

## Current Nursing Practice for Prevention of Ventilator Associated Pneumonia in ICUs

Nahed Kandeel and Nayera Tantawy

Critical Care Nursing Department, Faculty of Nursing, Mansoura University, Egypt  
[Nahed\\_Kandeel2000@yahoo.com](mailto:Nahed_Kandeel2000@yahoo.com)

**Abstract:** Ventilator-associated pneumonia (VAP) continues to be an important cause of morbidity and mortality in ventilated patient. Strategies for prevention of VAP is a significant concern for health care team in intensive care units (ICUs). Nursing practice for prevention of VAP would have a significant impact on patient outcome. The main aim of the study was to investigate the current nursing practice for prevention of VAP in ICUs. The study involved a convenient sample of 150 critical care nurses. Data were collected from six ICUs at one University Hospital in Egypt between June 2011 and September 2011. Two methods were used for data collection including nurses' self administered questionnaire about the current practices for prevention of VAP, and direct observation of nursing care of mechanically ventilated patients. The results of the study revealed that there is no available protocol for VAP prevention in the studies ICUs. This explains the variation in nursing practice among ICUs, and why all evidences are not translated into practice. The findings of the study highlighted the need for developing and implementing a protocol for VAP prevention in ICUs. There is also a need for training programs for nurses on infection control and VAP preventive measures.

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### 1. Introduction

Ventilator-associated pneumonia is the most common intensive care unit acquired infection among patients receiving mechanical ventilation (**Rello et al., 2002; Pieracci and Barie 2007**). VAP is defined as a form of nosocomial pneumonia that occurs in patients receiving mechanical ventilation for greater than 48 hours (**Kollef, 1999**). It affects 8% to 27% of mechanically ventilated patients (**Chastre and Fagon 2002**). The rate of VAP in developing countries is higher than the National Healthcare Safety Network benchmark rates, and is associated with a significant impact on patient outcome (**Arabi et al., 2008**). The mortality rates in a patient with VAP range from 20 to 70% (**Heyland et al., 1999; Chastre and Fagon, 2002; Tejerina et al., 2006**). The predominant organisms responsible for infection are *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and Enterobacteriaceae (**Chastre and Fagon 2002**). Numerous risk factors for the development of VAP have been identified in the literature (**Bonten et al 2004; Maselli and Restrepo, 2011**). These factors are divided into modifiable and nonmodifiable (**Kollef, 1999; Tablan et al. 2004**). Modifiable risk factors involve the supine position, gastric overdistension, contamination of ventilator circuits, frequent patient transfers and low pressure of the endotracheal tube cuff. Nonmodifiable factors include male gender age over 60 years, acute respiratory distress syndrome, multiorgan failure, coma, chronic obstructive pulmonary disease, tracheostomy, re-intubation, neurosurgery and cranial trauma (**Kollef,**

**1999; Tablan et al. 2004**). Airway intubation was identified as the most important risk factor. VAP increases the duration of mechanical ventilation, prolongs ICU length of stay, increases mortality rate and increases health care costs (**Luna et al 2003; Gillespie 2009; Bonten, 2011**). The cost of VAP is approximately five-fold higher than non-infected patients (**Erbay et al, 2004**). Therefore, prevention of VAP was on the top of research agenda in intensive care medicine in the past 25 years (**Bonten, 2011**). The prevention of VAP is also a major challenge, and a significant concern for critical care nurses who care for mechanically ventilated patients. Critical care nurses have an important role in reducing risk factors, identifying early symptoms (**Myrianthefs et al., 2004**), and implementing relevant preventive measures. There is evidence that these measures decrease the incidence of VAP and improve patient outcome (**Maselli and Restrepo, 2011**). Various strategies and guidelines for prevention of VAP have been developed and recommended. The 2003 guidelines (**Tablan et al., 2004**) from The Centers for Disease Control and Prevention (CDC) in the United States of America (USA) provide recommendations for nursing practice. The CDC guideline has been implemented in the USA (**Manangan et al., 2000**). The greatest number of reports on VAP and its preventive measures in ICUs is published from USA and other European countries, but information on this area from Egypt is scarce. Hence, the main objective of this study was to investigate the current nursing

practice for prevention of VAP in ICUs at one University Hospital in Egypt.

