Title: Critical care nurses' knowledge of, adherence to and barriers toward evidence-based guidelines for the prevention of ventilator-associated pneumonia – a survey study

Summary

Objectives: To explore critical care nurses' knowledge of, adherence to and barriers toward evidence-based guidelines for prevention of ventilator-associated pneumonia.

Design: A quantitative cross-sectional survey.

Methods: Two multiple-choice questionnaires were distributed to critical care nurses (n = 101) in a single academic center in Finland in the fall of 2010. An independent-samples t-test was used to compare critical care nurses' knowledge and adherence within different groups. The principles of inductive content analysis were used to analyze the barriers toward evidence-based guidelines for prevention of ventilator-associated pneumonia.

Results: The mean score in the knowledge test was 59.9%. More experienced nurses performed significantly better than their less-experienced colleagues (p = 0.029). The overall, self-reported adherence was 84.0%. The main self-reported barriers toward evidence-based guidelines were inadequate resources and disagreement with the results as well as lack of time, skills, knowledge, and guidance.

Conclusion: There is an ongoing need for improvements in education and effective implementation strategies.

Clinical implications: The results could be used to inform local practice and stimulate debate on measures to prevent ventilator-associated pneumonia. Education, guidelines as well as ventilator bundles and instruments should be developed and updated to improve infection control.

Key words: Ventilator-associated pneumonia, Evidence-based guidelines, Knowledge, Adherence, Barriers

Introduction

Ventilator-associated pneumonia (VAP) is the commonly encountered (12–33.8%) nosocomial infection in critical care situations (Karhu et al., 2011; Ylipalosaari et al., 2006). Previous prevalence and prospective cohort studies have shown that VAP is associated with high morbidity and mortality rates as well as prolonged lengths of intensive care unit (ICU) and hospital stay (Babcock et al., 2004; Ylipalosaari et al., 2006). Prevention of this nosocomial infection could reduce costs and improve patient-related outcomes and patient safety and the quality of care (Babcock et al., 2004; Marra et al., 2009; Safdar et al., 2005).

Routine critical care nursing interventions have been shown to reduce the incidence of VAP (Ricart et al., 2003). The Institute for Healthcare Improvement (IHI 2006), the Centers for Disease Control and Prevention (CDC, 2003) and Rello et al., (2010) have designed VAP bundles (VBs) to help reduce or eliminate VAP and promote adherence to evidence-based guidelines (EBGs) in order to improve patient outcomes (Table 1).

According to previous studies, critical care nurses' knowledge about EBGs for preventing VAP is currently limited (Blot et al., 2007; Labeau et al., 2008). The lack of knowledge may be a barrier toward adherence to EBGs (El-Khatib et al., 2010). Despite frequent reminders and supplementary educations, adherence (Gurses et al., 2008; Ricart et al., 2003) and attitudes (Kaynar et al., 2007; Pogorzelska and Larson, 2008) toward EBGs are reportedly poor. Further research is needed to evaluate critical care nurses' knowledge, attitudes and beliefs in order to understand, inform and develop current practices for VAP prevention (Ajzen, 2005), especially in Scandinavia, where the topic has largely been undiscussed in the contrast of the Middle East (El-Khatib et

al., 2010) and majority of European countries (Ricart et al., 2003; Blot et al., 2007; Labeau et al., 2008).

Research questions and objectives

The objectives of this study were to explore critical care nurses' knowledge of, adherence to and barriers toward EBGs for prevention of VAP. The key research questions were as follows:

1) What do critical care nurses know about EBGs for prevention of VAP?

2) To what extent do critical care nurses adhere to EBGs for prevention of VAP?

3) What are the barriers toward EBGs for prevention of VAP?

Methods

Design

A quantitative cross-sectional survey was conducted based on two pre-validated multiple-choice questionnaires developed to explore critical care nurses' knowledge of, adherence to and barriers toward EBGs for prevention of VAP.

Sample and settings

The study was conducted in a single academic center in Finland in a 22-bed mixed adult general ICU in the fall of 2010. Participants were selected for the survey using convenience (accidental) sampling: participants were included in the survey if they happened to be in the right place at the right time (Burns and Grove, 2009). The inclusion criteria were as follows: 1) informed consent was obtained and 2) participants were direct care providers (bedside). However, physicians and students were excluded.

The questionnaires were distributed to all nursing staff (N = 173) by the head nurses in charge, who arranged an appropriate time (30min) and place to gather the responses. Due to the nature of spot testing, the questionnaires were completed under the head nurse's supervision. Each participant responded anonymously and only once.

Questionnaires

Two international multiple-choice questionnaires were used to evaluate critical care nurses' knowledge of (Labeau et al., 2007), adherence to and barriers toward EBGs for prevention of VAP (Ricart et al., 2003). Questionnaires were adapted, translated and evaluated by two methodological and content experts (i.e., one physician and one registered nurse), who were selected based on their clinical ICU expertise. In addition, questionnaires were pre-tested for internal validity by a group of critical care nurses (*n* = 12) who did not participate in the primary study (Burns and Grove, 2009).

