Research Article

Knowledge Regarding Ventilator-associated Pneumonia and its Prevention Among Nurses Working at Intensive Care Units of Two Teaching Hospitals in Sri Lanka

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Abstract

Introduction: Ventilator-associated Pneumonia (VAP) is the commonest hospital-acquired infection among mechanically ventilated patients in Intensive Care Units (ICUs). Previous studies on ICU nurses report poor practice on VAP and preventive measures. The study aimed to assess knowledge on VAP and its prevention among ICU nurses from two teaching hospitals in Sri Lanka. Methods: A descriptive cross-sectional study was conducted among 127 nurses from adult ICUs. Data were collected using a pre-tested self-administered questionnaire and analysed using SPSS version 20. Knowledge levels were categorized as good (above 75%), average (50-75%) and poor (below 50%). Results: Overall results showed that 62.2% had average, 33.1% had good, and 4.7% had poor knowledge on VAP and its prevention. The mean knowledge score was 70.15 ± 10.5. Most participants had good knowledge on the meaning of VAP (68.5%), upper respiratory tract functions (84.3%), causative microorganisms (56.7%) and mode of transmission (78.7%). The majority had an average knowledge on standard precautions (48.8%) for VAP and poor knowledge on signs of VAP (52%). Regarding prevention of VAP, most of them had good knowledge on natural preventive mechanisms (92.1%), using of suction catheters (96.9%) and reducing microbial colonization in the oropharynx (93.7%). In contrast, poor knowledge was evident on minimum endotracheal (ET) suction pressure (69.3%), minimum ET cuff pressure (64.6%), early weaning from ventilator (72.4%), and disinfection of ventilator parts (53.5%). Conclusions: Overall knowledge of ICU nurses on VAP and its preventive measures was average. Knowledge deficiencies were identified in preventive strategies in maintaining airways and disinfection.

Keywords: Nurses, Ventilator-associated pneumonia, Intensive care unit, Knowledge, Prevention

Introduction

Ventilator-associated Pneumonia (VAP) is an infection in lung parenchyma. It is acquired after invasive mechanical ventilation of 48–72 hours [1]. This disease condition results delayed extubation, extended stays in Intensive Care Units (ICUs) and hospitals, increased mortality and morbidity, and increased use of health care resources [2,3]. It is major and common among Healthcare-Associated Infections (HAIs) in developing countries [1,4].

In a one-day point-prevalence survey conducted in 1265 ICUs worldwide in 2007, among all patients with an infection, the prevalence of respiratory tract infections was 63.5% and in Asia, it was 65.6% [5]. A recent systematic review on VAP in adults has reported a VAP-associated mortality rate ranging from 16.2% to 74.2% in the Southeast Asia region [1]. In Sri Lanka, a study conducted at the Teaching Hospital Karapitiya, Galle, in 2010 has revealed that 29.4% of patients admitted to its ICUs with mechanical ventilation had lower respiratory tract infections [6].

The clinical signs of VAP include; significant heavy microbial growth in the cultures from tracheal aspirates, increased body temperature, development of progressive new infiltrate on X-ray, and leukocytosis [white blood cells (WBC) < 10×10^9/L) or leukopenia (WBC <3×10^9 /L] [7]. VAP can be classified into two types. One type of VAP occurs within 48 hours after tracheal intubation. This is usually termed as early onset VAP and often results from aspiration, which complicates the intubation process. The other type occurs after 48 hours of intubation and is known as late onset VAP [8]. Early onset VAP is often caused due to antibiotic sensitive bacteria such as *Staphylococcus aureus*, *Haemophilus influenzae,* and *Streptococcus pneumoniae,* whereas late onset VAP is frequently caused by antibiotic resistant pathogens such as *Staphylococcus aureus*, *Acinetobacter* species, *Pseudomonas aeruginosa*, and *Enterobacter* species [8].

Two important processes occur in the pathogenesis of VAP, bacterial colonization of the respiratory tract and aspiration of contaminated secretions into the lower airway [9]. Therefore, the strategies to prevent VAP usually focus on reducing the burden of bacterial colonization in the respiratory tract, decreasing the incidence of aspiration, or a combination of both [9]. Many strategies and guidelines have been developed to prevent VAP. The Centers for Disease Control (CDC) in United States of America (USA) has published a guideline that describes several specific preventive measures for VAP, focusing on the following major areas; sterilization or disinfection and maintenance of equipment and devices to prevent transmission of microorganisms to the respiratory tract, prevention of person-to-person transmission of bacteria, increasing host defense against infection, and precautions for prevention of aspiration [10].