## 2. Methodology

**Design:** This study has a descriptive design.

**Setting:** The study was conducted in six adult ICUs including surgical, general, neurological, medical, anesthesia, chest and hepatic ICUs at one University Hospital in Egypt.

**Sample:** The study included a convenient sample of 150 nurses who work in one of the studied ICUs, and who accepted to participate in the study.

**Tools:** Two tools were used for collecting data about the current practices for prevention of VAP in ICUs .

Tool 1: "**Nursing Practice for Prevention of VAP Questionnaire**"

The questionnaire was designed to investigate the measures critical care nurses use to reduce the rate of VAP. The questionnaire consisted of four sections. The first three sections were adopted from **Cason et al., (2007)** tool "The Oral Care Ventilator Patients Questionnaire" after making minor modifications. **Cason et al., (2007)** adapted this tool from **Sole et al (2001)** instrument "Techniques and Airway management Practices". The first section of the tool included questions on general characteristics of the participants: years of ICU experience, level of education, job title and the type of ICU where the participants worked. The second section involved questions about the CDC guidelines, such as the frequency of hand washing, use of gloves for oral care, subglottic suctioning, the degree of the head of the bed, and nurses' education about VAP. The third section involved questions about oral care practice (**Cason et al., 2007**). The fourth section of the questionnaire asked about the current practice for endotracheal tube route, suctioning and ventilator care. This section was developed by the investigators based upon relevant guidelines and literature (**Sole et al., 2002 1; Sole et al., 2003; Labeau et al., 2007**).

The questionnaire was translated into Arabic version by the authors. To ensure the validity of translation, back translation technique was used (**Birbili, 2000**) by a translator from the Faculty of Education, the English Department. The two versions were reviewed, and modifications were made accordingly. We pilot-tested the questionnaire between May and June 2011 in Surgical ICU and Chest ICU at one University Hospital, involving ten critical care nurses. The aim of the pilot study was to assess the clarity of the statements, and make necessary amendments prior to the main study.

Tool 2: "**Nursing Practice for Prevention of VAP Observation Form**"

This tool was developed based upon relevant guidelines and literature (**Dodek et al., 2004; Tablan**

**et al., 2004; Branson 2005; Lorente, et al.,2007; Coffin et al., 2008; Muscedere et al., 2008**). It is a checklist involved 15 items related to measures for prevention of VAP, such as decontamination of hands, patient's position, regular oral care, and sterilization of suction equipment. Investigators responded to items by checking one of two choices: "done" or "not done".

### Data collection

Data were collected between June 2011 and September 2011. Before starting the data collection process, baseline information about the studied ICUs were collected involving the number of beds in each unit, the existence of guideline for prevention of VAP, and the number of ventilated patients in each ICU. Two methods were used for data collection including nurses' self administered questionnaire about the current practices for prevention of VAP and direct observation of nursing care of mechanically ventilated patients.

Questionnaires were distributed to all critical care nurses working in the studied ICUs after explaining the aim of the study. Of the 160 distributed questionnaires, we collected 150, reflecting an overall response rate of 93.75% .

Observation of nursing care of mechanically ventilated patients were carried out between 8 am and 12 am during morning shifts. Thirty observations were collected from each ICU by the investigators. The total number of observations was 180.

### Ethical considerations

The study was approved by the ethical review committee of the Faculty of Nursing affiliated to the University from which data were collected. Permission to conduct the study was obtained from the study site administrative authorities. It was emphasized to all nurses working in the studied ICUs that participation in the study was voluntary. Verbal consent was obtained from nurses who accepted to take part in the study. In order to maintain the confidentiality of the participants, the responses were collected anonymously, data were coded, and the name of the hospital from which data were collected was not be referred to in any published work.

### Data analysis

Descriptive statistics were computed for all data. The Statistical Package for Social Science (SPSS version 15.0) was used to analyze the collected data. To explore differences in care practice among ICUs, Chi-Square test was used.

## 3. Results

### Demographic characteristics of participant nurses

Table 1 presents the demographic data of participants. The largest percentage (40.7%) had between 6 and 10 years of ICU experience, and 34% had between 1and 5 years of ICU experience. The largest percentage (40.7%) held high school level

nursing education certificate, 24.7% held a bachelor degree in nursing, and 34.7% graduates of Technical Nursing Institute. The largest percentage (39.3%) were staff nurses, 36% were Technical Institute nurses and 24.7% were head nurses. The largest percentage (33.3%) work in surgical ICU.

