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Critical Care Nurses' Performance Regarding Prevention of Ventilator-Associated Pneumonia in Selected Hospitals, Khartoum "Observation Study"

Faroq Abdulghani Al-Shameri

Department of Applied Medical Sciences, College of Medical Sciences, Al-Razi University, Sana'a, Yemen

Email address

faroqalshameri@gmail.com

Abstract

This study aimed to evaluate critical care nurse's performance regarding VAP prevention in selected hospitals, Khartoum state, Sudan. It was a descriptive cross-sectional study, from December 20th, 2015 till February 15th, 2016 in intensive care units of Khartoum teaching hospital, Omdurman Military hospital and Al-Ribat University, teaching hospital at Khartoum State, Sudan. It consisted of 120 nurse who deal with patient mechanical ventilation. A non-probability, purposive sample selection was used. Data was collected from the direct observation chick list tool which consisted of two main parts, first is a socio-demographic characteristic of the nurse, and second is consisted of 20 items regarding nurses' practice skills about VAP prevention. The data was analyzed by SPSS program for Windows V.20, which include a descriptive statistical analysis and inferential statistical analysis. The results revealed that; with regards to age, the majority of the participants age was between 23-30 years old, (71.7%) were female, according to qualifications (86.7%) had bachelor degree, and (47.6%) had less than 1 year of experience. The practice performance compliance of nurses about VAP prevention consisted of 20 items distributed on 4 preventive measures elements (infection control, ventilator care, endotracheal suction, and aspiration & colonization) the mean was (1.16 from 3), (2.83 from 5), (1.85 from 6), and (1.30 from 6) respectively, the overall mean of practice performance compliance of nurses about VAP prevention was (7.12 from 20), which is a poor result, showed that, the most of the nurses have un-adequate practice performance compliance about VAP prevention. Development of a protocol and continuous education program for all working nurses was recommended to improve the level of nursing practice in critical care units.

Keywords

Ventilator-Associated Pneumonia, Nurses' Performance, Critical Care, Nurses, Khartoum

1. Introduction

Ventilator-associated pneumonia (VAP) is the most common infectious complication among patients admitted in intensive care units (ICUs), VAP referred as pneumonia which, developed in patients receiving mechanical ventilation, it developed within 48 to 72 hours after the tracheal intubation to the patient [1].

VAP represents a common nosocomial complication arising in the ICU, it affect 8 to 20% of ICU patients, and up to 27% of mechanically ventilated patients [2]. VAP is the leading cause of hospital acquired infections in the ICUs [3]. In 2002,

an estimated 250,000 healthcare-associated pneumonias developed in U.S.A. hospitals and 36,000 of these were associated with deaths. Patients with mechanically-assisted ventilation have a high risk of developing healthcare-associated pneumonia. For the year 2010, National Health care Safety Network (NHSN) facilities reported that, more than 3,525 VAPs and the incidence for various types of hospital units ranged from 0.0-5.8 per 1,000 ventilator days [4]. Mortality rate in patients with VAP range from 20 to 50% and may reach more than 70% when the infection is caused by

multi-resistant and invasive pathogens [5-7].

The incidence of VAP is 37.2 per 1000 ventilation day in developing countries and the mortality rate for VAP patients was 80% [8].

The predominant organisms responsible for infection are *Pseudomonas aeruginosa*, *Klebsiella* species, *Enterobacter species*, and non-typical *Haemophilus influenzae* are the most common gram-negative isolates. *Staphylococcus aureus*, including the more recently emerged methicillin- resistant strains, has been documented to be the most common gram-positive isolate [9].

Numerous risk factors for development of VAP have been identified in literature [10]. These factors are divided into modifiable and non-modifiable. Modifiable risk factors involve the supine position, gastric over distention, contamination of ventilator circuits, frequent patient transfers and low pressure of endotracheal tube cuff. Non-modifiable factors include male gender age over 60 years, acute respiratory distress syndrome, multi organ failure, coma, chronic obstructive pulmonary disease, tracheostomy, reintubation, neurosurgery and cranial trauma [9]. Airway intubation was identified as the most important risk factor [11].

VAP is associated with considerable morbidity, including prolonged ICU length of stay, prolonged mechanical ventilation, and increased costs of hospitalization [6, 12, 13]. Therefore, prevention of VAP was on the top of research agenda in intensive care medicine in the past 25 years [14].