In ICUs, nurses work in a wide variety of settings, and they are the first line of defence in preventing bacterial colonization of the oropharynx and the gastrointestinal tract [11] while adhering to the principles of patient safety [12]. They are responsible for the overall care of patients on ventilators, including checking tube placement and cuff status, assessing lung secretions and the adequacy of humidification ensuring the patency of the airway [13], checking respiratory rate, volume and pressure, analysing arterial blood gas, and performing pulse oximetry and capnometry to assess breathing [14]. Nurses, therefore, need to have adequate knowledge to carry out the above functions, especially to reduce the risk of VAP [11]. Further, lack of knowledge about evidence-based practice guidelines among ICU nurses could be a barrier to compliance and thereby prevention of VAP [2,11,15-16].

Many research studies have been conducted in other countries to assess the knowledge regarding VAP among ICU nurses, and results indicate that nurses had poor knowledge on the prevention of VAP [17–19]. However, there was no published research found on the knowledge of ICU nurses on VAP or its prevention in Sri Lankan settings. Two audits have been conducted in the ICUs at the National Hospital of Sri Lanka (NHSL), aiming at the usage of the VAP bundle and its compliance. One of them found that lung protection strategies were practised on less than one-third (31%) of patients [20], and the other audit showed that

compliance to the VAP bundle was very low (28%) [3]. Moreover, the above audits have indicated poor practice regarding preventing VAP in ICUs at the NHSL and recommended raising awareness among staff, including ICU nurses, about preventing VAP. The above audits have also indicated the importance of finding out how much the ICU nurses are aware of the relevant practices. Therefore, this study aimed to assess knowledge on VAP, and its prevention among ICU nurses in two teaching hospitals in the Western Province of Sri Lanka. The study also assessed the associations between socio-demographic variables and nurses' knowledge regarding VAP.

Methods

Study design and Study setting
A descriptive cross-sectional study was conducted to assess the knowledge regarding VAP among ICU nurses at the Colombo South Teaching Hospital (CSTH) and Sri Jayewardenepura General Hospital in Sri Lanka (SJGH).

Study setting and study population
The study was conducted in all the adult ICUs, including general ICU, cardiology ICU, neurology ICU, and cardiothoracic ICU in SJGH, and medical and surgical ICUs in CSTH. Neonatal ICUs were omitted because practice guidelines are somewhat different from adult ICUs. All the nurses in the above ICUs of both hospitals during the study period were included into the study population, and those who were on leave or released for ICU training at the time of data collection were excluded. Of the total 150 nurses in ICUs of these two hospitals, 127 consented to participate in the study.

Study instrument
A structured, self-administered questionnaire was developed by the investigators based on the CDC guidelines [10]. Some of the items on the prevention of VAP were adopted from a previous study in 2007 [21]. Content validity was achieved through expert opinion from two nursing academics having more than ten years of experience in ICUs. The questionnaire included three sections; Section A considered demographic data (5 questions), Section B considered knowledge on VAP (26 questions), and Section C considered knowledge on preventive measures (12 questions). It was pre-tested using a sample of 30 nurses from another teaching hospital who were not included in the study population. Accordingly, two of the questions from the knowledge section were modified to improve clarity.

Data collection
After obtaining ethical approval and permission from the relevant hospital authorities, all the ICU nurses from both hospitals were informed about the study through the Chief Nursing Officers using an advertisement with relevant information. Informed written consent was obtained from those who volunteered after giving the information sheet and giving them an opportunity to clarify any questions. The questionnaires were administered at a convenient date and time with prior appointment, and participants were asked to complete it individually without discussing with others. The questionnaires were collected soon after the completion on the same day to prevent data contamination.

Data analysis
The data were analyzed using Statistical Package for Social Sciences (SPSS) for windows version 20.0. Data were coded by the investigators before entering to the computer. Descriptive statistics were used to calculate the frequencies and means of the demographic data: gender, educational level, years of experience working as a nurse, and years of experience as an ICU nurse. Frequency distributions and cross-tabulations were used to provide an overall description of the data. Participants who selected a correct choice from a certain item were considered to have knowledge

on that item, and participants who selected the wrong choice from a certain item were considered to have no knowledge on that item. A correct answer was given one mark, the incorrect or unknown response was given zero marks and the attainable total score was 38. Then, the total score was converted to 100. Knowledge levels were categorized as follows: good (above 75%), average (75% - 50%) and poor (below 50%) [22]. Spearman's rank correlation coefficient test was done to find associations between socio-demographic variables and nurses' knowledge regarding VAP.

Ethical consideration

Ethical clearance was obtained from the Ethics Review Committee of the Faculty of Medical Sciences, University of Sri Jayewardenepura, Sri Lanka (N2014/10), and from the ethical review boards of both hospitals. Voluntary participation was encouraged while their privacy and confidentiality were ensured at all the stages of the study. The study was conducted on dates and times convenient to the ICU staff, and there were no disturbances to their routine patient care activities. All the information was gathered anonymously after obtaining written consent.

