entry into the

lungs and is believed to be a primary factor in the development of VAP, and In the current study, the lowest score achieved by all participant's categories were regarding the question of using endotracheal tubes with extra lumen for drainage of subglottic secretion 2% before compared to 49% after program implementation.

In relation to nurses knowledge about frequency of humidifier changes and use of open vs closed suction system, their response were low before 17.6%, 7.8% compared to 92.2%, 76.5% after the program respectively. This low score before program implementation might be influenced by the clinical practice of the technician who are in charge of managing these systems. these results come in accordance with that reported by<sup>(29)</sup> Memish *et al.* (2001) and Zeitoun *et al.* (2001),<sup>(29,30)</sup> who mentioned that frequency of humidifier changes is the responsibility of the respiratory therapists who may be influenced by manufactures'

recommendations to change heat and moisture exchange filters every 48 hours. Studies concluded that infrequent changes to heat and moisture exchangers may be associated with a slightly decreased incidence of VAP, as well as the use of closed suction systems that are changed for each new patients and as clinically indicated

Regarding to nurses practice to ventilator bundles for the prevention of VAP as evidence based practice (table 4). Significant changes were noted in nurses' hand washing practices before contact with a patient with a rate of 47.1% as base compared with 100% after intervention. This result agreed with Boyce & Pittet (2002)<sup>(31)</sup> who noticed an observed changes in nurses' practice of hand washing that indicated some level of professionalism and awareness among nurses regarding proper hand washing. Decontamination of hands before and after contact with a patient along with wearing

gloves is an important action taken for reducing infection.<sup>(32,33)</sup>

Patient positioning specially keeping the head of bed elevated at least 30 -45 degrees unless medically contraindicated is an essential strategy to minimize aspiration of oral and gastric secretions and consequently decrease incidence of VAP.<sup>(33)</sup> the present study elevating head of bed (HOB) used with a rate of 7.8% before intervention compared to 84.3% after intervention. Some nurses reported that semi-recumbent positioning may be unsafe for some patients, this come in accordance with a recent study by Grap et al.,(2005)<sup>(34)</sup> who stated that the mean HOB elevation in patients receiving mechanical ventilation was consistently lower than the recommendations of 30-to 45.

In a study of critically ill long –term-care residents performed by Hanneman & Gusick (2005)<sup>(35)</sup> who investigated the association between dental plaque colonization and the lower respiratory tract

infection, their findings suggested that dental plaque could serve as a reservoir for microorganisms, so oral decontamination is an effective method for reducing VAP. In the present study oral care every two hours was practiced by 2% only of nurses before compared to 27.5% after program implementation. A study made by Bouza and Rincon, (2008)<sup>(36)</sup> found that the nurses self- report more frequent oral care than is documented. The mean documented frequency of oral care in intubated patients was 3.3 episodes during a 24-hours period while the self-report frequency was 4.2 episodes. The AACN procedure manual for critical care recommend brushing teeth with a pediatric or soft toothbrush twice daily, using oral swabs, applying mouth moisturizer to the oral mucosa and lips every 2 to 4 hours, suctioning oral cavity and pharynx frequently, changing oral suction equipment and tubing every 24 hours.<sup>(37,38)</sup> The current study stated that 31.4% of

nurses used separate suction catheter for oral suctioning before the program compared to 41.2% after the program, this could be attributed to insufficient supplies.

Draining subglottic secretions reduced the incidence of VAP by nearly half and reducing the length of stay in ICU by 3.1 days compared with standard endotracheal care, so removal of these secretions by using closed suction system decreases environmental contamination of the respiratory device, consequently reduces the risk of aspiration and could be the most cost effective and save intervention.<sup>(38)</sup> Deep subglottic suctioning can be done routinely during patient assessment and as needed for endotracheal tube repositioning and or patient transport.<sup>(39)</sup> In the current study there was a significant change in nurses practices after the program than before regarding suctioning through repositioning patient and repositioning endotracheal tube and deflating cuff.

This study clarifies that there is an

improvement in nurses practice in relation to draining ventilator condensate frequently without opening circuit 17.2% before compared to 92.2% after the program. This agreed with Pruitt and Jacob (2006).<sup>(40)</sup> who stated that maintaining a closed circuit reduces the opportunity for contamination to occur from outside pathogens. In addition Centers of Disease Control and Prevention recommend that circuit changes should occur when the circuit has become visibly soiled rather than routinely.<sup>(41,42)</sup>

Upgrading and improving pediatric intensive care nurses knowledge and practice can be associated with changing their attitudes and behaviors toward children care and consequently decreasing hospital acquired infections mainly ventilator associated pneumonia.<sup>(43,44)</sup> Regarding mean score level of nurses knowledge and practice to evidence based guidelines and ventilator bundle for prevention of ventilator associated pneumonia (table 4) there was an observable change after program implementation than

before.