The prevention of VAP is also a major challenge, and a significant concern for critical care nurses who care for mechanically ventilated patient. Critical care nurses have an important role in reducing risk factors, identify early symptoms, and implementing relevant preventive measures [11]. There is evidence that these measure decrease the incidence of VAP and improve patient outcome [10].

A number of evidence-based guidelines have been developed in recent years to direct clinical practice in an attempt to improve patient care, and in particular care of the critically ill. Specific guidelines have been developed to both prevent VAP and treat it appropriately as soon as possible. The 2003 guidelines from The Centers for Disease Control and Prevention (CDC) in the United States of America (USA) provide recommendations for nursing practice. Main preventive strategies include proper positioning, use of sterile equipment and educational strategies for educating health care personnel regarding prevention of VAP [15].

To ensure the highest standards of nursing care, nursing practice must be based on a strong body of scientific knowledge and proper practice. This can be achieved through adherence to the evidence based guidelines for prevention of ventilator associated pneumonia, ultimately improving patient outcomes [16].

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 Sudan is scarce. Hence, the main objective of this study is to investigate the current nursing practice for the prevention of VAP in ICUs at selected major governmental hospitals in Khartoum, Sudan.

2. Methodology

A hospital based non-experimental cross-sectional descriptive study, the researcher adopted the study to be enable to describe nurses' performance regarding ventilator-associated pneumonia prevention.

2.1. Study Setting

The study was conducted in the Khartoum state major governmental hospitals; Khartoum Teaching Hospital (public hospital), Omdurman Military Hospital (military hospital) and Al-Ribat University Hospital (police hospital). The criteria for selecting these setting were geographical proximity, feasibility for conducting the study, availability of the required sample because nurses working in these units are responsible for a larger population of mechanically ventilated patients than other nurses in acute care hospitals.

2.2. Sample and Sampling Technique

The sample size for the present study was 120 nurses. A non-probability, purposive sample selection was used in order to obtain the representative sample according to the following criteria: registered nurses with an intensive care (ICU) qualification, registered nurses with no formal training in ICU (these nurses were included as they are in close contact with mechanically ventilated patients and need to be familiar with ventilator associated pneumonia and the current evidence based guidelines for prevention of VAP.)

2.3. Instruments

Direct observation check list tool was used to collecting data about nurses' performance for VAP prevention. This tool was developed based upon relevant guidelines and literature (*Dodek et al.,* 2004; *Tablan et al.,* 2004; Branson 2005*; Lorente et al.*, 2007; *Coffine et al*., 2008; *Muscedere et al*., 2008). It consisted of 20 items related to measures for prevention of VAP; 3 items regarding infection control measures, 5 items regarding mechanical ventilator care, 6 items regarding endotracheal suction care, and 6 items regarding aspiration and colonization prevention strategies. Investigators responded to items by checking one of two choices: "done" or "not done".

2.4. Method of Data Collection

The researcher obtained the permission from the Ethical Committee at the College of Nursing/National Ribat university. Before collecting the data, the official permission from the ministry of health (Khartoum), the administrative of all three hospitals included in the study. The researcher promised to keep the participant's information confidential, and use these data for this study only then they explained the purpose of this study to each participant. Data were collected between December 20th 2015 till February 15th 2016. 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. Observation of nursing care of mechanically ventilated patients were carried out between 8 am and 12 am during morning shifts, and between 6 pm to 10 pm for afternoon and night shifts. The total number of observations was 120.

2.5. Data Analysis

The data was analyzed by SPSS program for Windows V.20 (Statistical Package for Science Service) application for statistical data analysis. It includes descriptive statistical analysis (frequency, percentage, mean and standard deviation).

3. Results

Socio-demographic Characteristics

(Table 1) Shows the socio-demographic characteristics, the majority of participant age was between (23-30) years old. Most of them (71.7%) were females.

The experience years varies (47.6%) of them had less than 1 year, (39.2%) had 1 to 5 years of experience, and the remaining (13.2%) had more than 5 years of experience.

