# Nursing Knowledge and Preventive Practices of Ventilator-Associated Pneumonia as Perceived by Intensive Care Nurses in Hail City, KSA

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**ABSTRACT**

***Context:*** Ventilator-associated Pneumonia (VAP) is a recognized nosocomial infection and a leading cause of high morbidity and mortality. Intensive Care Unit (ICU) nurses are in the best position to put the known evidence-based strategies into practice to prevent VAP.
***Aim:*** The study assessed nursing knowledge and preventive practices of ventilator-associated pneumonia as perceived by intensive care nurses in Hail City, Saudi Arabia.
***Methods:*** Data were collected using a descriptive cross-sectional research design. The study was conducted in intensive care units of Government hospitals in Hail City on a convenient sample of all available critical care nurses who met the inclusion criteria during the data collection period. The sample size (n) for this analysis was 84. Data were collected using a structured interview questionnaire including sociodemographic data and nurses' knowledge of VAP. The second tool is nurses' practice observational checklist regarding VAP prevention.
***Results:*** revealed that age median (IQR) is 30(6), median years of experience (IQR) 6(6), 67.9% had received VAP prevention training, and 78.6% had received information for preventing VAP. The study also reveals that 38.09% of the nurses had poor knowledge regarding VAP prevention, and they had a good median (IQR) 6(4) in the preventive practice of VAP. Age, experience in nursing, in the ICU, training on VAP prevention, and receiving information on preventing VAP significantly affected nurses' knowledge about preventing VAP in ICU patients. Experience in ICU and educational institutions as source of information and more than one source of information significantly affect the nurses' total preventive practice regarding VAP. Correlation analysis between overall knowledge and practice indicates no statistically significant correlation (the p-value for the correlation was 0.060).
***Conclusion:*** Over one-third of the nurses had poor knowledge regarding VAP. The study recommended that there should be in-service training and periodic educational programs targeting nurses to improve nurse's knowledge and practices regarding VAP guidelines by the Ministry of Health.

***Keywords:*** Intensive care nurses, knowledge, preventive practices, ventilator-associated pneumonia

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## 1. Introduction

An intensive care unit (ICU) is an area of a hospital that provides aggressive therapy using state-of-the-art technology and invasive and noninvasive monitoring for critically ill and high-risk patients. In these units, the patient's physiological variables are reported to the practitioner continuously so that titrated care can be provided. Mechanical ventilation may be one method of this care that is used to save patient life *(Varon, 2016).*

Mechanical ventilation may be a planned part of patients' management *(Pham et al., 2017).* Mechanically ventilated patients have an increased risk of lung infection and ventilator-associated pneumonia (VAP). By bypassing the natural defenses of the airway, intubation serves as a direct pathway for bacterial invasion *(Sobeih et al., 2018).* Ventilator-associated pneumonia (VAP) is characterized by infection of pulmonary parenchyma in patients subjected to invasive mechanical ventilation for at least 48 hours *(Papazian et al., 2020).*

VAP is recognized as a major issue worldwide and a common healthcare-associated infection (HAI) among developing countries associated with higher mortality, longer length of stay, and associated cost burden among patients *(Kollef et al., 2014; Barbier et al., 2013; Allegranzi et al., 2011).* The most frequent and most avoidable complication of a patient's hospital stay is healthcare-associated infections (HAI), particularly ventilator-associated pneumonia (VAP). They occur more frequently and may have more harmful effects in critically sick patients due to physiologic impairments, such as a weakened immune system and multiple organ dysfunctions. VAP is still an important cause of mortality and morbidity in mechanically ventilated patients. VAP can be primarily prevented by increasing the knowledge and practice of ICU nurses to improve nursing care, which plays an important role in outcomes *(Weng et al., 2017).*

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Prevention is the most economical method for reducing the difficulties brought on by VAP. Preventive strategies for VAP include avoiding intubation, minimizing sedation, pairing daily spontaneous awakening and breathing trials, conservative fluid management, conservative transfusion thresholds, low tidal volume ventilation, and early mobility *(Sobeih et al., 2018).*

The critical care nurse's role in preventing VAP is significant and essential *(Sobeih et al., 2018). Dehghan et al. (2022)* claim that the nursing care plan written by ICU nurses should include precautions against VAP. In addition, knowledgeable and skilled nurses are essential to delivering patient care and prompt and wise decisions to reduce patient risks *(Chithra & Raju, 2017).*