#### **CONCLUSION AND RECOMMENDATION:**

This study concluded that there is an adequate improvement in nurses' knowledge and practice to evidence based guidelines for prevention of ventilator associated pneumonia in pediatric intensive care units after implementation of educational program. This study reported that there is no previous guideline for prevention of ventilator associated pneumonia at Mansoura pediatric intensive care units. Repeated educational program to all staff working in ICU including technician and respiratory therapists is important to raise the awareness of all personnel about the problem. Posters and handouts to raise the awareness of VAP and the evidence based guidelines for the prevention of ventilator associated pneumonia should be placed within the ICU. Another study is recommended to investigate the level of nursing compliance with ventilator bundle for the prevention of ventilator associated pneumonia.

**Table (1): Percentage Distribution of the Sample According to Their Sociodemographic Data and General Characteristics (n=51)**

| Items   | Frequency | Percent |
|---|-----------|---------|
| Age in years  |           |         |
| 20- < 30  | 33        | 64.7    |
| 30- < 40  | 15        | 29.4    |
| 40+   | 3         | 5.9     |
| Place of work   |           |         |
| General ICU (medical, neurological )                  | 34        | 66.7    |
| Surgical ICU  | 17        | 33.3    |
| Qualification   |           |         |
| Bacaloryes ( BSC)                                     | 29        | 56.9    |
| Technical Institute                                   | 3         | 5.8     |
| Diploma   | 19        | 37.3    |
| Years of experience in ICU                            |           |         |
| 1-5   | 27        | 52.9    |
| 6-10  | 16        | 31.4    |
| > 10  | 8         | 15.7    |
| Job title   |           |         |
| Head Nurse  | 15        | 29.4    |
| Hakima  | 26        | 51.0    |
| Sister  | 10        | 19.6    |
| Hours spent in ICU                                    |           |         |
| 6   | 28        | 54.9    |
| 8   | 8         | 15.7    |
| 12  | 15        | 29.4    |
| Previously taken a training program on VAP prevention |           |         |
| Yes   | 10        | 19.6    |
| N0  | 41        | 80.4    |

**Table (2): Percentage Distribution of Nurses' General Knowledge About VAP Before and After Program Implementation (n= 51)**

| Items   | Before program |      | After program |      | Test of Significance |         |
|---|----------------|------|---------------|------|----------------------|---------|
|   | No.            | %    | No.           | %    | Z-test               | p-value |
| <b>What is the VAP?</b>   |                |      |               |      |                      |         |
| Incorrect   | 29             | 56.9 | 2             | 3.9  | 5.60                 | 0.000   |
| Correct   | 22             | 43.1 | 49            | 96.1 |                      |         |
| <b>Causes of VAP?</b>   |                |      |               |      |                      |         |
| Incorrect   | 32             | 62.7 | 4             | 7.8  | 5.60                 | 0,000   |
| Correct   | 19             | 37.3 | 47            | 92.2 |                      |         |
| <b>Risk factors of VAP?</b>   |                |      |               |      |                      |         |
| Incorrect   | 36             | 70.6 | 3             | 5.9  | 6.52                 | 0.000   |
| Correct   | 15             | 29.4 | 48            | 94.1 |                      |         |
| <b>Causative organisms?</b>   |                |      |               |      |                      |         |
| Incorrect   | 36             | 70.6 | 3             | 5.9  | 6.52                 | 0,000   |
| Correct   | 15             | 29.4 | 48            | 94.1 |                      |         |
| <b>Diagnostic criteria of VAP?</b>  |                |      |               |      |                      |         |
| Incorrect   | 4              | 7.8  | 4             | 7.8  | 0.87                 | 0.385   |
| Correct   | 47             | 92.2 | 47            | 92.2 |                      |         |
| <b>Prevention of VAP?</b>   |                |      |               |      |                      |         |
| Incorrect   | 15             | 29.4 | 2             | 3.9  | 3.19                 | 0.001   |
| Correct   | 36             | 70.6 | 49            | 96.1 |                      |         |
| <b>When should perform hand washing?</b>  |                |      |               |      |                      |         |
| Incorrect   | 41             | 80.4 | 15            | 29.4 | 5.10                 | 0.000   |
| Correct   | 10             | 19.6 | 36            | 70.6 |                      |         |
| <b>Elevating head of the bed 30-45 is important or not?</b>                     |                |      |               |      |                      |         |
| Incorrect   | 30             | 58.8 | 2             | 3.9  | 5.76                 | 0.000   |
| Correct   | 21             | 41.2 | 49            | 96.1 |                      |         |
| <b>Is suction important to child related to a ventilator?</b>                   |                |      |               |      |                      |         |
| Incorrect   | 22             | 43.1 | 4             | 7.8  | 4.23                 | 0.000   |
| Correct   | 29             | 56.9 | 47            | 92.2 |                      |         |
| <b>How many times per day?</b>  |                |      |               |      |                      |         |
| Incorrect   | 22             | 43.1 | 3             | 5.9  | 4.36                 | 0.000   |
| Correct   | 29             | 56.9 | 48            | 94.1 |                      |         |
| <b>Do you use anti-acid for children related to a ventilator?</b>               |                |      |               |      |                      |         |
| Incorrect   | 23             | 45.1 | 18            | 35.3 | 0.71                 | 0.478   |
| Correct   | 28             | 54.9 | 33            | 64.7 |                      |         |
| <b>Oral hygiene is important for children connected to a ventilator or not?</b> |                |      |               |      |                      |         |
| Incorrect   | 13             | 25.5 | 2             | 3.9  | 3.32                 | 0.001   |
| Correct   | 38             | 74.5 | 49            | 96.1 |                      |         |
| <b>How many times you clean the baby's mouth a day?</b>                         |                |      |               |      |                      |         |
| Incorrect   | 46             | 90.2 | 33            | 64.7 | 2.84                 | 0.004   |
| Correct   | 5              | 9.8  | 18            | 35.3 |                      |         |