#### **Nurses' self report of the current general practice for VAP prevention**

Table 2 illustrates nurses' self report of general nursing practice for prevention of VAP in the studied ICUs. Most participants (53.3%) reported always washing their hands between patients and 43.3% frequently wash their hand between patients. Similarly, most participants (52%) reported always using gloves for oral care, and 46.7% reported doing it frequently. A total of 46.7% reported performing subglotting suctioning frequently, while 22.7% said that they always carry out this procedure. A total of 39.3% maintain the head of the bed elevated at 30-45 degree for a mechanically ventilated patient, 35.3% perform this procedure three times per day, 22.7% do it twice per day, and 2.7% carry out this procedure only once per day. The vast majority of participants (91.7%, 98.7% respectively) did not attend infection control workshops or conferences, or any training program on VAP prevention.

#### **Oral care practice**

Table 3 shows nurses' self report of oral care practice. According to the vast majority of participants (98.7%), no oral care protocol is available in the ICU. A total of 30% participants reported carrying out oral suctioning every 8 to 12 hours, 28% perform it every 4 hours, 26% carry out this procedure only as needed, and 15.3% did oral suctioning every 2 hours. With regard to tooth brushing, a total of 43.3% indicated carrying out tooth brushing only as needed, 33.3% provide tooth brushing every 8 to 12 hours and only 22% perform this procedure every 4 hours. Concerning oral swabbing technique, 81.3% reported carrying out oral swabbing only as needed. Most participants (72.6%) use normal saline as a mouthwash for patient's oral care, 6.7% use Hydrogen Peroxide, and 20.7% do not use any solution for oral care.

#### **Current practice for endotracheal tube route, suctioning and ventilator care**

Table 4 presents nurses' self report of the current practice of endotracheal tube route, suctioning, and ventilator care. With regard to endotracheal tube and suctioning, most participants (98.0%, 81.3%, and 98.7% respectively) reported using oral intubation route, daily changing of suction system, and using open suction system. A total of 62.0% reported changing the ventilator circuits every new patient, 26% change it only when clinically indicated. A variation in the frequency of airway humidifier use

was evident. A total of 32.7% reported sometimes using airway humidifier, 32% rarely use it, and 26% do not use it at all. The majority of participants (84.7%, 86% respectively) stated using heated humidifier, and sterile water as a solution for the airway humidifier. According to the largest percentage of participants (61.3%), airway humidifier is changed when clinically indicated.

**Table 1: Demographic characteristics of participant nurses**

Characteristics	N 150	%
<b>Years of experience</b>		
< 1 year	10	6.7
1 – 5 years	51	34
6 – 10 years	61	40.7
11 – 20 years	26	17.3
> 20 years	2	1.3
<b>Level of education</b>		
Bachelor degree	37	24.7
Technical Nursing Institute	52	34.7
High school nursing education	61	40.7
<b>Job</b>		
Head nurse	37	24.7
Technical Institute nurse	54	36
Staff nurse	59	39.3
<b>Type of Intensive Care Unit</b>		
Surgical	50	33.3
General	9	6
Neurological	12	8
Medical	12	8
Anesthesia	19	12.7
Chest	23	15.3
Hepatic	25	16.7

#### **Observations of the current practice for prevention of VAP in the studied ICUs**

Table 5 illustrates the observed current practices for prevention of VAP in the studied ICUs. Observations showed that there is no significant differences among ICUs in the use of gloves when handling body fluids ( $P=0.544$ ). However, a significant difference was noted among the studied ICUs ( $P=0.012^*$ ) concerning the decontamination of hands before caring for the patient, as most nursing staff of Chest ICU were more committed to decontamination of hands before caring for the patient than the staff in other ICUs.

