Assessment of Knowledge and Compliance to Evidence-Based Guidelines for VAP Prevention among ICU Nurses in Tanzania

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Abstract

**Background:** Implementation of evidence-based guidelines (EBGs) related to VAP is an effective measure for the prevention of ventilator-associated pneumonia (VAP). While low knowledge regarding the EBGs related to VAP prevention among ICU nurses is still a major concern among nurses in ICUs globally, the situation in Tanzania is scarcely known. This study aimed to assess the ICU nurses’ knowledge, compliance, and barriers toward evidence-based guidelines for the prevention of VAP in Tanzania.

**Methods:** A cross-sectional study, involving ICU nurses of major hospitals in Tanzania, was conducted. A structured questionnaire was administered among 116 ICU. Data analysis included descriptive statistics and independent t-test.

**Results:** The mean knowledge score was 38.6% which is lower than the lowest ever reported knowledge score for EBGs for VAP prevention. Nurses with a degree or higher level of nursing education performed significantly better than the nurses with a diploma or lower level of nursing education (p=0.004). The mean self-reported adherence score for EBGs for the prevention of VAP was 60.8%. The main barriers to the implementation of EBGs for VAP prevention were lack of skills (96.6%), lack of adequate staff (95.5%), and lack of knowledge (79.3%).

**Conclusion:** Considering the severity and impact of VAP, and the higher risks of HAI in resource-limited countries like Tanzania, the lower level of knowledge and compliance implies the need for on-going educational interventions and evaluation of the implementation of the EBGs for VAP prevention by considering the local context.

Introduction

In hospitals, Intensive Care Units (ICUs) are among the leading wards in the rate of hospital-acquired infections (HAI)[1, 2]. Patients in hospitals in low-income countries are at higher risk of HAI than patients in hospitals in high-income countries. In a review, the pooled incidence density of ICU-acquired HAI in low-income countries was 47.9 per 1000 patient-days compared to 13.6 per 1000 patient-days in the United States[3].

Ventilator-Associated Pneumonia (VAP) is one of the most common and fatal HAI in ICUs[3–5]. It is defined as ‘nosocomial pneumonia in ventilated patients that develops more than 48 hours after initiation of mechanical ventilation, characterized by a new or progressive infiltrate, fever, altered white blood cell count, and purulent tracheobronchial secretions’[6]

Although the exact attributable mortality related to VAP is difficult to ascertain, VAP has long been associated with prolonged ICU stays and increased hospital costs globally[7]. While there is inadequate information regarding VAP incidence in Tanzania and other African countries, the higher burden of infectious diseases and limited resources for treatment and rehabilitation predispose these countries to
increased VAP prevalence [5, 8]. Implementation of evidence-based guidelines (EBGs) related to VAP serves as an effective measure for the prevention of ventilator-associated pneumonia (VAP).

To prevent VAP more reliably and effectively, a group of evidence-based interventions called a “VAP bundle” is recommended to help clinicians deliver bedside care [9]. Ventilator-Associated Pneumonia Bundle (VAP bundle) is a series of evidence-based interventions that when implemented together will achieve significant outcomes of reducing VAP in patients on mechanical ventilation[9, 10]. The VAP bundle components include the following[9, 11]: Elevation of the head of the bed(at 30° to 45°), daily “Sedation Vacations” and assessment of readiness to be extubated, daily oral care (with chlorhexidine for post-cardiac surgery), peptic ulcer disease(PUD) prophylaxis, and deep venous thrombosis(DVT) prophylaxis[9]. Although there has been some discordance regarding specific bundle components among some researchers [12, 13], VAP reduction has been achieved when the compliance of the main bundle components is achieved [10, 14], provided that there is a high level of adherence(above 95%) to all components of the bundles, unless there is a clear reason for clinical variance, and the reasons are clearly documented[15]. At such high compliance, VAP can be effectively prevented, as revealed in a recent study in the Democratic Republic of Congo, where improving compliance of the VAP bundle components from 0 to 32.75% lowered the VAP incidence density from 33.74 to 18.05 VAP cases per 1000 days on the ventilator [16].