On the positive side, early detection and prompt treatment of pneumonia infection help reduce VAP prevalence. The knowledge, attitude, and methods nurses use significantly impact patients' status because patients admitted to the ICU depend fully on them *(Sobeih et al., 2018).* Another key point to lower the risk of problems from mechanical breathing is the ventilation bundle which was advised by the Institute for Healthcare Improvement in 2012 *(Madhuvu et al., 2020).* Previous studies indicated that considering the severity and impact of VAP and the higher risks of hospital-acquired infections in resource-limited countries, the lower level of knowledge and compliance implies the need for ongoing educational interventions and evaluation of the implementation of VAP prevention by considering the local context *(Bankanie et al., 2021).*

## 2. Significance of the study

In Saudi Arabia, during two years of surveillance, around 1,469,658 patient days and 569,961 ventilator days, a total of 1,694 VAP events were identified. The overall VAP rate was 2.97 per 1000 ventilator days. Five types of ICUs contributed 96% of the ventilator days surveyed in all types of ICUs: Adult medical-surgical, neonatal, adult medical, pediatric medical-surgical, and pediatric medical cardiac ICU. VAP rates per 1000 ventilator days were highest in adult medical (4.40), pediatric cardiothoracic (3.64), and adult medical surgical ICUs (3.61) but lowest in neurological, pediatric surgical, and respiratory ICUs (all were zeros) *(Humayun et al., 2021).*

By assessing the knowledge and preventive practices of ICU nurses regarding VAP, the study can identify gaps in knowledge and practice that, when addressed, could lead to better patient outcomes through reduced incidence of VAP. The study's findings can highlight areas where additional training or education is needed for ICU nurses. Understanding the current state of preventive practices among ICU nurses can lead to developing and implementing standardized protocols and guidelines for VAP prevention. The study contributes to the body of evidence that can be used to refine and improve evidence-based practices in the ICU. The study's results can support healthcare administrators and policymakers in creating policies emphasizing the importance of VAP prevention and allocating resources toward continuous ICU staff education and training. By focusing on Hail City, KSA, the study provides valuable insights specific to the region, which can be used to tailor interventions and educational programs to meet the unique needs and challenges healthcare providers face in that area. The study raises awareness about the critical role that ICU nurses play in preventing VAP. This awareness can increase recognition and support for the nursing profession, particularly in infection control and patient safety.

## 3. Aim of the study

This study aimed to assess nursing knowledge and preventive practices regarding ventilator-associated pneumonia as perceived by intensive care nurses.

### 3.1. Research question

- What is the level of knowledge of ICU nurses regarding preventing ventilator-associated pneumonia?
- What is the ICU nurses' level of practice regarding preventing ventilator-associated pneumonia?
- Is there any relation between the sociodemographic characteristics of the study nurses and their total knowledge and practice scores regarding VAP?

## 4. Subjects & Methods

### *4.1. Research Design*

The study's aim was achieved using a descriptive cross-sectional research design. A descriptive cross-sectional research design is a type of observational study that aims to describe the characteristics of a population or phenomenon at a specific point in time *(Setia, 2016).*

### *4.2. Study setting*

The study was conducted at intensive care units of Hail Governmental hospitals in Saudi Arabia. The Hail Region is located in the center of northern Saudi Arabia. Its 118,322 square kilometers total land area comprises 6% of the Saudi Arabian kingdom's entire land area. Four hospitals were selected based on case availability: King Khalid Hospital, Hail General Hospital, King Salman Specialist Hospital, and Sharaf Hospital.

### *4.3. Subjects*

A convenient sample included all available nurses (250) recruited from the previously mentioned settings. Inclusion criteria included all nurses from both genders who agreed to participate in the study. Therefore, the researcher calculated the sample size using the Raosoft software, with a margin of error of 5%, a confidence level of 95%, and a response distribution of 50%. There are 84 participants in the sample.

### *4.4. Tools of data collection*

Two tools were designed to collect data in this study.

#### 4.4.1. Structured Interview Questionnaire

The questionnaire is designed by the researcher and consists of three parts:

Part I: The nurses' sociodemographic data sheet, including age, gender, educational level, years of experience in nursing, years of experience in ICU, training on VAP

prevention, and receiving information regarding VAP, and source of information.

Part II: Nurses' knowledge regarding VAP. The researchers designed it based on selected interventions that *Labeau et al. (2007)* emphasized. Nine multiple-choice questions to assess nurses' knowledge regarding preventing VAP, such as oral vs nasal route for endotracheal intubation, frequency of ventilator circuit changes, and type of airway humidifier. The results were displayed as frequency and parentage distribution of correct and incorrect answers. Overall knowledge less than 3.5 is considered poor, 3.5 and more than 3.5 is considered good, Median (IQR): 3.5 out of 9 with IQR=3.