**Table 2: Nurses' self report of general preventive measures for VAP**

Nursing Practice	Total	
	No.	%
<b>1- Hand washing between patients</b>		
Always	80	53.3%
Frequently	65	43.3%
Sometimes	3	3.3%
<b>2-Use of gloves for oral care</b>		
Always	78	52.0%
Frequently	70	46.7%
Sometimes	2	1.3%
<b>3- Perform subglottic suctioning</b>		
Always	34	22.7%
Frequently	70	46.7%
Sometimes	44	29.3%
Rarely	2	1.3%
<b>4- Maintains head of bed elevated at 30 - 45 degree</b>		
Once per day	4	2.7%
Twice per day	34	22.7%
Three times per day	53	35.3%
All the day	59	39.3%
<b>5- Patient's position most frequently used</b>		
Supine positioning	40	26.7%
Semi recumbent position	110	73.3%
Prone position	0	0%
<b>6- Education</b>		
<b>Attending infection control workshops and conferences</b>		
Yes	13	8.7%
No	137	91.3%
<b>Attending training programs on prevention of VAP</b>		
Yes	2	1.3%
No	148	98.7%

There was a significant difference ( $P=0.009^*$ ) concerning maintaining the patient in a semi recumbent position ( $30^\circ$  to  $45^\circ$ ) among the studied ICUs. It worth mentioning that all the staff (100%) of Hepatic and Neuro ICUs maintain patient in a semi recumbent position. Observations showed that all nurses in the studied ICUs do not use any antiseptic solution for oral care, do not maintain adequate pressure in endotracheal tube cuff, do not use closed endotracheal suctioning system, or sterilize or disinfect suction equipment. A significant difference ( $P=0.001^*$ ) was noted among ICUs concerning checking the nasogastric tube for residual volume. A statistical differences were found regarding the use of a sterile technique when applying tracheal suctioning ( $P=0.050^*$ ) and rinsing reusable respiratory equipment with sterile water ( $P=0.004^*$ ). In all the studied ICUs, a new ventilator circuit is used for each patient, and the circuits are changed when become solid or malfunctioned. Statistical significant differences were found regarding certain aspects of ventilator care, such as removing condensate from ventilatory circuit ( $P=0.014^*$ ), using sterile water for bubbling humidifier ( $P=0.000^*$ ), and changing a heat-moisture exchanger when becomes malfunction or solid ( $P=0.033^*$ ).

**Table 3: Nurses' self report of oral care practice**

Nursing Practice	Total	
	N= 150	%
<b>1- Availability of a written oral hygiene protocol in ICU</b>		
Yes	2	1.3%
No	148	98.7%
<b>2-Frequency of oral suctioning</b>		
Every 2 hours	23	15.3%
Every 4 hours	42	28.0%
Every 8-12 hours	45	30.0%
Only as needed	40	26.7%
<b>3-Frequency of tooth brushing</b>		
Every 4 hours	33	22.0%
Every 8-12 hours	50	33.3%
Only as needed	65	43.3%
Not at all	2	1.3%
<b>5- Frequency of oral swabbing</b>		
Every 4 hours	3	2.0%
Every 8-12 hours	16	10.7%
Only as needed	122	81.3%
Not at all	9	6.0%
<b>5- Mouth wash solution</b>		
Chlorhexidine Gluconate	0	0.0%
Hydrogen peroxide	10	6.7%
Others (saline)	109	72.6%
Don't use any solutions	31	20.7%

**Table 4: Nurses' self report of the current practice of endotracheal tube route, suctioning and ventilator care**

Nursing Practice	Total	
	N= 150	%
<b>Endotracheal tube and suctioning</b>		
<b>1- Endotracheal route</b>		
Oral intubation	147	98.0%
Nasal intubation	1	.7%
Both routes of intubation	2	1.3%
<b>2- Frequency of changing suction system</b>		
Daily change	122	81.3%
Weekly change	5	3.3%
Every new patient	15	10.0%
When clinically indicated	8	5.3%
<b>3- Suction system</b>		
Open suction systems	148	98.7%
Closed suction systems	2	1.3%
Both systems	0	0.0%
<b>Care of ventilator</b>		
<b>1- Frequency of ventilator circuits changes</b>		
Every 48 hours	10	6.7%
Every week	7	4.7%
Every new patient	93	62.0%
When clinically indicated	40	26.7%
<b>2- Frequency of airway humidifier use</b>		
Always	14	9.3%
Sometimes	49	32.7%
Rarely	48	32.0%
No	39	26.0%
<b>3- Type of solution used in airway humidifier</b>		
Normal saline	129	86.0%
Sterile water	17	11.3%
Taped water	4	2.7%
<b>4- Type of airway humidifier</b>		
Heated humidifier	127	84.7%
Heat and moisture exchangers	1	.7%
Both types of humidifiers	22	14.7%