To attain high compliance, nurses have to be well equipped with appropriate knowledge and skills to EBGs as necessary factors for their implementation.

**Background**

Although knowledge does not necessarily reflect practice, it remains the first step in the implementation of evidence-based practices. The biggest barrier to compliance with evidence-based practice is not that nurses disagree with the evidence, but rather that nurses do not know whether the evidence exists or do not know what they should be doing[17]. Being the closest patient care providers, nurses in ICU need to have knowledge on the prevention of various hospital-acquired infections for better care of the patient.

Knowledge regarding the EBGs related to VAP prevention is a global concern among nurses in ICUs [4, 18–20], and differs from country to country. The mean knowledge scores reported in various studies range between 41.2% among ICU nurses during the annual Congress of the Flemish Society for Critical Care Nurses[21] and 78.1% among ICU nurses in a tertiary care university hospital in USA [22]. Although low- and middle-income Countries (LMICs) are more burdened with ICU-acquired HAI, the knowledge and skills among clinicians in preventing the HAI is lower than in high-income countries (HICs). In a study to assess the knowledge regarding the EBGs for VAP prevention among nurses, doctors, and respiratory therapists in the USA, all groups had high knowledge about the EBGs for VAP prevention, and intergroup differences in knowledge were not significant [22]. This was contrary to studies done in Egypt [23] and Ethiopia [24] that involved nurses alone, where nurses demonstrated inadequate knowledge.
In addition to the higher rates of infectious diseases in Africa, studies regarding VAP and EBGs for VAP prevention are scarce [3]. In Tanzania, like other sub-Saharan African Countries [3], ICUs are not without risks for VAP. The majority of patients admitted in adult ICUs present the risk factors reported by Wu et al [25]. While prolonged hospitalization and other VAP-related complications are frequently reported, there is no clear documentation of VAP incidences and prevalence. Low nurse-patient ratio, high workload, lack of clear and contextualized VAP protocol, limited strictness in maintaining asepsis during aseptic techniques and limited access to online internet resources are common observable risk factors. The number of specially educated critical care nurses and nurses who have attained specialized ICU knowledge for VAP prevention is also limited. However, the knowledge levels of ICU nurses in Tanzania regarding the EBGs for VAP prevention is unclear, and little attention has been paid to the studies regarding knowledge and compliance to EBPs for VAP prevention among nurses, despite the importance of EBP for VAP prevention in improving the quality and safety of patient's care in ICUs. Therefore, among other things, it was imperative to assess nurses' knowledge and compliance toward EBGs for prevention of VAP by nurses working in ICUs, to discover the existing gaps. This gap in knowledge and compliance can be the first step for comprehensive interventions such as clinical teaching to improve knowledge and compliance, and to influence local policy making related to VAP prevention. Therefore, we conducted this study to assess knowledge and compliance towards EBGs for VAP prevention among ICU nurses in Tanzania. To our knowledge, this is the first study regarding knowledge and compliance to EBGs for VAP prevention in Tanzania using a standardized international questionnaire and among the few studies conducted in Africa around this topic.

**Research questions and objectives**

The main objective of this study was to explore ICU nurses' knowledge, adherence, and barriers towards EBGs for prevention of VAP in Tanzania. The specific research questions were as follows:

1. What do ICU nurses know about EBGs for prevention of VAP in Tanzania?
2. To what extent do ICU nurses adhere to EBGs for prevention of VAP in Tanzania?
3. What are the barriers towards EBGs for prevention of VAP in Tanzania?

**Methods**

*Design*

A cross-sectional study, with a quantitative approach, was conducted among ICU nurses from all major hospitals in Tanzania.

*Sampling and sample size*

Convenient sampling was employed in the selection of participant nurses. All ICU nurses who were available during the data collection period and willing to participate were included in this study. The
inclusion criteria for the participants were as follows: 1) The participants were bedside care providers to ICU patients 2) signed informed consent for participation.