#### 4.4.2. Nurses' Practice Observational Checklist Regarding VAP Prevention

The researcher designed the observation checklist based on evidence-based guidelines for preventing ventilator-associated pneumonia using CDC guidelines (2018) to assess the nursing practices regarding VAP prevention. It included different VAP prevention practices (48 practices) such as hand washing (6 practice steps), oral care (9 practice steps), suctioning from endotracheal tube and tracheostomy (13 practice steps), assess tube placement by aspiration (3 practice steps), elevate the head of the bed by approximately equal or greater than 30 degrees (3 practice steps), subglottic oropharyngeal secretion (6 practice steps), assessment of daily sedation reduction/discontinuation (3 practice steps), assess eligibility for daily weaning trails unless contraindicated (3 practice steps), and the used of devices to prevent DVT (3 practice steps).

*Scoring system*

Each correct practice was scored as one (for done), and the incorrect practice was scored as zero (for not done or not applicable). Using Bloom's cut-off point for classification, with 60–100% being good and <60% poor scores.

### *4.5. Procedures*

A panel of five nursing experts from the Hail University College of Nursing assessed the tools' validity; their modifications were considered and implemented.

Ethical consideration: All ethical issues were considered before conducting the study, and ethical approval was obtained from the Research Ethics Committee (REC) of Hail University. A formal letter was sent to the managers of selected hospitals, and each nurse was assured that the data collected remained confidential and that no personal identification was needed. Verbal consent was obtained from each participant. The researchers assured the participants that participation in the study was voluntary and that they had the right to withdraw at any time. This research study lasted six months, from 10/1/2023 until 11/6/2023.

A pilot study was conducted on ten percent of the sample (8 nurses) to provide feedback about the questions and ensure the reliability of the questionnaire. The reliability of the tools was assessed using the Cronbach alpha reliability test, which reflected high reliability (0.921) for the overall tools.

Once the research proposal was approved, the researcher coordinated with various hospital authorities in Hail City, Saudi Arabia, to get approval for this study. The critical care nurses at each hospital received a briefing on the research study's aim. They were also shared with an electronic link to the questionnaire to assess their knowledge, and the researcher fielded a practice-based checklist in the clinical settings.

### *4.6. Data analysis*

Data were imported from an Excel Sheet to IBM SPSS Statistics version 21.0 for Windows® (IBM et al., USA). Categorical data, including gender, education, training, and source of information, were presented as frequency and percentages. The normality for the continuous variables was checked using the Kolmogorov–Smirnov test (number >50). The data were not normally distributed, as shown by the results of the Kolmogorov–Smirnov ($P$ <0.05), indicating a nonnormal distribution. Therefore, we used the Mann-Whitney U and Kruskal-Wallis tests to assess the association between knowledge scores and participants' characteristics. The shape of the knowledge score distribution among independent variables was not similar, so the mean rank test was utilized. Knowledge and VAP prevention practice scores were presented as the median and interquartile range (IQR). The correlation between the overall knowledge about VAP and the overall prevention practice of VAP was assessed using the Spearman correlation test. A p-value ≤0.05 was considered statistically significant.

## 5. Results

The sociodemographic data of the participants is shown in Table 1. 75% of the participants were females, and the median age was 30 years with an interquartile range (IQR) of 6 years. The education level of the participants varied, with 91.6% holding a Bachelor of Science in Nursing (BSN), 3.6% holding a diploma, and 4.8% having a postgraduate degree. The median years of experience were 6 (IQR=6), and the median years of ICU experience were 1 (IQR=3). Most participants (79.8%) reported receiving training in preventing infection in the ICU, and 67.9% reported being trained specifically in preventing ventilator-associated pneumonia (VAP).

Additionally, 78.6% of participants reported receiving information on VAP prevention, with the most common source of information being infection control units (48.8%), followed by practice (44.0%) and education institutions (42.9%, n=36). Fewer participants reported receiving information from other sources (14.3%), and 33.3% reported receiving information from more than one source. Finally, 17.9% reported receiving information from more than two sources.

Table 2 shows the frequency and percentage distribution of participants' knowledge regarding preventing ventilator-associated pneumonia. Regarding the route for endotracheal intubation, 54.8% of the participants answered correctly that the oral route is preferred over the nasal route. Only 32.1% of participants correctly identified that it is recommended to change circuits for every new patient or when clinically

indicated. For the type of airway humidifier, 44.0% of participants answered correctly. Only 11.9% of participants correctly identified the frequency of humidifier changes.