Statistical significant (P<0.05)



**Table (3): Percentage Distribution of Nurses Knowledge About Evidence –Based Guideline for Prevention of VAP Before and After the Program (n=51)**

| Items  | Before program |      | After program |      | Test of significance |          |
|--|----------------|------|---------------|------|----------------------|----------|
|  | No.            | %    | No.           | %    | Z-test               | p- value |
| <b>Oral vs. nasal route for endotracheal intubation</b>                          |                |      |               |      |                      |          |
| • Incorrect  | 27             | 52.9 | 5             | 9.8  | 4.48                 | 0.000008 |
| • Correct  | 24             | 47.1 | 46            | 90.2 |                      |          |
| <b>Frequency of ventilator circuits changes</b>                                  |                |      |               |      |                      |          |
| • Incorrect  | 21             | 41.2 | 6             | 11.8 | 3.14                 | 0.001692 |
| • Correct  | 30             | 58.8 | 45            | 88.2 |                      |          |
| <b>Type of airway humidifier</b>   |                |      |               |      |                      |          |
| • Incorrect  | 38             | 74.5 | 2             | 3.9  | 7.10                 | 0.000000 |
| • Correct  | 13             | 25.5 | 49            | 96.1 |                      |          |
| <b>Frequency of humidifier changes</b>   |                |      |               |      |                      |          |
| • Incorrect  | 42             | 82.4 | 4             | 7.8  | 7.37                 | 0.000000 |
| • Correct  | 9              | 17.6 | 47            | 92.2 |                      |          |
| <b>Open vs. closed suction systems</b>   |                |      |               |      |                      |          |
| • Incorrect  | 47             | 92.2 | 12            | 23.5 | 6.82                 | 0.000000 |
| • Correct  | 4              | 7.8  | 39            | 76.5 |                      |          |
| <b>Frequency of change in suction systems</b>                                    |                |      |               |      |                      |          |
| • Incorrect  | 28             | 54.9 | 10            | 19.6 | 3.48                 | 0.000497 |
| • Correct  | 23             | 45.1 | 41            | 80.4 |                      |          |
| <b>Endotracheal tubes with extra lumen for drainage of subglottic secretions</b> |                |      |               |      |                      |          |
| • Incorrect  | 50             | 98.0 | 26            | 51.0 | 5.22                 | 0.000000 |
| • Correct  | 1              | 2.0  | 25            | 49.0 |                      |          |
| <b>Kinetic vs. standard beds</b>   |                |      |               |      |                      |          |
| • Incorrect  | 49             | 96.1 | 14            | 27.5 | 6.93                 | 0.000000 |
| • Correct  | 2              | 3.9  | 37            | 72.5 |                      |          |
| <b>Patient positioning</b>   |                |      |               |      |                      |          |
| • Incorrect  | 31             | 60.8 | 8             | 15.7 | 4.48                 | 0.000007 |
| • Correct  | 20             | 39.2 | 43            | 84.3 |                      |          |