The questionnaires were distributed to a total of 116 nursing staff by the well-trained research assistants with a Master of Science in Nursing (Critical Care and Trauma). The ICU nurses from all hospitals which provide ICU care in Dar es Salaam were involved. The ICU nurses from other regions of Tanzania were conveniently obtained at St. John's University in Dodoma where they were upgrading their diploma into degrees through bachelor studies. No any participant identification information was required, and the questionnaire was filled only once.

The questionnaire

The questionnaire was adopted from Jasson et al(2013), and was previously applied in Finland in 2013 for assessment of knowledge and compliance toward evidence-based practices for prevention of VAP among the critical care nurses[26]. This questionnaire was prepared from two international pre-validated questionnaires used for assessment of knowledge [27], and compliance and barriers [28]. The knowledge questionnaire comprised of nine closed-ended questions with a difficulty and discriminative indexes of 0.1—0.9; discrimination 0.10—0.65 respectively[29] and supplemented by one question on the use of 0.12% chlorhexidine gluconate antiseptic rinse [12], making a total of 10 objective questions.

The overall Self-reported adherence questionnaire included questions from three main sources:

i) The original questionnaire by Ricart et al(2003)(question 1-12)[28]

ii) The supplementary questions from the American Association for Respiratory Care’ (AARC, 2010) recommended open endotracheal suction (ETS) practices(question 13-20) [30], and

iii) The World Health Organization (WHO, 2009) recommended hand hygiene practices (question 21-25).

Assessment of barriers to implementation of the EBGs for VAP prevention was done according to Jasson et al(2013). The barriers were outlined and participant nurses were required to either agree by selecting ‘Yes’ or disagree by selecting a ‘No’ option. The percentages of the responses were tabulated and compared.

The overall questionnaire for the assessment of knowledge, compliance, and barriers was evaluated by two experts: One was a registered nurse with a master of critical care nursing, and another is an anaesthesiologist. These experts had ICU working experience of 6 and 9 years respectively.

The overall questionnaires were further pre-tested for validity by a group of ICU nurses (n = 12) who were not included among participants for the main study.

Measurements of variables
In assessing knowledge, each correct answer was given one mark, thus the total score ranged from 0-10. To minimize subjectivity in reporting for compliance, the participant nurses were required to estimate the number of times they adhere to each particular item in every 10 indications for each item. Therefore, in each item, a total of 10 points was given if an item is always and correctly adhered to, and the least score was 0 if the item is not adhered to at all. This allowed an estimate of the adherence rate for each particular item even when the adherence was not 100% per a given item. The total score ranged from 0 to 250. The percentage score for each item was calculated, and the overall adherence score was reported in percentage (Table 3).

Data analysis

Raw data were uploaded and analyzed using Statistical Package for the Social Sciences (SPSS) version 20. Descriptive statistics such as frequency and percentages were used to describe the demographics, adherence, and barriers of participant nurses regarding the implementation of EBGs for VAP prevention. Knowledge and adherence of ICU nurses were compared by different levels of ICU experiences (≤ 5 yrs vs. >5 yrs) and nursing education (below degree vs degree and above). A p-value of less than 0.05 was considered statistically significant.

Results

Demographic characteristics of participants

A total of 116 ICU nurses were involved in the study. Nurses aged between 31-39 years constituted the largest proportion (42.6%). Most had acquired nursing education at the diploma level and below (74.1%), often with <5 years of experience (78.1%). About 35% acknowledged having ever cared for a patient with VAP. Only about 16 % (n=114) had ever had an in-service course on VAP. Demographic information of the participants has been summarized in Table 1.

Knowledge

The mean knowledge score (Fig 1) was 3.86 (SD=1.56), equivalent to 38.6%. Thirty one percent achieved more than half of the total points. The scores ranged from 1-9 (10-90%). The 75th percentile was 50% score.