Regarding open vs closed suction systems, 56.0 % of participants correctly identified the preferred system. Only 15.5% of participants correctly identified the change frequency in suction systems. For endotracheal tubes with an extra lumen for drainage of subglottic secretions, 38.1% of participants answered correctly. Similarly, 38.1% of participants correctly identified that the kinetic bed reduces the risk of VAP. Regarding patient positioning, 70.2% of participants knew that semi-recumbent positioning is recommended to reduce the risk of VAP. The overall knowledge of the participants in this study was poor (38.09%).

Table 3 shows the adherence of participants to evidence-based practices for preventing VAP. The overall median of VAP prevention practice among ICU nurses was 6 out of 9 (IQR=4). The results indicate that hand washing was observed as a good practice by 79.8% (n= 67) of participants. For oral care, only 41.7% (n=35) showed good practice. Most participants, 86.9% (n=73), demonstrated good practice for suctioning from the endotracheal tube/tracheostomy. Assessing tube placement by aspiration was observed as a good practice by 97.6% (n=82) of participants.

Elevating the head of the patient to approximately equal or greater than 30 degrees was seen as a good practice by 83.3% (n=70). In the case of subglottic oropharyngeal secretions, 25% (n=21) demonstrated good practice, 46.4% (n=39) showed poor practice, and 28.6% (n=24) were not applicable. For assessing patients for daily sedation reduction/discontinuation, 50% (n=42) exhibited good practice, 17.9% (n=15) demonstrated poor practice, and 32.1% were not applicable. Assessing eligibility for daily weaning trials unless contraindicated was observed as good practice by 57.1% (n=48) of participants and poor practice by 42.9%. Most participants (64.3%, n= 54) showed good practice for using devices to prevent deep vein thrombosis (DVT). Overall good practice, Media (IQR): 6 (4).

Table 4 reveals the factors that impact the knowledge about preventing ventilator-associated pneumonia (VAP). Gender did not significantly affect knowledge about VAP prevention, as the p=0.258. On the other hand, age was found to be a significant factor, with participants aged ≥30 years having a higher mean rank (48.34) compared to those aged <30 years (36.38) (p=0.023). Regarding education, there were no significant differences in knowledge among those with a diploma, bachelor's degree, or postgraduate degree (p=0.636).

In terms of experience, participants with ≥ 6 years of experience had a significantly higher mean rank (49.42) than those with <6 years (34.12) (p= 0.004). Additionally, experience in the ICU was also found to be highly significantly influenced nurses' knowledge, with those who had >1 year of experience having a highly significant mean rank (52.63) than those with <1 year of experience (33.72) (p <0.001).

Only training specifically on VAP prevention significantly affected knowledge among the training-related variables. Participants who received training on VAP prevention had a highly significant mean rank (47.23) than those who did not (32.52), (p=0.009). Similarly, those who received information on VAP prevention had a significantly higher mean rank (45.97) than those who did not (29.78) (p=0.011). Among the different sources of information, none of the sources significantly affected knowledge about VAP prevention.

Table 5 shows the relation between the sociodemographic characteristics of the studied nurses and their total practice. Table show significant differences based on experience in the ICU. Participants with more than one year of working experience in the ICU had significantly higher mean ranks (48.62) than those with less than one year of working experience (37.20), with a p-value of 0.031.

Regarding the source of information, nurses who did not receive information from educational institutions had a significantly higher mean rank (47.38) than those who received information from educational institutions (36.00), with a p-value of 0.033. Moreover, the nurse with no more than one source of information had a significantly higher VAP prevention practice (47.08) than those who had (33.34), with a p-value of 0.014.

On the other hand, there was no significant difference between male and female nurses in their VAP prevention practices (p=0.818). Also, nurses below 30 years had a lower mean rank than those aged 30 years and above, although this difference was not statistically significant (p=0.066). Education level, and nursing experience do not significantly affect VAP prevention practice (p>0.05). Similarly, receiving training in preventing infection in the ICU (p=0.605), preventing VAP (p=0.168), or receiving information for preventing VAP (p=0.965) did not significantly affect their VAP prevention practices (p>0.05). Other variables, such as practice, the presence of other sources of information, presence of more than two sources and other factors, did not significantly affect VAP prevention practice.

Table 6 presents a correlation analysis between overall knowledge and overall practice. The correlation coefficient (r) between the two variables was 0.206, indicating no significant correlation (the p-value for the correlation was 0.060). The sample size (n) for this analysis was 84.