According to the level of education, majority of them (86.7%) had a bachelor degree, and only (7.5% and 5.8%) had diploma and master degree respectively. Concerning to the specialized diploma nurses in ICU, the majority of them (80.0%) didn't had specialized diploma, but more than half of nurses (53.3%) had attended an educational program in infection control.

Table 1. *Socio-demographic characteristics.*

Socio-demographic characteristics of nurses	n=120	
	Freq.	Percent
Gender		
Male	34	28.3%
Female	86	71.7%
Age		
Mean	26.71	
Std. deviation	3.41	
Level of education		
Diploma	9	7.5%
Bachelor	104	86.7%
Master	7	5.8%
Years of experience		
Less than 1 year	57	47.6%
(1-5) years	47	39.2%
(6-10) years	11	9.1%
More than 10 years	5	4.1%
Specialized Diploma nurses in I.C.U		

Socio-demographic characteristics of nurses	n=120	
	Freq.	Percent
Yes	24	20.0%
No	96	80.0%
Attendance an educational program in infection control		
Yes	64	53.3%
No	56	46.7%

Observations for the prevention of VAP among nurses' practice

(Table 2) shows the observations for the prevention of VAP among nurses' practice, in which more than half of the nurses didn't follow the infection control measures; (66.66%) didn't wash hand before and after patient contact, (58.33%) didn't wash hand during the contact with patient, while (61.66%) didn't change gloves during the contact with patients.

However, the nurses who they follow the recommended ventilator care measure; (61.66%) of nurses used humidifier to humidity respiratory circuit, (96.66%) used a new ventilator circuits for each patient, while only (41.66%) of them observed and drained the condensate that, have been collected in the tubing of M. V periodically, (33.33%) they changed ventilator circuits when, it became soiled or malfunctioned, and (41.66%) of nurses used sterile water to fill the humidifier.

Furthermore, regarding the endotracheal suction care measures; most of nurses (63.33%), they didn't maintain an adequate pressure in the endotracheal tube cuff, (78.33%) of them didn't use sterile technique while applying the tracheal suction, among of them (65.00%), they didn't sterilize or disinfect the suction equipment before use, similarly (65.00%) of them didn't avoid saline lavage with suction. During the use of the open suction system, (56.66%) of nurses wear sterile gloves, but due to the unavailability of the closed suction system, all nurses didn't wear a clean glove.

According to the aspiration and colonization prevention measures; majority of nurses (86.66%) didn't use topical antimicrobial agents for oral decontamination to the patients, most of nurses (56.66%) didn't monitor the continuous patient positions in 30°-45° (if not contraindicated), (61.66%) of nurses didn't perform a regular oral suction to the patients, and (65.00%) of them didn't perform a regular oral hygiene with antiseptic mouth wash to the patients. However, all of them didn't check patient's gastric residual volume (GRV) every 4-6 hours. And due to the unavailability of subglottic endotracheal tube type, all the nurses didn't aspirate subglottic secretion continuously,

Table 2. *Nurses' practice skills for VAP prevention.*

No	Practice measures	Nurses respondent (n=120)			
		Done		Not Done	
		Freq.	(%)	Freq.	(%)
	Infection control measures				
1	Wash hand before and after patient contact	40	33.33	80	66.66
2	Wash hand during the contact with patients (between them)	50	41.66	70	58.33
3	Change gloves during the contact with patients (between them)	46	38.33	54	61.66
	Ventilator care measures				
4	observed and drained the condensate that, have been collected in the tubing of M. V periodically	50	41.66	70	58.33
5	Use of humidifier for humidity respiratory circuit	74	61.66	26	38.33