Fig 1: Participant ICU nurses score for knowledge test

Independent sample t-test revealed that, nurses with higher level of nursing education (degree and above) scored significantly higher than their colleagues with diploma and below (4.57, SD=1.22 vs 3.62, SD=1.60, p= 0.001)(Table 4). However, although more experienced nurses (ICU experience > 5 years) scored slightly higher than their less experienced colleagues (ICU experience < 5 years), the differences in score was not statistically significant (3.96, SD =1.27, vs 3.86, SD=1.66, p=0.1)
The top three items to which nurses answered correctly were related to patient positioning (70.7%), oral vs. nasal route for endotracheal intubation (55.2%), use of 0.12% chlorhexidine gluconate antiseptic oral rinse (52.6%)(Table 2). The three least scored items were related to: Frequency of humidifier changes (12.9%), type of airway humidifier (23.3%) and Open vs. Closed suction systems (28.4%)(Table 2).

Having a recent course on VAP, or ever cared a VAP patient did not significantly affect the knowledge on EBGs for VAP prevention (Table 4).

**Adherence**

The mean self-reported adherence score for EBGs for prevention of VAP (Table 3) was 15.20 (SD=0.93) which is equivalent to 60.8%.

Independent sample t-test revealed that experience and educational levels had no significant association with self-reported adherence to EBGs for VAP prevention (Table 4).

The three most adhered procedures were related to semi-recumbent positioning of the patient (92.4%), patient positional treatment (91.8%), and enteral feeding protocol/avoidance of gastric over distension (91.2). The four least adhered procedures were related to Pre-suctioning analgesic (0.4%), use of protective gowns during suctioning (11.6%), face mask-wearing during suctioning (11.6%), continuous subglottic suctioning (11.6%).

Having a recent course on VAP, or ever cared a VAP patient with VAP did not significantly affect the compliance to EBGs for VAP prevention.

**Barriers**

The main reported barriers to implementation of EBGs for VAP prevention (Table 4) include Lack of skills (96.6%), Lack of staff (95.7%), and Job discretion (94%). The least reported barriers include the procedures considered unnecessary (4.3%), (Table 5).

**Discussion**

This study aimed at determining knowledge, compliance, and barriers to implementation of EBGs for VAP bundle prevention in Tanzania as a resource-limited setting. The mean knowledge score was 38.6%. This score is below the mean scores ever reported in various studies, ranging from 41.2% among nurses during the annual congress of the Flemish Society for Critical Care Nurses in November 2005[21] to 78.1% in USA [22]. Poor knowledge regarding the EBGs related to VAP prevention has also been reported in Iran [18], Yemen [20] and Taiwan [31] in Asia, and Egypt [23] and Ethiopia[24] in Africa. The differences in knowledge scores may be explained by the differences in models of healthcare delivery in ICUs[22], and lack or differences in specific guidelines and policy regarding training and practice of EBGs for VAP prevention in ICUs [27]. Developing a specific guideline and policy for training VAP prevention by
considering the challenges in the resource-limited setting, without compromising the effectiveness in VAP prevention, could be helpful in minimizing the knowledge differences in resource-limited settings. Such standardized guidelines would take into consideration the costs related to recommendations for VAP prevention.

This study reveals a higher range of knowledge among nurses (10-90%) not only among ICU nurses in different hospitals but also within the same hospital. This higher range in knowledge between the lowest and the highest knowledge score may imply the difficulty in sharing evidence-based information among staff. The difficulty in sharing knowledge in hospitals in resource-limited settings has been extensively documented [32][33]. Some associated factors to information sharing include: Differences in educational levels, limited resources, job dissatisfaction, lack of motivation, and lower level of professional education [32, 33]. Other factors may include high workload, lack of organized on-the-job training, and lack of emphasis to improve knowledge or practice regarding EBGs. Yonkaitis and Maughan [34] have provided a simplified and useful guide for EBG knowledge sharing and evaluation (the 6 ‘A’s’ of EBPs) which may be adopted in resource-limited settings to assess the need, acquire the best evidence, appraise the evidence, apply evidence and disseminate evidence [34].