Labeau et al's (2007) pre-validated questionnaire (difficulty 0.1–0.9; discrimination 0.10–0.65) comprises nine closed-ended questions, which are considered appropriate for objectively measuring participants' level of knowledge (Burns and Grove, 2009; Polit and Beck, 2011). The questionnaire was supplemented by one question (Table 3, question 10) about the use of 0.12% chlorhexidine gluconate antiseptic rinse (CDC, 2003; Rello et al., 2010). Therefore, the final questionnaire comprised ten questions. One point was given for each correct answer. Thus, the total score ranged from 0 to 10.

Ricart et al.'s (2003) original questionnaire was used to evaluate critical care nurses' self-reported adherence to and barriers toward 25 potential non-pharmacological strategies for the prevention of VAP. The original questionnaire was supplemented by questions about the American Association for Respiratory Care' (AARC, 2010) recommended open endotracheal suction (ETS) practices (Table 3, questions 13–20) and VBs, including the World Health Organization' (WHO, 2009) recommended hand hygiene practices (Table 4, questions 21–25). One point was given if participants adhered to an item. The total score ranged from 0 to 25. If any of the strategies were not

used routinely, the participants were asked to indicate one of six barriers toward EBGs. One of the six barriers was presented as an open-ended question.

Data analysis

SPSS 18.0 for Windows was used for statistical analysis (SPSS Inc., Chicago, Illinois, USA). Descriptive statistics included frequency ratings and percentages to describe demographics, adherence and perceived barriers of participants. An independent-samples t-test was used to compare the knowledge and adherence of critical care nurses' with different levels of ICU experience (≤ 5 yrs vs. > 5 yrs) and education (registered nurses vs. nursing assistants). The five year cutoff for ICU experience was based on previous studies (Ricart et al., 2003; Labeau et al., 2008; El-Khatib et al., 2010). A *p* value less than 0.05 was considered statistically significant.

The principles of inductive content analysis were used to analyze, categorize and quantify the barriers toward EBG for prevention of VAP (Elo and Kyngäs, 2008). Initially, answers to the only open-ended question were open-coded based on the descriptions. Next, similar open-codes were grouped together into categories. Further, each category was labeled using content-specific keywords (e.g., lack of time, knowledge etc.). Finally, the open-codes were quantified within each category by calculating how many times each open-code occurred (Table 4).

Ethical considerations

Approval for the survey was obtained from University Hospital. In Finland, according to the Medical Research Act (488/1999, and amendments 295/2004), approval of the

local ethics committee is not required in studies focusing on staff members. Submission of a questionnaire was considered consent to participating in the study. Participants were assured of the voluntary nature of their participation. The anonymity of data was assured by coding the data. The data were stored on a password-protected computer, and only the corresponding author had access to the data.

Results

Demographics

The questionnaires were distributed to available critical care nurses (n = 101). The final response rates ranged from 56.4% (registered nurses) to 100% (nursing assistants). Demographic information of the study participants is shown in Table 2. The majority of participants (89.1%) were registered nurses, often with > 10 yrs ICU experience (40.6%).

Knowledge

The mean score (Figure 1) in the knowledge test was 5.99 (SD 1.40) based on ten questions (i.e., 59.9% correct answers), and 66.3% of participants achieved more than half of the available points (Figure 1). More experienced nurses (ICU experience > 5yrs) scored (6.04, SD 1.39) significantly better (p = 0.029) than their less-experienced (ICU experience ≤ 5 yrs) colleagues (5.38, SD 1.51). The level of knowledge of nursing assistants' was lower than registered nurses, but the difference was not statistically significant (p = 0.191).

The most well-known EBGs for prevention of VAP (Table 3) were related to patient positioning (99.0%) and use of 0.12% chlorhexidine gluconate antiseptic rinse (95.0%). The least well-known EBGs were related to the frequency of humidifier (5.0%) and suction system changes (26.7%).

Adherence

The mean score in self-reported adherence to EBGs for prevention of VAP (Table 4) was 20.99 (SD 2.97) on 25 questions (84.0%). There was no significant difference in adherence between the registered nurses and nursing assistants, or between different levels of ICU experience.

The most highly adhered procedures were related to semi-recumbent positioning of the patient (94.1%), humidification with heat and moisture exchangers (94.1%) and to infection control practices, such as adequate hand hygiene (93.1%) and to aseptic technique, such as maintaining the sterility of the suction catheter until insertion into airway (93.1%) and disposal of the used catheter and gloves in the manner that prevents contamination of secretions (93.1%). The most poorly adhered to guidelines (Table 4) pertained to two nurses perform the ETS (46.5%), use of a continuous subglottic suctioning system (27.7%) and use of protective gowns during ETS practices (24.8%).

Barriers

The main barriers toward EBGs for prevention of VAP were inadequate resources and disagreement with the results of previous studies (Table 4). However, other barriers against following EBGs (Table 5) included lack of time (14.3%), patient-related barriers (14.3%), lack of skills (11.9%), knowledge (7.1%), and guidance (7.1%), forgetfulness (7.1%), procedure consisted unnecessary (7.1%) and lack of staff (4.8%). Minor barriers were outside job description (4.8%), and lack of outcome expectancy (2.4%).