**Table (1): Frequency and percentage distribution of participants' sociodemographic data (n=84).**

| Variables | No. | % |
|---|---|---|
| **Gender** | | |
| Male | 21 | 25.0 |
| Female | 63 | 75.0 |
| **Age (years)** | | |
| Median (IQR) | 30 (6) | |
| **Education** | | |
| Diploma | 3 | 3.60 |
| Bachelor | 77 | 91.6 |
| Postgraduate | 4 | 4.8 |
| **Years of experience** | | |
| Median (IQR) | 6(6) | |
| **Years of ICU experience** | | |
| Median (IQR) | 1(3) | |
| **Have you trained in preventing infection in the ICU?** | | |
| Yes | 67 | 79.8 |
| No | 17 | 20.2 |
| **Have you been trained on preventing VAP?** | | |
| Yes | 57 | 67.9 |
| No | 27 | 32.1 |
| **Have you received information on preventing VAP?** | | |
| Yes | 66 | 78.6 |
| No | 18 | 21.4 |
| **Source of information** | | |
| Education institution | | |
| No | 48 | 57.1 |
| Yes | 36 | 42.9 |
| Infection control Unit | | |
| No | 43 | 51.2 |
| Yes | 41 | 48.8 |
| Practice | | |
| No | 47 | 56.0 |
| Yes | 37 | 44.0 |
| Others | | |
| No | 72 | 85.7 |
| Yes | 12 | 14.3 |
| More than one source | | |
| No | 56 | 66.7 |
| Yes | 28 | 33.3 |
| More than two sources | | |
| No | 69 | 82.1 |
| Yes | 15 | 17.9 |

*ICU: intensive care unit; IQR: interquartile range*

## 6. Discussion

VAP is one of the most prevalent health issues in ICUs, and healthcare workers (HCWs) are responsible for patients on mechanical ventilation (MV); cooperation is necessary for its prevention *(Alkubati et al., 2021)*. The study assesses nursing knowledge and prevention practices of ventilator-associated pneumonia perceived by intensive care nurses in Hail City hospitals.

The result of this study presents the participants' knowledge regarding the VAP. The median score for overall knowledge was 3.5 (IQR=3); the overall knowledge of the participants in this study was poor among more than one-third of them, while nearly two-thirds had a good knowledge score. This finding may be referred to around one fifth of them did not receive training in preventing infection in the ICU and did not receive information for preventing VAP. Additionally, nearly one-third of them did not receive training regarding VAP prevention. Similarly, *Getahun et al. (2022)* found the mean knowledge score (10.1±2.41). 98(48.04%) participants had good knowledge, and 106(51.96%) had poor overall knowledge about preventing ventilator-associated pneumonia.

*Hassan and Wahsheh (2017)* reported that more than three-quarters of nurses had a low knowledge level regarding pathophysiology, risk factors, and ventilator-associated pneumonia preventative measures; nurses showed significant improvements in mean scores on the knowledge level of ventilator-associated pneumonia and prevention measures after an educational program ($p<0.05$). The main reasons for not applying prevention measures were the lack of time and not following unit protocols.

**Table (2): Frequency and percentage distribution of participants' knowledge regarding preventing ventilator-associated pneumonia (VAP) (n=84).**

| Knowledge elements | No. | % |
|---|---|---|
| **Oral vs. nasal route for endotracheal intubation** | | |
| Incorrect | 38 | 45.2 |
| Correct | 46 | 54.8 |
| **Frequency of ventilator circuits changes** | | |
| Incorrect | 57 | 67.9 |
| Correct | 27 | 32.1 |
| **Type of airway humidifier** | | |
| Incorrect | 47 | 56.0 |
| Correct | 37 | 44.0 |
| **Frequency of humidifier changes** | | |
| Incorrect | 74 | 88.1 |
| Correct | 10 | 11.9 |
| **Open vs. closed suction systems** | | |
| Incorrect | 37 | 44.0 |
| Correct | 47 | 56.0 |
| **Frequency of change in suction systems** | | |
| Incorrect | 71 | 84.5 |
| Correct | 13 | 15.5 |
| **Endotracheal tubes with extra lumen for drainage of subglottic secretions** | | |
| Incorrect | 52 | 61.9 |
| Correct | 32 | 38.1 |
| **Kinetic vs. standard beds** | | |
| Incorrect | 52 | 61.9 |
| Correct | 32 | 38.1 |
| **Patient positioning** | | |
| Incorrect | 25 | 29.8 |
| Correct | 59 | 70.2 |
| **Total:** | | |
| Poor | 32 | 38.09 |
| Good | 52 | 61.9 |
| **The median score for overall knowledge was** 3.5 (IQR=3). | | |

Knowing the principles of evidence-based care cannot ensure the implementation of these principles; a lack of knowledge is a potential barrier to applying evidence-based guidelines to prevent VAP. The median adherence score was 6 out of 9, with an interquartile range (IQR) of 4. Good practice was observed in several areas: Hand washing, suctioning from the endotracheal tube/tracheostomy, and assessing tube placement by aspiration among most participants. Most participants also elevated the patient's head to at least 30 degrees. However, over half of the participants practiced oral care poorly, and around half managed subglottic oropharyngeal secretions poorly. Daily sedation assessment showed that fifty percent demonstrated good practice.