| No | Practice measures | Nurses respondent (n=120) | | | |
| | | Done | | Not Done | |
		Freq.	(%)	Freq.	(%)
6	Use a new ventilator circuits for each patient	116	96.66	4	3.33
7	Change the ventilator circuits when it became soiled or malfunctioned	40	33.33	80	66.66
8	Fill the bubbling humidifier with sterile water	50	41.66	70	58.33
Endotracheal suction care					
9	Maintain an adequate pressure in endotracheal tube cuff	44	36.66	76	63.33
10	Wear clean gloves with closed suction system	Not available at all			
11	Wear sterile gloves with an open suction system	68	56.66	52	43.33
12	Use a sterile technique when applying the tracheal suction	26	21.66	94	78.33
13	Sterilization or disinfection of suction equipment	42	35.00	78	65.00
14	Avoid saline lavage with the endotracheal suction	42	35.00	78	65.00
Aspiration and colonization prevention measures					
15	Monitor continuous patient positions in 30°-45° (if not contraindicated)	52	43.33	68	56.66
16	Perform a regular oral hygiene with antiseptic mouth wash	42	35.00	78	65.00
17	Use a topical antimicrobial agents for oral decontamination	16	13.33	104	86.66
18	Perform a regular oral suction	46	38.33	74	61.66
19	Aspirate the subglottic secretion continuously (if ventilator more than 48 hrs.)	Not available at all			
20	Check patient`s gastric residual volume (GRV) every 4 to 6 hours	0	00	120	100

(Table 3) Shows the performance scores of compliance with elements of ventilator bundle practices among nurses. It appears that, the all nurses at different work area, they didn't comply with VAP bundle elements.

Out of the three practice of infection control measures, the five practice of ventilator care measures, the six practice of endotracheal suction care measures, and the six practice regarding the aspiration and colonization prevention measures, the mean was 1.16±0.94, 2.83±1.18, 1.85±0.94 and 1.30±0.84 respectively.

In addition, it shows that the overall mean for nurses' performance of VAP prevention was 7.12±2.47 out of 20 practice measures.

Table 3. Mean of the performance compliance scores of study subjects with variables of VAP prevention.

| No | Variables for main practice area | Max. score | Nurses' respondent (120) | |
			mean	SD
I	Infection control measures	3	1.16	0.94
II	Ventilator care measures	5	2.83	1.18
III	Endotracheal suction care	6	1.85	0.94
IV	Prevention of aspiration and colonization	6	1.30	0.84
Overall (total)		20	7.12	2.47

4. Discussion

The present study aimed to assess the performance of the prevention of ventilator associated pneumonia among intensive care unit nurses, who deal with patient`s mechanical ventilator.

The findings reveled that, most of nurses were female, majority of them belong to 23-30 age group, with the bachelor degree of education level, and varies equal or less than 5 years of experience in ICUs, furthermore they didn't have a specialized diploma in ICU, similarly with the finding of a study conducted by *Alkhadir M. A.* in 2012, titled "*Assessment The Level Of ICU Nurses Knowledge And Practice Regarding VAP Prevention Guidelines In Al-Sha'ab Teaching Hospital, Sudan*" in which he found the same results [17].

Regarding the nurses' performance of the prevention of VAP which contained 4 prevention practice measures (infection control, ventilator care, endotracheal suction care and the prevention of aspiration & colonization), most of the nurses have poor performance compliance regarding these measures, whereas the overall mean was 7.12±2.47.

Similarly, *Ali N. S.*, (2013) & *Osman M. O.*, (2014) studies illustrated that, poor nurses' compliance with VAP prevention bundle elements [18, 19].

The findings of the observation of nursing care showed that, most of participants are not adhere to infection control measures like hand hygiene practice and routine gloves wearing. Differently with other studies done by *Ali N. S.*, (2013) and a study done by *Cason et al.*, (2007), studies illustrated that, nurses' compliance with hand washing practice and gloves wearing [18, 20]. The practice of hand washing and routine gloves wearing are the most important actions to reduce the transmission of microorganisms in ICUs [9]. Hence, all ICU nurses must adhere to the recommendations of hand washing and gloves wearing [20].

It observed that, most nurses change ventilator circuit for each patient and about a quarter carry out this procedure when clinically indicated. Similarly, *Ali N. S.*, (2013) study illustrated same results [18]. Furthermore, *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 [21]. Other studies have indicated the frequency of

ventilator circuit changes does not reduce the risk of VAP, hence this action is not recommended [22, 23]. Based on the current evidence, *Tablan et al.*, (2004) & *Dodek et al.*, (2004) recommended new circuits for each patient, and changing the ventilator circuits when visually became solid [9, 24].

It also observed that, most nurses use heated humidifier and only quarter of them use sterile water as a solution for the humidifier. Similarly, *Ali N. S.*, (2013) study illustrated same results except about using sterile water for humidifier whereas the most of nurses use it [18]. Two randomized clinical trials found no significant difference in the incidence of VAP when using heat and moisture exchanger filters compared with heated humidifiers [25, 26]. However, the use of heat and moisture exchanger is preferable in adult ICUs, as it reduces nurses workload, decreases financial cost, and provides better safety [25]. 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"* [27].