Results

The response rate was 84.7%. As shown in Table 1, most of the participants (94.5%) were females, 39.4% had more than ten years of experience, and 39.4% had 1-5 years of ICU experience. Most (90.6%) of the participants have attained a diploma level of education in nursing. The participants had obtained knowledge regarding VAP from in-service education programs (67.7%), lectures in their basic nursing education (48.8%), and through ICU training (34.6%) (Table 2).

The overall mean knowledge score regarding VAP was 70.15±10.5. Among the study participants, 62.2% had knowledge at an average level, 33.1% had a good level of knowledge and 4.7% showed

a poor level of knowledge. Further, the mean knowledge score of the nurses from SJGH was 68.76±10.5, and the mean knowledge score for CSTH was 73.41±9.8.

Table 1: Socio-demographic and workplace characteristics of study participants (n=127)

Characteristics	n	%
Gender		
Male	7	5.5
Female	120	94.5
Educational level		
Diploma in Nursing	115	90.6
Graduate	7	5.5
Post-graduate	5	3.9
Experience as a nurse		
Less than one year	14	11.0
1-5 years	40	31.5
6-10 years	23	18.1
More than 10 years	50	39.4
Experience as an ICU nurse		
Less than one year	24	18.9
1-5 years	50	39.4
6-10 years	15	11.8
More than 10 years	38	29.9
Hospital		
SJGH	89	70.1
CSTH	38	29.9

SJGH- Sri Jayewardenepura General Hospital,

CSTH- Colombo South Teaching Hospital

Table 2: Frequency distribution of sources of knowledge regarding VAP and its prevention among ICU nurses (n=127)

Source of knowledge*	n	%
Basic nursing education	62	48.8
In-service education	86	67.7
ICU training	44	34.6
From doctors	23	18.1
Media	09	7.1

* Multiple responses were allotted

ICU- Intensive Care Unit

The frequencies of correct answers for general knowledge regarding VAP are presented in Table 3. Most participants (89.8%) identified that VAP is preventable, and a majority (66.1%) have correctly responded that VAP develops after 48 hours or longer following intubation. Regarding causative agents of VAP, 73.2% identified *Staphylococcus aureus* correctly, while the majority (60.6%) identified *Pseudomonas aeruginosa* as incorrect.

With regard to the signs of VAP, almost all the participants (96.9%) knew that fever is a sign of VAP. The majority (58.3%) had incorrectly answered that leukopenia is not a sign of VAP and difficulty in breathing is a sign of VAP (64.6%), although it is not a sign of VAP. Most participants (85%) correctly answered that aspiration of secretions is a way of entering microorganisms into the lower respiratory tract.

Most of the participants gave correct answers to the questions on standard precautions: washing hands (96.9%), gloving (89.8%), wearing masks (92.9%), and wearing gowns (55.1%). However, most of them (82.7%) had not identified wearing goggles as one of the standard precautions (Table 3).

Table 3: Knowledge regarding various aspects of Ventilator-associated pneumonia (n=127)

Items	Correct responses	
	n	%
Characteristics of VAP		
It is a nosocomial infection	90	70.9
It is a non-communicable disease	99	78
It develops after 48 hours or longer	84	66.1
It is related to mechanical ventilation	113	89
It is preventable	114	89.8
Causative microorganism of VAP		
Staphylococcus aureus	93	73.2
Hemophilious influenza	70	55.1
Pseudomonas aeruginosa	50	39.4
Signs of VAP is/are		
Fever	123	96.9
Leukopenia	53	41.7
Difficulty in breathing	45	35.4
Mode of entering of microorganisms into the lower respiratory tract		
While suctioning	107	84.3
From upper respiratory tract	90	70.9
Aspiration of secretions	108	85
Functions of the upper respiratory tract		
Moisturizing air	116	91.3
Warming the air	105	82.7
Filtering the air	112	88.2
Standard precautions related to VAP		
Hand washing	123	96.9
Wearing gowns	70	55.1
Wearing goggles	22	17.3
Gloving	114	89.8
Wearing masks	118	92.9

VAP- Ventilator-Associated Pneumonia

Table 4: Knowledge on preventive measures of ventilator-associated pneumonia (n=127)

Categories	Correct responses	
	n	(%)
Natural mechanisms of the respiratory tract to prevent entering microorganisms	117	92.1
Type of fluid used in the humidifier chamber in a heated humidifier	116	91.3
Minimum suction pressure for an adult patient	39	30.7
Position of the patient on ventilators to prevent VAP	91	71.7
Minimum ET tube cuff pressure for an adult patient	45	35.4
Best suction system for preventing VAP	93	73.2
Disposal of a suction catheter	123	96.9
Maintenance of the ET tube cuff pressure	82	64.6
Early weaning of the patient	35	27.6
Precaution used to prevent gastric colonization of microorganisms	63	49.6
Preventing oropharyngeal colonization of microorganisms	119	93.7
Disinfection of the ventilator parts	59	46.5

ET- Endotracheal, VAP- Ventilator-Associated Pneumonia

As shown in Table 4, 117 participants (92.1%) correctly answered the questions regarding the natural mechanisms of the upper respiratory tract. Almost half (50.4%) of the participants did not have knowledge on precautions used to prevent gastric colonization of microorganisms. The majority (64.6%) of the participants incorrectly answered the question on minimum Endotracheal (ET) tube cuff pressure for an adult patient and the minimum suction pressure for an adult patient (69.3%).