5- Frequency of humidifier changes		
Every 48 hours	22	14.7%
Every 72 hours	5	3.3%
Every week	31	20.7%
When clinically indicated	92	61.3%

**Table 5: Observations of current nursing practices for prevention of VAP in ICUs**

Practices		Surgical ICU	Neuro ICU	Medical ICU	Anesthesia ICU	Chest ICU	Hepatic ICU	Test of significance	
		%	%	%	%	%	%	X <sup>2</sup>	P value
1	Wearing gloves when handling body fluids.	46.7	43.3	46.7	50	43.3	43.3	8.875	0.544
2	Decontaminating hands before caring for the patient.	76.7	73.3	86.7	86.7	90	73.3	22.755	0.012*
3	Maintaining patients in a semi recumbent position (30 to 45) unless contraindicated.	76.7	100	86.7	86.7	76.7	100	15.328	0.009*
4	Performing regular oral care with an antiseptic solution.	0	0	0	0	0	0	7.119	0.212
5	Maintain adequate pressure in end tracheal tube cuff.	0	0	0	0	0	0	1.388	0.926
6	Checking the nasogastric tube for residual volume.	16.7	30	6.7	36.7	10	13.3	28.981	0.001*
7	Performing continuous subglottic suctioning before deflating cuff or repositioning the tube.	33.3	0	6.7	26.7	23.3	13.3	32.850	0.000*
8	Using closed endotracheal suctioning system.	0	0	0	0	0	0	-	-
9	Using sterile technique when applying tracheal suctioning.	20	10	26.7	36.7	23.3	26.7	18.284	0.050*
10	Sterilization or disinfection of suction equipment.	0	0	0	0	0	0	9.874	0.079
11	Using new ventilator circuits for each patient.	100	100	100	100	100	100	-	-
12	Changing ventilator circuits when become soiled or malfunctioned.	100	100	100	100	100	100	-	-
13	Removing condensate from ventilatory circuit.	83.3	86.7	86.7	73.3	66.7	100	14.224	0.014*
14	Using sterile water to fill bubbling humidifier.	20	56.7	13.3	0	0	0	65.177	0.000*
15	Changing a heat-moisture exchanger that is in use by a patient when it malfunctions mechanically or becomes visibly soiled.	6.7	0	0	13.3	0	0	19.584	0.033*

#### 4. Discussion

The findings of nurses' self report questionnaire indicate that a large percentage of critical care nurses implemented some preventive measures for VAP. However these measures were not uniformly implemented in the studied ICUs. More than half of nurses (53.3%) reported always washing their hands, and 43.3% reported frequently washing their hands between patients. Observation of nursing care also showed that most participants are adhered to hand hygiene practice. Similarly, **Cason et al., (2007) and Grap and Munro (1997)** studies illustrated nurses' compliance with hand washing practice. Nurses' self report of the use of gloves for oral care were between 'always' (52%) and 'frequently' (46.7%) performing this practice for mechanically ventilated patients. In **Cason et al (2007)** study, most nurses reported wearing gloves in to provide oral care. The practice of hand washing and routine gloves are the most important actions taken for reducing transmission of microorganisms in ICUs (**Tablan et al., 2004**). Hence, all ICU nurses must adhere to the recommendations of hand washing and wearing gloves (**Cason et al., 2007**).

The findings of the current study showed variations in performing subglottic suctioning with a large percentage of nurses reporting 'frequently' (46.7%) carrying out this procedure and 22% reporting always performing this procedure. In **Krein et al., (2008)** study, only 21% of the surveyed hospitals reported using subglottic secretion drainage. Muscedere et al., (**2011**) meta analysis study concluded that the use of endotracheal tubes with subglottic secretion drainage is effective for the prevention of VAP, and may be associated with reduced duration of mechanical ventilation and ICU length of stay. In the same sense, **Dezfulian et al., (2005)** meta analysis study illustrated that continuous aspiration of subglottic secretions reduced the incidence of VAP by half, shortened ICU stay by 3 days, and delayed the onset of VAP by 6 days.