In our study, nurses with a degree or higher level of nursing education performed significantly better than the nurses with a diploma or lower level of nursing education. These results are consistent with studies in Taiwan [31], Ethiopia [24], and Belgium [27] but are contrasted by the study in New Zealand [35]. However, contrary to other studies [21, 22, 27, 28], and consistent with others [26], nursing assistants were included because they are also involved in bedside care of critically ill patients in ICU. However, their proportion was very low (1.7% of the entire sample), and therefore the results should be interpreted with caution.

Our study, unlike several others [21, 27, 36] revealed that there was no differences in knowledge between more experienced nurses and less experienced nurses. These results are consistent with studies in New Zealand [35], Ethiopia [24], and USA [22]. In resource-limited countries like Tanzania, continuing education programs for in-service nurses are not common. The reliable source of knowledge remains college nursing training. Therefore, nurses with lower nursing education are likely to remain with little knowledge despite their increased clinical experiences, most of which is based on routine works and fulfilling medical orders.

In our study, the mean self-reported adherence to EBGs for the prevention of VAP was 60.8%. This score is below the adherence scores ever reported in various studies, ranging between 77.7% in Spain [28] and 83% in USA [37]. Consistent with other studies [26], neither nursing level of education nor experience was associated with significant variability in adherence. In a similar study in Ethiopia [24], only higher nursing experience was associated with increased adherence to EBGs for VAP prevention. It implies that there are other factors than the nursing level of education, and experience that affect compliance to the EBGs for VAP prevention, which may range from institutional factors such as lack of sufficient management support and policy, to individual factors such as heavy workload and increased job stress in a resource-limited setting.
Consistent with other studies[26], the most commonly self-reported adherences were related to semi-recumbent positioning. Others include patient positional treatment, enteral feeding protocol/avoidance of gastric over distension, use of a formal infection-control program, sterility of suction catheter maintained until inserted into airway, sodium chloride instillation and disposal of used catheter and gloves in a manner that prevents contamination from secretions. The reason for high adherence score could be because these are part of the local guideline for ICU care of critically ill patients in most ICUs in Tanzania, and therefore, are routinely performed. The least adhered component was related to presuctioning analgesia(0.4%), which is much lower than the previously reported studies[26]. In Tanzania, administering presuctioning analgesia is almost not done in ICUs.

The main barriers to the implementation of EBGs for VAP prevention were lack of skills (96.6), lack of staff (95.5%), and lack of knowledge (79.3%). These factors are also reported in several other studies[38][37]. Lack of knowledge and skills may be attributed to inability to transform research into practice, and poor information sharing among nurses as the majority of ICU nurses have lower nursing education levels [22][38]. Poor information sharing among ICU nurses is revealed by a wider range of knowledge score of 80% (10%-90%) in the present study. Others include lack of guidance (78.4%), and laziness (75%) [26]

In summary, it is necessary that the knowledge, compliance, and barriers are assessed so that measures are taken for the improvement of clinical outcomes of our ICU patients. The knowledge levels and compliance of ICU nurses in Tanzania regarding EBGs for VAP prevention are lower than the lowest ever reported level of knowledge in the published studies. This may be the single most important barrier to the implementation of the EBGs for VAP prevention.

**Implication and recommendation for practice**

Considering the implication of VAP in the quality of ICU patients, and the role of adherence to the EBGs in prevention of VAP and improving quality of ICU patient care, educational measures to improve knowledge, preparing local guidelines and enhancing information sharing among nurses may have significant outcomes in prevention of VAP. Whenever possible, increasing the Nurse to patient ratio in ICUs will add to the implementation of the recommended EBGs for VAP prevention. The results of this study will help in guiding local practice and education, and will be the baseline of reference after implementation of educational measures. Furthermore, being the first study regarding knowledge and compliance to EBGs for VAP prevention in Tanzania using standardized international questionnaire, the results of this study adds to the existing literature regarding the state of sub Saharan Africa and other resource-limited settings.