Statistical significant (P&lt;0.05)

**Table (4): Percentage Distribution of Nurses' Practice to Ventilator Bundles as Evidence-Based Practices for the Prevention of VAP Before and After the Program (n=51)**

| Items   | Before program |       | After program |       | Test of significance |          |
|---|----------------|-------|---------------|-------|----------------------|----------|
|   | No.            | %     | No.           | %     | Z-test               | p-value  |
| <b>Frequent hand washing and using infection precaution devisees by all care providers:</b>             |                |       |               |       |                      |          |
| Done  | 24             | 47.1  | 51            | 100.0 | 5.83                 | 0.000000 |
| Not done  | 27             | 52.9  | 0             | 0.0   |                      |          |
| <b>Elevate head of bed 30- 45 degrees, unless contraindicated</b>                                       |                |       |               |       |                      |          |
| Done  | 4              | 7.8   | 43            | 84.3  | 7.55                 | 0.000000 |
| Not done  | 47             | 92.2  | 8             | 15.7  |                      |          |
| <b>Monitor gastric residuals every 4 hours in enterally fed patients to prevent aspiration</b>          |                |       |               |       |                      |          |
| Done  | 5              | 9.8   | 39            | 76.5  | 6.60                 | 0.000000 |
| Not done  | 46             | 90.2  | 12            | 23.5  |                      |          |
| <b>Perform oral care every 2 hours consisting of brushing with oral swab</b>                            |                |       |               |       |                      |          |
| Done  | 1              | 2.0   | 14            | 27.5  | 3.35                 | 0.001    |
| Not done  | 50             | 98.0  | 37            | 72.5  |                      |          |
| <b>Use separate suction catheter for tubing catheter for oral suctioning</b>                            |                |       |               |       |                      |          |
| Done  | 16             | 31.4  | 21            | 41.2  | 0.82                 | 0.410    |
| Not done  | 35             | 68.6  | 30            | 58.8  |                      |          |
| <b>Suction hypo pharynx before:-</b>  |                |       |               |       |                      |          |
| a) endotracheal (ET)  |                |       |               |       |                      |          |
| Done  | 47             | 92.2  | 50            | 98.0  | 0.90                 | 0.369    |
| Not done  | 4              | 7.8   | 1             | 2.0   |                      |          |
| b) repositioning patient or   |                |       |               |       |                      |          |
| Done  | 3              | 5.9   | 34            | 66.7  | 6.34                 | 0.000    |
| Not done  | 48             | 94.1  | 17            | 33.3  |                      |          |
| c) repositioning ET tube and deflating cuff   |                |       |               |       |                      |          |
| Done  | 3              | 5.9   | 22            | 43.1  | 4.36                 | 0.000    |
| Not done  | 48             | 94.1  | 29            | 56.9  |                      |          |
| <b>Use in- line ET tube suction system</b>  |                |       |               |       |                      |          |
| Done  | 5              | 9.8   | 29            | 56.9  | 4.90                 | 0.000    |
| Not done  | 46             | 90.2  | 22            | 43.1  |                      |          |
| <b>Keep end of ventilator circuit, suction devices, and manual ventilation bag and mask off the bed</b> |                |       |               |       |                      |          |
| Done  | 12             | 23.5  | 29            | 56.9  | 2.18                 | 0.030    |
| Not done  | 39             | 76.5  | 22            | 43.1  |                      |          |
| <b>Drain ventilator condensate frequently without opening circuit</b>                                   |                |       |               |       |                      |          |
| Done  | 0              | 0.0   | 47            | 92.2  | 1.52                 | 0.128    |
| Not done  | 51             | 100.0 | 4             | 7.8   |                      |          |

Statistical significant (P&lt;0.05)

**Table (5): Mean Score Level of Nurses' General Knowledge, Evidence-Based Guideline and Practices of Ventilator Bundles for Prevention of VAP Before and After Program (n=51)**

| Items   | Before program |        | After program |        | Test of significance |         |
|---|----------------|--------|---------------|--------|----------------------|---------|
|   | Mean           | SD     | Mean          | SD     | t-test               | p-value |
| 1. General knowledge about VAP                                | 8.6078         | 1.9908 | 12.1569       | 1.0464 | -11.059              | .000    |
| 2. Knowledge of evidence-based guideline for VAP prevention   | 2.4706         | 1.3469 | 7.2941        | 1.7005 | -22.106              | 0.000   |
| 3. Nurses' practices to ventilator bundles for VAP prevention | 2.1400         | 1.4287 | 5.5800        | 1.5265 | -13.796              | 0.000   |

Statistical significant (P<0.05)

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