Semi recumbent position was the most frequently position used in the studied ICU. There is a strong evidence that placing the patient in a semi recumbent position prevents aspiration, thereby reducing the risk for VAP (**Drakulovic et al., 1999; Tablan et al., 2004**). However, the findings of a recent multicenter, observational study suggest that backrest elevation was less than recommended, and was influenced by clinical practices and patient condition (**Rose et al., 2010**). A meta-analysis conducted by **Alexiou et al., (2009)** showed that patients who were placed in a semirecumbent position at 45° have significantly

lower incidence of VAP compared to those who were placed in a supine position. Despite discrepancies in the reported evidence concerning the semi recumbent position, it remains a common VAP prevention recommendation.

The findings of nurses' self report questionnaire, and observations showed that there was no written oral care protocol available in all the studied ICUs. This is similar to the findings of a study conducted in Alexandria Main University Hospital in Egypt which reported absence of oral care protocol in the ICUs (**Alhirishi, 2010**). This actually explains the discrepancies in the practice of oral care among the studies nurses. A largest percentage of nurses reported the use of tooth brushing only as needed, and the majority reported carrying out oral swabbing only as needed. This may be due to unavailability of oral care supplies in the studied ICU. **Alhirishi (2010)** also found that oral care is carried out without the use of toothbrushing or antiseptic solutions. A randomized trial of dental brushing for VAP prevention (**Pobo et al., 2009**) illustrated that the toothbrush group and standard group had similar rates of suspected VAP (20.3% vs 24.7%;  $p = 0.55$ ). In the same sense, **Lorente et al., (2012)** found no statistical significant differences regarding the incidence of VAP between patients who received toothbrushing and those who did not receive toothbrushing. The two studies also concluded that adding toothbrushing to chlorhexidine oral care does not help to prevent VAP in mechanically ventilated patients (**Pobo et al., 2009; Lorente et al., 2012**). A randomized, controlled clinical trial was conducted by **Munro et al (2009)** to test the effects of toothbrushing and chlorhexidine in decreasing the risk for VAP in adult mechanically ventilated patients. They found that Chlorhexidine, reduced early VAP in patients without pneumonia, but the toothbrushing protocol did not have any significant effect on VAP. Despite the strong evidence which supports the effectiveness of Chlorhexidine in reducing the incidence of VAP (**Koeman et al., 2006; Munro et al., 2009; Snyders et al., 2011**), it is not used in the studied ICUs. In the current study, most nurses use saline as a mouth wash solution and 6.7% use Hydrogen Peroxide. Although normal saline is cost effective, but such use has not been thoroughly tested. Normal saline has limited use as a mouth rinse due to its tendency to cause dryness (**Bowsher et al., 1999**). Hydrogen Peroxide mouth rinse has been used untested for long time for ICU patients, and its use for oral care is still unresolved issue (**Berry et al., 2007**).

Oral intubation route is most common in the studied ICU. Evidence suggests that oral intubation is preferable as it prevents aspiration of contaminated secretions, hence reduces the incidence of VAP (**Kollef, 2004**). Almost, in all the studied ICU, open suction system is used as it is less expensive than closed suction system. Studies have found no differences in the incidence of VAP with open versus closed suction systems (**Zeitoun et al., 2003; Lorente et al., 2005; Siempos et al., 2008**). However, one experimental study conducted in causality ICU and general ICU in Alexandria University Hospital in Egypt illustrated that using closed suction system reduces the incidence of VAP by 20% in comparing with open suction system, decreases the mortality rate and the duration of mechanical ventilation (**Ba-Alwy, 2008**). However, the findings of this study can not be generalized to other ICUs in Egypt due to the small sample size.

Most nurses reported changing suction system daily. **Sole et al., (2002)** 2 found that suction devices becomes colonized with potential pathogens within 24 hours of use. Most nurses reported changing ventilator circuit every new patients and about a quarter carry out this procedure when clinically indicated. **Kollef et al., (1995)** randomized controlled trial of once-a-week circuit changes versus no ventilator circuit changes in adult ICU, illustrated that the incidence of VAP was 28.8% in patients receiving weekly circuit change and 24.5% in patient receiving no circuit change. Other studies have indicated that the frequency of ventilator circuit changes does not reduce the risk of VAP, hence this action is not recommend (**Cook et al., 1998; AARC Evidence Clinical Based Guidelines 2003**). Based on the current evidence, **Tablan et al., (2004) and Dodek et al., (2004)** recommended new circuits for each patient, and changing the ventilator circuits when visually become solid.