In contrast, more than half of daily weaning trials were observed as good practice, with more than two-fifths poorly practiced daily weaning trials. The highest percentage of participants practiced using devices to prevent deep vein thrombosis well. Overall, there is variability in adherence to VAP prevention practices among ICU nurses. These results underscore the variability in adherence to VAP prevention practices and suggest that while some principles are well integrated into practice, others require further emphasis and education. The gaps in practice, particularly in oral care and management of subglottic secretions, indicate areas where targeted interventions and training may be needed to ensure comprehensive implementation of evidence-based guidelines and improve patient outcomes.

*Madhuvu et al. (2020)* reported similar findings that the median self-reported adherence was 8/10 (IQR: 6–8). The most adhered-to procedures were performing oral care on mechanically ventilated patients (n = 259, 90.9%) and semi-fowler positioning of the patient (n = 241, 84.6%). Also, *Darawad et al. (2018)* mentioned that nurses had high compliance and practice levels related to VAP.

Regarding the relationship between the sociodemographic characteristics and the nurses' total knowledge about VAP prevention, the present study reveals a statistically significant relationship between age, nursing experience, ICU experience, training on VAP prevention, and receiving information on VAP prevention. The elder nurses (more than thirty years of age), those with equal or more than six years of nursing experience, those with more than one year of ICU experience, and those who trained on preventing VAP and receiving information on VAP prevention had the higher mean rank. The current study also reveals a statistically significant association between experience in the ICU and education in educational institutions and the preventive practice of VAP with those with more than one year of ICU experience and those not trained in the academic institution having the higher mean rank.

**Table (3): Frequency and percentage distribution of participants practice evidence-based VAP prevention (n=84).**

| | No. | % |
|---|---|---|
| **Hand washing** | | |
| Good practice | 67 | 79.8 |
| Poor practice | 17 | 20.2 |
| **Oral care** | | |
| Good practice | 35 | 41.7 |
| Poor practice | 49 | 58.3 |
| **Suctioning from the endotracheal tube /tracheostomy** | | |
| Good practice | 73 | 86.9 |
| Poor practice | 11 | 13.1 |
| **Assess tube placement by aspiration** | | |
| Good practice | 82 | 97.6 |
| Poor practice | 2 | 2.4 |
| **Elevate the head by approximately equal to or greater than 30 degrees** | | |
| Good practice | 70 | 83.3 |
| Poor practice | 14 | 16.7 |
| **Subglottic oropharyngeal secretions** | | |
| Good Practice | 21 | 25.0 |
| Poor practice | 39 | 46.4 |
| Not Applicable | 24 | 28.6 |
| **Assess the patient for daily sedation reduction/discontinuation** | | |
| Good Practice | 42 | 50.0 |
| Poor practice | 15 | 17.9 |
| Not Applicable | 27 | 32.1 |
| **Assess eligibility for daily weaning trials unless contraindicated** | | |
| Good Practice | 48 | 57.1 |
| Poor practice | 36 | 42.9 |
| Not Applicable | 0 | 0.0 |
| **Use devices to prevent DVT** | | |
| Good Practice | 54 | 64.3 |
| Poor practice | 30 | 35.7 |
| Not Applicable | 0 | 0.0 |
| **Overall good practice** | | |
| Median (IQR): | 6 (4) | |

These results suggest that experience and continuous clinical exposure are crucial in enhancing nurses' knowledge of VAP prevention. Elder nurses and those with extensive nursing and ICU experience will likely have accumulated more practical knowledge and skills. Additionally, targeted training and access to information about VAP prevention are effective strategies for improving nurses' understanding and adherence to evidence-based practices. Therefore, ongoing professional development and access to up-to-date information are essential for maintaining high standards of care in ICU settings.

Conversely, *Madhuvu et al. (2020)* reported no association (p=0.674) between participants' years of experience in intensive care and their overall knowledge score and no relationship between participants' knowledge and adherence to evidence-based guidelines (p=0.144).