**Limitations**

This study had some limitations worth mentioning. First, the participant ICU nurses outside Dar es Salaam City were conveniently obtained at St. John's University. These may not be representative of all
other nurses in their respective hospital. Second, this study did not exhaustively evaluate other factors that may affect compliance, such as managerial factors.

**Conclusion**

The average knowledge level and compliance regarding the EBGs for VAP prevention in Tanzania was lower than the lowest ever reported elsewhere. Level of nursing education was shown to be associated with better knowledge scores. Barriers towards EBGs were identified. There is a need for ongoing in-service educational interventions and effective implementation strategies. Considering the consequences of VAP, Nursing curriculums in all levels should include a part for EBGs for VAP prevention.

**Declarations**

**Ethics approval and consent to participate**

Ethical approval was granted by the Muhimbili University of Health and Allied sciences Institutional Review Board, with number MU/PGS/SAE/Vol. XI. Permission for data collection was granted by the respective hospital managements, and informed consent forms signed by each individual participant. The form had introduction of the study, significance, benefits, risks, and participants' voluntary nature of their participation. All steps and procedures were performed in accordance with the relevant guidelines approved by the IRB and specific hospitals involved in the study.

**Consent for publication**

Not Applicable

**Availability of data and materials**

Data for the study are available to the corresponding author and may be accessed upon request

**Competing interests**

The authors declare that there is no any competing interest.

**Funding**

None

**Authors' contributions**

VB and AO were involved in conception, designing, analyzing, writing reports and writing manuscripts. LW had engaged in analyzing, interpreting data and writing reports. LY was the overall supervisor in all stages from conception to manuscript preparation and publication. All authors have read and approved the manuscript.
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Tables
| Variable                                      | Frequency | Percent |
|-----------------------------------------------|-----------|---------|
| **Age (n=115)**                               |           |         |
| 20-29                                         | 32        | 27.8    |
| 30-39                                         | 59        | 51.3    |
| 40-49                                         | 23        | 20      |
| 50-59                                         | 1         | 0.9     |
| **Level of nursing education (N=115)**        |           |         |
| Diploma and below                             | 86        | 74.1    |
| Degree and above                              | 30        | 25.9    |
| **Sex (N=116)**                               |           |         |
| Male                                          | 20        | 17.2    |
| Female                                        | 96        | 82.8    |
| **Hospital (N=116)**                          |           |         |
| MNHT†                                         | 53        | 45.7    |
| MOI ‡                                         | 25        | 21.6    |
| Kairuki                                       | 3         | 2.6     |
| Aga Khan                                      | 14        | 12.1    |
| Others §                                       | 21        | 18.1    |
| **Type of ICU (N=116)**                       |           |         |
| General ICU                                   | 61        | 52.6    |
| Cardiac ICU                                   | 10        | 8.6     |
| Orthopedic ICU                                | 25        | 21.6    |
| Emergency                                     | 20        | 17.2    |
| **Ever heard about VAP (N=116)**              |           |         |
| Yes                                           | 59        | 50.9    |
| No                                            | 57        | 49.1    |
| **Ever cared for a VAP patient (N=116)**      |           |         |
| Yes                                           | 41        | 35.3    |
| No                                            | 75        | 64.7    |
| **Had any recent course (N=114)**             |           |         |
| Yes                                           | 18        | 15.8    |
| No                                            | 96        | 84.2    |