Most nurses reported using heated humidifier and sterile water as a solution for the humidifier. Two randomized clinical trials found no significant difference in the incidence of VAP when using heat and moisture exchanger filters compared with heated humidifiers (**Memish et al., 2001; Lacherade et al., 2005**). However, heat and moisture exchanger is preferable for use in adult ICUs as it reduces nurses workload, decreases financial cost, and provides better safety (**Memish et al., 2001**). Similar results were found by another meta analysis study (**Siempos et al., 2007**). Use of sterile water to fill the humidifier of ventilator is recommended by the Center for Disease Control's 1982 "Guideline for the Prevention of Nosocomial

Pneumonia". The findings showed that most nurses change humidifier when clinically indicated and 20.7% change it every week. Guidelines recommended changing a heat-moisture exchanger that is in use by a patient when it malfunctions mechanically or becomes visibly soiled (**Coffin et al., 2008**).

Observations illustrated that most nurses did not implemented infection control measures when handling patient's body fluids (except for Anesthesia ICU) and when applying tracheal suctioning or when dealing with suction equipment. This could be due to lack of nurses' education and training on infection control measures. **Alp and Voss (2006)** emphasized that hand washing before and after patient care, using of gloves when dealing with body fluids, and sterilizing equipment are basic elements in prevention of VAP. This indicates the need for infection control training programs for all critical care nurses working the studied ICU. It is noted that in all the studied ICUs, nurses performed oral care without any antiseptic solution, and did not use closed tracheal suctioning. As mentioned early, this is due to unavailability of supplies and inadequate resources required for carrying out these procedures. In all the studied ICUs, nurses did not maintain adequate pressure in endotracheal tube (ETT) cuff which reflects their inadequate knowledge about the importance of this action in prevention of VAP. Maintaining the ETT cuff pressure between 20 and 30 cm H<sub>2</sub>O prevents the movement of secretions from the mouth into the lungs, hence reduces the incidence of VAP (**Grap et al, 2012**). Significant differences were found among the studied ICUs concerning some aspects of care, such as checking nasogastric tube for residual volume, performing subglottic suctioning before deflating cuff, using sterile technique when applying tracheal suctioning and using sterile water to fill bubbling humidifier. Variations in nursing practice among ICUs, and not implementing all evidences into practice could be due to the absence of a uniform protocol for VAP prevention in the studied ICU, and lack of nurses' training in this area. Hence, in order to decrease the incidence of VAP, protocols for VAP prevention and monitoring tools must be developed (**Augustyn, 2007**). Additionally, critical care nurses need to receive training on VAP preventive measures and to be orientated about the current evidence based guidelines. **Babcock et al (2004)** found that an educational program for ICU nurses and respiratory therapy staff on correct practices for VAP prevention, risk factors and preventive strategies was associated with reduced rate of VAP in ICU setting. In the same sense, **Gallagher's (2012)**

study findings suggest that education of nurses can improve mechanically ventilated patient outcome, and improve the quality of care.

On the other hand, it is very interesting that in the absence of VAP prevention protocol, and infection control training programs at the hospital, participant nurses implemented some of the preventive measures, and followed some of the recommendations for VAP prevention. May be nurses leaned what they know from their clinical experience, or may be from doctors' instructions. This issue worth to be investigated.

### Conclusion and recommendations

The current study provided a rounded picture of the current nursing practice for prevention of VAP in ICUs. The findings revealed variations in nursing practice for VAP prevention across the studied ICUs. The study illustrated an absence of a uniform protocol for prevention of VAP in the studied ICU. This indicates the need for developing a protocol for VAP prevention based upon current evidence based guidelines. There is also a need for establishing a system to ensure that VAP prevention protocol will be implemented consistently in all ICUs. We recommend involving all ICUs nurses in infection control training programs and VAP prevention program to update their knowledge and enhance their skills in this area. For newly employed staff, we recommend integrating infection control and VAP prevention programs as a part of critical care orientation program. Hospital administrative authorities should provide the supplies and resources required for prevention of VAP. Further qualitative studies are required to explore the basis of nursing practice for prevention of VAP in ICUs.

### Limitations

Our findings represent nursing practices for prevention of VAP in six ICUs at one University Hospital in Egypt. Hence we can not make generalization from the current study.

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