Another study by *Getahun et al. (2022)* revealed that ICU nurses who had taken training on VAP prevention had higher odds of adequate knowledge than nurses who had not taken regular training. These findings were also supported by *Chithra and Raju (2017),* who revealed that continuous education and training improved knowledge and adherence related to VAP preventive measures, and significant practical improvements were observed after education sessions.

In summary, the data indicates no significant correlation between the nurses' overall knowledge of VAP prevention and their actual practice of these preventive measures. This finding suggests that knowing VAP prevention does not necessarily translate into implementing of these practices in the ICU. Factors other than knowledge, such as institutional policies, workload, or practical barriers, might influence the adherence to evidence-based practices. These findings are supported by *Aloush and Al-Rawajfa (2020).* Higher adherence to VAP bundles may present challenges outside a nurse's control, such as gaining resources, continuing education, and observation schedules. In addition, applying active strategies, such as incentives, support for the decision, regular observation, and assessing bundle issues might be more cost-effective to encourage nurses to perform and adhere to the bundle *(Jansson et al., 2018).* Reinforcement of compliance and practice of VAP should be conducted regularly and evaluated for proper performance during clinical work.

**Table (4): Relation between the sociodemographic characteristics of the study nurses and their total knowledge (n=84).**

| Variable | No. | % | Mean rank | Test value | P-value |
|---|---|---|---|---|---|
| **Gender** | | | | | |
| Male | 21 | 25.0 | 37.36 | 553.5[a] | 0.258 |
| Female | 63 | 75.0 | 44.21 | | |
| **Age** | | | | | |
| <30 years | 41 | 48.8 | 36.38 | 630.5[a] | 0.023 |
| ≥30 years | 43 | 51.2 | 48.34 | | |
| **Education** | | | | | |
| Diploma | 3 | 3.6 | 38.50 | 0.905[a] | 0.636 |
| Bachelor | 77 | 91.7 | 42.10 | | |
| Postgraduate | 4 | 4.8 | 53.25 | | |
| **Experience** | | | | | |
| < 6 years | 38 | 45.2 | 34.12 | 555.5[a] | 0.004 |
| ≥ 6 years | 46 | 54.8 | 49.42 | | |
| **Experience in the ICU** | | | | | |
| ≤ 1 year | 45 | 53.6 | 33.72 | 482.5[b] | <0.001 |
| > 1 year | 39 | 46.4 | 52.63 | | |
| **Have you trained in preventing infection in the ICU?** | | | | | |
| Yes | 67 | 79.8 | 42.54 | 566.5[b] | 0.973 |
| No | 17 | 20.2 | 42.32 | | |
| **Have you been trained on preventing VAP?** | | | | | |
| Yes | 57 | 67.9 | 47.23 | 500.0[b] | 0.009 |
| No | 27 | 32.1 | 32.52 | | |
| **Have you received information on preventing VAP?** | | | | | |
| Yes | 66 | 78.6 | 45.97 | 365.0[b] | 0.011 |
| No | 18 | 21.4 | 29.78 | | |
| **Source of information** | | | | | |
| Education institution | | | | | |
| No | 48 | 57.1 | 40.51 | 768.5[a] | 0.381 |
| Yes | 36 | 42.9 | 45.15 | | |
| Infection control Unit | | | | | |
| No | 43 | 51.2 | 42.91 | 864.0[a] | 0.874 |
| Yes | 41 | 48.8 | 42.07 | | |
| Practice | | | | | |
| No | 47 | 56.0 | 39.17 | 713.0[a] | 0.152 |
| Yes | 37 | 44.0 | 46.73 | | |
| Others | | | | | |
| No | 72 | 85.7 | 42.33 | 420.0[a] | 0.876 |
| Yes | 12 | 14.3 | 43.50 | | |
| More than one source | | | | | |
| No | 56 | 66.7 | 41.78 | 743.5[a] | 0.697 |
| Yes | 28 | 33.3 | 43.95 | | |
| More than two sources | | | | | |
| No | 69 | 82.1 | 40.13 | 354.0[a] | 0.053 |
| Yes | 15 | 17.9 | 53.40 | | |

** [a]Mann-Whitney Test; [b]Kruskal Wallis Test ICU: intensive care units; VAP: ventilator-associated pneumonia. A high mean rank indicated high knowledge of DVT: Deep Venous Thrombosis*

## 7. Conclusion

In light of the study results, the study found that most participants were female nurses with a median age of 30 years, and most held a Bachelor of Science in Nursing. Experience levels varied, with a median of six years in nursing and one year in the ICU. While the highest percentage had received general ICU infection prevention training, only over two-thirds had specific training for preventing ventilator-associated pneumonia (VAP). Knowledge of VAP prevention was generally poor, with a median practice score of 6 out of 9. Hand washing and suctioning were well-practiced, while oral care and managing subglottic secretions were not. Age, nursing experience, ICU experience, and specific training on VAP prevention significantly influenced knowledge levels. Notably, ICU experience and receiving information from educational institutions impacted VAP prevention practices, while gender, age, and general training did not. However, overall knowledge did not significantly correlate with practice, indicating other factors influence the implementation of VAP preventive measures.