† Muhimbili National Hospital  
‡ Muhimbili Orthopaedic Institute  
§ Includes KCMC, Bugando Medical Centre, Mbeya Zonal Hospital and Dodoma Regional Referral Hospital
| Questions                                                                 | Answer and (%) |
|---------------------------------------------------------------------------|----------------|
| 1. Oral vs. nasal route for endotracheal intubation                        |                |
| Oral intubation is recommended                                             | 64 (55.2)      |
| Nasal intubation is recommended                                            | 28 (24.1)      |
| Both routes of intubation can be recommended                               | 17 (14.7)      |
| I do not know                                                              | 7 (6)          |
| 2. Frequency of ventilator circuit changes                                 |                |
| It is recommended to change circuits every 48 h (or when clinically indicated) | 45 (38)        |
| It is recommended to change circuits every week (or when clinically indicated) | 25 (20.5)      |
| It is recommended to change circuits every 72 h (or when clinically indicated) | 15 (12.9)      |
| I do not know                                                              | 10 (8.6)       |
| 3. Type of airway humidifier                                               |                |
| Heated humidifiers are recommended                                         | 38 (32.6)      |
| Heat and moisture exchanges are recommended                                | 27 (23.3)      |
| Both types of humidifiers can be recommended                               | 41 (35.3)      |
| I do not know                                                              | 10 (8.6)       |
| 4. Frequency of humidifier changes                                         |                |
| It is recommended to change humidifiers every 48 h (or when clinically indicated) | 74 (63.8)      |
| It is recommended to change humidifiers every 72 h (or when clinically indicated) | 23 (19.8)      |
| It is recommended to change humidifiers every week (or when clinically indicated) | 15 (12.9)      |
| I do not know                                                              | 10 (8.6)       |
| 5. Open vs. closed suction systems                                         |                |
| Open suction systems are recommended                                       | 33 (32.6)      |
| Closed suction systems are recommended                                     | 27 (23.3)      |
| Both systems can be recommended                                            | 41 (35.3)      |
| I do not know                                                              | 10 (8.6)       |
| 6. Frequency of change in suction systems                                  |                |
| Daily changes are recommended (or when clinically indicated)               | 40 (34.5)      |
| Weekly changes are recommended (or when clinically indicated)              | 26 (22.4)      |
| It is recommended to change systems every new patient (or when clinically indicated) | 36 (31.0)      |
| I do not know                                                              | 10 (8.6)       |
| 7. Endotracheal tubes with extra turn for drainage of subglottic secretions|                |
| These endotracheal tubes reduce the risk for VAP                          | 56 (48.3)      |
| These endotracheal tubes increase the risk for VAP                         | 30 (25.9)      |
| These endotracheal tubes do not influence the risk for VAP                 | 21 (18.3)      |
| I do not know                                                              | 9 (7.8)        |
| 8. Kinetic vs. standard beds                                               |                |
| Kinetic beds increase the risk for VAP                                     | 30 (25.9)      |
| Kinetic beds reduce the risk for VAP                                       | 33 (28.4)      |
| The use of kinetic beds does not influence the risk for VAP                | 21 (18.3)      |
| I do not know                                                              | 9 (7.8)        |
| 9. Patient positioning                                                     |                |
| Supine positioning is recommended                                         | 17 (14.7)      |
| Semi-recumbent positioning is recommended                                  | 26 (22.4)      |
| The position of the patient does not influence the risk for VAP            | 12 (10.3)      |
| I do not know                                                              | 9 (7.8)        |
| 10. Use of 0.12% chlorhexidine gluconate antiseptic oral rinse              |                |
| 0.12% chlorhexidine gluconate antiseptic oral rinse reduce the risk of VAP | 61 (52.6)      |
| 0.12% chlorhexidine gluconate antiseptic oral rinse increase the risk of VAP| 33 (28.4)      |
| 0.12% chlorhexidine gluconate antiseptic oral rinse does not influence the risk of VAP | 20 (17.2)      |
| I do not know                                                              | 10 (8.6)       |

Mean score=2.86, 28.6%  
SD=1.57, 15.7%
### Table 3: Intensive Care Unit nurses’ self-reported adherence to EBGs for prevention of VAP.