The findings of this study illustrated that, most nurses did not maintain adequate pressure in endotracheal tube (ETT) cuff which reflects their inadequate knowledge about the importance of this action for the prevention of VAP. Similarly, *Ali N. S.*, (2013) study found [18]. Maintaining the ETT cuff pressure between 20 and 30 cm H_2O prevents the movement of secretions from the mouth into the lungs, hence it reduces the incidence of VAP [28]. In all the studied ICU, open suction system is used due to it availability as it is less expensive than closed suction system and more than half of nurses wearing sterile gloves when use. Studies have found no differences in the incidence of VAP with open versus closed suction systems [29-31]. Unfortunately, this study shows that, most nurses didn't use sterile technique when applying tracheal suction, they didn't sterilize or disinfect suction equipment and also they didn't avoid saline lavage with suctioning, which, is reflect their inadequate knowledge about the importance of these actions for the prevention of VAP also lack of trained nurses in this particular area. Similarly, *Ali N. S.*, (2013) study found [18]. The practice of maintain sterile technique when applying tracheal suction, is the most important action to reduce the transmission of infection into lungs [5, 24]. Hence, all ICU nurses must adhere to the recommendation of sterile technique when applying tracheal suction [20].

It observed in this study that, most of the nurses don't keep the patient in semi recumbent position (30°-45°) which is different from the findings of *Ali N. S.*, (2013) whereas in her study, the semi recumbent position was the most frequently position used [18]. There is a strong evidence that placing the patient in a semi recumbent position prevent aspiration, thereby it reduces the risk of VAP [9]. A meta-analysis is done & showed that, patients who were placed in a semi recumbent position at 45° have significantly lower incidence of VAP compared to those who were placed in a supine position [32].

In the current study, most nurses didn't perform a regular oral hygiene with antiseptic mouth wash or use topical antimicrobial agents for oral decontamination and they didn't perform a regular oral suction. Furthermore, all of the nurses didn't check the gastric residual volume every 4-6 hours and aspirate the subglottic secretion continuously due to the unavailability of subglottic endotracheal tube. Similarly, *Alhirishi*, (2010) found that, the oral care is carried out without the use of tooth brushing or antiseptic solutions [33]. Also *Ali. N. S.*, (2013) found that, a largest percentage of nurses reported the use of tooth brushing only as needed not in regular time [18]. In *Krein et al.*, (2008) study, only 21% of the surveyed hospitals reported using subglottic secretion drainage [34]. A meta-analysis study concluded that, the use of endotracheal tubes with subglottic secretion drainage is effective for the prevention of VAP [35]. In the same sense, another 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 [36].

Finally, on the other hand, it is very interesting that, in the absence of VAP prevention protocols, and infection control training programs at those hospitals, but most of the participant nurses implemented some of the preventive measures, and followed some of the recommendations for VAP prevention.

5. Conclusion

The present study concluded that, the major of nurses who participated in this study, were female graduated from the college of nursing with bachelor degree.

Their practice for the prevention of VAP, is assessed by direct observation for twenty preventive measures, which they were classified in four areas; infection control, ventilator care, endotracheal suction care, and prevention of aspiration & colonization.

Whereas, the mean of each area was less than half of the maximum score, they had a poor practice compliance to the recommended measures for the prevention of ventilator-associated pneumonia.

As well as, the overall mean of the twenty preventive measures, was inadequate for the prevention of ventilator-associated pneumonia among nurse's practice.

Recommendations

For the colleges of nursing: it's preferable to put mechanical ventilation care and the prevention guidelines for VAP in the curriculum of nursing lectures for students to have a basic adequate knowledge.

For institutions that provide nursing health care services: involving all ICUs nurses in infection control training programs and VAP prevention program to update their knowledge and enhance their skills in this area and developing a protocol for VAP prevention based upon current evidence base guidelines, also establishing a system to ensure that, VAP prevention protocol will be implemented consistently in all ICUs.

For hospital administrative authorities should provide all the supplies and resources required for prevention of VAP.

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