**Table (5): Relation between the sociodemographic characteristics of the study nurses and their total practice (n=84).**

| Variable | No. | % | Mean Rank | Test value | P-value |
|---|---|---|---|---|---|
| **Gender** | | | | | |
| Male | 21 | 25.0 | 41.45 | 639.5[a] | 0.818 |
| Female | 63 | 75.0 | 42.85 | | |
| **Age** | | | | | |
| < 30 years | 41 | 48.8 | 37.55 | 678.5[a] | 0.066 |
| ≥30 years | 43 | 51.2 | 47.22 | | |
| **Education** | | | | | |
| Diploma | 3 | 3.6 | 39.33 | | |
| BSN | 77 | 91.7 | 42.46 | 0.119[a] | 0.942 |
| Postgraduate | 4 | 4.8 | 45.63 | | |
| **Experience** | | | | | |
| < 6 years | 38 | 45.2 | 37.68 | 691.0[a] | 0.097 |
| ≥ 6 years | 46 | 54.8 | 46.48 | | |
| **Experience in the ICU** | | | | | |
| ≤1 year | 45 | 53.6 | 37.20 | 639.0a | 0.031 |
| > 1 year | 39 | 46.4 | 48.62 | | |
| **Have you trained in preventing infection in the ICU?** | | | | | |
| Yes | 67 | 79.8 | 43.19 | 523.50[a] | 0.605 |
| No | 17 | 20.2 | 39.79 | | |
| **Have you been trained on preventing VAP?** | | | | | |
| Yes | 57 | 67.9 | 45.00 | 627.0[b] | 0.168 |
| No | 27 | 32.1 | 37.22 | | |
| **Have you received information on preventing VAP?** | | | | | |
| Yes | 66 | 78.6 | 42.56 | 590.0b | 0.965 |
| No | 18 | 21.4 | 42.28 | | |
| **Source of information** | | | | | |
| Education institution | | | | | |
| No | 48 | 57.1 | 47.38 | 630.0b | 0.033 |
| Yes | 36 | 42.9 | 36.00 | | |
| Infection control Unit | | | | | |
| No | 43 | 51.2 | 44.88 | 779.0[b] | 0.354 |
| Yes | 41 | 48.8 | 40.00 | | |
| Practice | | | | | |
| No | 47 | 56.0 | 43.00 | 846.0[b] | 0.831 |
| Yes | 37 | 44.0 | 41.86 | | |
| Others | | | | | |
| No | 72 | 85.7 | 41.81 | 382.50[b] | 0.523 |
| Yes | 12 | 14.3 | 46.63 | | |
| More than one source | | | | | |
| No | 56 | 66.7 | 47.08 | 527.50[b] | 0.014 |
| Yes | 28 | 33.3 | 33.34 | | |
| More than two sources | | | | | |
| No | 69 | 82.1 | 44.28 | 394.50b | 0.147 |
| Yes | 15 | 17.9 | 34.30 | | |

**[a] Mann-Whitney Test; [b] Kruskal Wallis Test, ICU: intensive care units; VAP: ventilator-associated pneumonia; [c] high mean rank indicated good practice*

**Table 6: Correlation between the overall knowledge and overall practice**

| | | Practice |
|---|---|---|
| **Knowledge** | **Correlation Coefficient (r)** | 0.206 |
| | **P value** | 0.060 |
| | **N** | 84 |

## 8. Recommendations

- Critical care nurses must thoroughly understand VAP prevention strategies to minimize the risk of this potentially life-threatening infection. Some recommended strategies include hand hygiene, proper oral care, early mobilization, and implementing ventilator bundles.
- Ongoing knowledge and training for critical care nurses can also help improve their knowledge and skills in preventing VAP.
- Incorporating multidisciplinary rounds and involving respiratory therapists in the care of ventilated patients can also improve VAP prevention.

- Hospitals need a standardized protocol for VAP prevention and for nurses to follow it consistently.
- Regular monitoring and auditing of VAP rates can also help identify areas for improvement and ensure that prevention strategies are effective. By implementing these strategies and providing ongoing education, critical care nurses can play a vital role in reducing the incidence of VAP and improving patient outcomes.

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