Spearman's rank correlation coefficient test results showed no statistically significant relationship between gender (r(125)=-0.13, p=0.150), education level (r(125)=0.08, p=0.367), years of experience as a nurse (r(125)=-0.05, p=0.591), years of experience as an ICU nurse (r(125)=-0.04, p=0.658), hospital (r(125)=0.20, p=0.024) and knowledge levels at p< 0.001 significance level.

Discussion

The present study was conducted to assess the knowledge regarding VAP and its preventive measures among ICU Nurses. Such studies may be useful in identifying the shortcomings and detecting areas that require improvement to minimize VAP. Most (94.5%) of the nurses were females, in keeping with government policy of recruiting only 5% male nurses into Government hospitals in Sri Lanka.

Regarding sources of knowledge reported by participants, it was found that a very low number of study participants have used media (7.1%) to update their knowledge. In-service education was the source from that most of them (67.7%) have obtained their knowledge on VAP. It was questionable whether they had enough access to electronic media to update their knowledge. Further, only 34.6% participants reported ICU training as the source of learning, which indicates that the number of nurses working in ICUs who had the opportunity to undergo further training on ICU care was low. Furthermore, the Ministry of Health has reported that they conducted intensive care training only for 106 nurses in 2015 through the Post-Basic College of Nursing in Sri Lanka

[23].

The nurses in the present study have shown better knowledge compared to the studies from other countries, such as New Zealand, Belgium and Egypt on evidence-based guidelines for preventing VAP [17,21,24]. In the current study, the nurses' overall mean knowledge score on VAP and its preventive measures was approximately 70%, whereas the survey on VAP among 638 intensive care nurses in Belgium reported a mean knowledge score of 41.2% [21]. Similarly, the study from New Zealand [17] reported a knowledge score of 48% regarding nosocomial pneumonia and its prevention. Most ICU nurses in the current study were knowledgeable on practices regarding prevention of VAP, as recommended by the CDC guidelines published in 2003 in USA [10]. According to the evidence-based guidelines, semi-recumbent positioning is recommended to prevent VAP [25]. Most (71.7%) of the participants in the present study were knowledgeable about the correct position to keep the patient to prevent VAP. Most (64.6%) of the participants did not answer the question on minimum ET tube cuff pressure correctly, which reflects their inadequate knowledge about the importance of this area in the prevention of VAP. In contrast, 83.8% of participants correctly answered about ET tube cuff pressure in a study conducted in the NHSL in 2020 [26]. An endotracheal tube with a minimum cuff pressure of 20 cmH$_2$O should be maintained to reduce the chance of aspiration of secretions that accumulate above the cuff [24,27,28]. It was evident that knowledge regarding the minimum suction pressure was low (30.7%) among participants in the present study, and this was in contrast to the findings of another Sri Lankan study reporting good knowledge on the selection of correct negative pressure range (51.3%) [29].

Most (93.7%) of the participants had knowledge about preventing oropharyngeal colonization of microorganisms. Cleaning and decontaminating ventilator parts with an antiseptic agent are recommended to prevent VAP [30]. About half (50.4%) of the participants did not know about precautions to prevent gastric colonization of microorganisms. Peptic ulcer disease prophylaxis is needed to combat the stress of being treated with mechanical ventilation [31,32].

In the current study, most (91.3%) of the participants had knowledge on the recommended type of fluid used in the humidifier chamber in a heated humidifier according to the CDC guidelines [10]. Also, most (73.2%) of the participants in the current study were knowledgeable about the closed suction system as the recommended system for preventing VAP. In contrast, a study from Egypt reported that less than half of the nurses of their study population (44.4%) recognized closed suction systems as recommended [24].

Conclusion
Overall knowledge on VAP and its preventive measures among the participated ICU nurses was at an average level. Although the participants had good knowledge on many areas of VAP, gaps of knowledge were identified in a few areas, such as the level of minimum suction pressure, level of minimum ET tube cuff pressure, and methods of disinfection of respiratory equipment. It is recommended that nurses be updated with knowledge on VAP and its prevention methods to enhance positive outcomes among ICU patients and improve the quality of care.

Acknowledgements

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