|   |   |   |
|---|---|---|
| 1. | Removal of nasogastric tube as soon as clinically feasible | 81.6 |
| 2. | Enteral feeding protocol/avoidance of gastric over distension | 91.2 |
| 3. | Semi-recumbent positioning of the patient (30—45°) | 89.2 |
| 4. | Humidification with heat and moisture exchangers | 84.1 |
| 5. | Daily changes of heat and moisture exchangers | 59.1 |
| 6. | Chest physiotherapy | 55.5 |
| 7. | Adequate hand hygiene between patients | 87.5 |
| 8. | Use of a formal infection-control program | 90.6 |
| 9. | Maintenance of adequate pressure in the endotracheal-tube cuff | 82.1 |
| 10. | Scheduled drainage of condensate from ventilator circuits | 29.6 |
| 11. | Continuous subglottic suctioning | 11.6 |
| 12. | Use of protective gowns during suctioning | 11.6 |
| 13. | Pre-suctioning analgesic | 0.4 |
| 14. | Pre-suctioning hyperoxygenation | 41.1 |
| 15. | Face mask wearing during suctioning | 11.6 |
| 16. | Sterility of suction catheter maintained until inserted into airway | 90.8 |
| 17. | Protection of patients eyes and central venous catheter from secretions during suctioning | 10.9 |
| 18. | Two nurses perform suctioning | 13.0 |
| 19. | Sodium chloride instillation | 90.5 |
| 20. | Used catheter and gloves are disposed of in a manner that prevents contamination from secretions | 90.1 |
| 21. | Sedation protocol | 75.3 |
| 22. | Respirator and weaning protocols | 60.1 |
| 23. | Avoidance of unnecessary reintubation | 89.7 |
| 24. | Extubation protocol | 84.0 |
| 25. | Patient positional treatment | 91.8 |

Mean adherence was 60.8 (SD=3.8),
| Test variable          | Grouping                  | Mean (SD) | t-value | p-value |
|------------------------|---------------------------|-----------|---------|---------|
| **Knowledge**          |                           |           |         |         |
|                        | **Experience**            |           |         |         |
|                        | Experience>5              | 3.96 (1.27)| 0.343   | 0.1     |
|                        | Experience<5              | 3.85 (1.56)|         |         |
|                        | **Education**             |           |         |         |
|                        | Degree and above          | 4.57 (1.22)| 2.96    | **0.004**|
|                        | Diploma and below         | 3.62 (1.50)|         |         |
|                        | **Ever cared a VAP patient** |           |         |         |
|                        | Yes                       | 4.02 (1.28)| 0.897   | 0.37    |
|                        | No                        | 3.77 (1.71)|         |         |
|                        | **Had any training regarding VAP** |           |         |         |
|                        | Yes                       | 3.61      | 0.904   | 0.37    |
|                        | No                        | 3.91      |         |         |
| **Compliance**         |                           |           |         |         |
|                        | **Experience**            |           |         |         |
|                        | Experience>5              | 15.02 (0.6)| 1.706   | 0.09    |
|                        | Experience<5              | 15.30 (1.0)|         |         |
|                        | **Education**             |           |         |         |
|                        | Degree and above          |           |         |         |
|                        | Diploma and below         |           |         |         |
|                        | **Ever cared a VAP patient** |           |         |         |
|                        | Yes                       | 15.21 (1.30)| 0.206   | 0.81    |
|                        | No                        | 15.25 (0.66)|         |         |
|                        | **Had any training regarding VAP** |           |         |         |
|                        | Yes                       | 15.12 (0.61)| 0.839   | 0.407   |
|                        | No                        | 15.26 (0.99)|         |         |
| Barrier                             | n (%)  |
|------------------------------------|--------|
| 1. Lack of skills                  | 112(96.6) |
| 2. Lack of staff                   | 111(95.7) |
| 3. Job discretion                  | 109(94) |
| 4. Lack of knowledge               | 92(79.3) |
| 5. Lack of guidance                | 91(78.4) |
| 6. Laziness                        | 87(75) |
| 7. Considered unnecessary          | 5(4.3) |