Discussion

The study was conducted in a single university hospital and based on a nonprobability method of sampling. Therefore, it is difficult to generalize the results. Critical care nurses' mean score in the knowledge test was 59.9%, whereas previous studies have reported mean scores ranging from 41.2% (Blot et al., 2008) to 78.1% (El-Khatib et al., 2010). The variability of the scores might be due to differences between the specific healthcare delivery models (El-Khatib et al., 2010), routine critical care nursing duties (e.g., lack of specific respiratory therapists), local and international guidelines as well as views on good practice and/or a lack of consistent policy (Labeau et al., 2008).

In our study, as in several other studies (Blot et al., 2007; Labeau et al., 2008), more experienced nurses (ICU experience > 5 yrs) performed significantly better in the knowledge test than their less experienced (ICU experience ≤ 5 yrs) colleagues. However, El-Khatib et al. (2010) reported that the difference between groups was not significant. Contrary to previous studies (Ricart et al., 2003; Blot et al., 2007; Cason et al., 2007; Kaynar et al., 2007; Labeau et al., 2008; El-Khatib et al., 2010), nursing assistants were included in our study because they provided care for mechanically ventilated adult patients with an artificial airway. However, the sample of nursing assistants was less than 10% of the entire sample, and thus the results should be interpreted with caution.

The self-reported adherence to EBGs for prevention of VAP was 84%, which is in line with previous studies reporting adherence between 77.7–83.0% (Ricart et al., 2003; Kaynar et al., 2007). However, contrary to previous studies (CDC, 2007), no variability in adherence toward EBGs between different education or experience groups was found. The most common self-reported adherences were related to VB including

semi-recumbent positioning (CDC, 2003; IHI, 2006), adequate hand hygiene (CDC, 2003; Rello et al., 2010), and formal infection control programs, which may be due to well-implemented guidelines. However, self-reported adherences to hand hygiene (Berhe et al., 2005; CDC, 2007; De Wandel et al., 2010; Sahay et al., 2010; Tolentino-DelosReyes et al., 2007; WHO, 2009), oral care (Cutler and Davis, 2005; Furr et al., 2004; Jones et al., 2004) and ETS practices (Day et al., 2002; Kelleher and Andrews, 2008) were generally higher than reported in previous prospective, observational studies.

In addition, rigorous hand hygiene with alcohol disinfectants was not common practice when previous studies published prior to 2010 were conducted (Crunden et al., 2005; Resar et al., 2005; Berrile-Cass et al., 2006; Apisarnthanarak et al., 2007; Younnquist et al., 2007; Bloos et al., 2009; Hawe et al., 2009; Hutchins et al., 2009; Marra et al., 2009; Zaydfudim et al., 2009; Bird et al., 2010). Alcohol-based hand disinfection was considered in Blaumoun et al.'s (2009) and Bouadma et al.'s studies (2010a, 2010b), whereas earlier studies, such as Cocoanour et al. (2006), merely recommended its use. Recently, it has been shown that adequate hand hygiene is the single most effective practice in preventing VAP (Koff et al. 2011) and other nosocomial infections (Masterton et al., 2008; WHO, 2009).

The least well-adhered to EBGs were related to the frequency of humidifier and suction system changes. Heat and moisture exchangers were reported to be changed daily by 94.1% of critical care nurses (according to local practices), whereas the significance of such measures has been questioned by Masterton et al. (2008). The results also showed that the recommended use of open versus closed suction system was ambiguous. According to Masterton et al. (2008) and Subirana et al. (2010), the type of suctioning system has no effect on the incidence of VAP, in contrast to earlier

recommendations (Dodek et al., 2004) and studies (Blot et al., 2007; El-Khatib et al., 2010; Labeau et al. 2008).

The lowest self-reported adherences were related to continuous subglottic suctioning (Dodek et al., 2004; ATS, 2005; Masterton et al. 2008) and to some infection control practices. The use of protective gowns (CDC, 2003, 2007) and two nurses perform the open ETS were not well adhered (due to a lack of knowledge, guidance, and resources). According to the CDC (2007), adherence to appropriate glove use ranged from 15–82% in previous studies. Also poor memory, laziness and gowns kept at a long distance from where needed were reported as barriers toward EBGs (Table 5).

According to previous literature, the routine use of sodium chloride instillation should be avoided (AARC, 2010; CHP, 2010). The self-reported adherence to sodium chloride instillation before tracheal suctioning was 68.3%. The reasons for nonadherence were related to the lack of guidance, and time and outcome expectancy. Based on robust evidence, the safety (effect on hemodynamic, respiratory and intracranial system) and efficacy (improved oxygenation, increased secretions, yield, tube patency, and prevention of VAP) of sodium chloride instillation has been questioned (AARC, 2010). However, recent reports provided new information about the safety (Overend et al., 2009; Paraz and Stockton, 2009) and efficacy (Caruso et al., 2009; Christensen et al., 2010) of sodium chloride instillation, used also in bronchoalveolar lavages. According to single (Caruso et al., 2009) and multicenter (Christensen et al., 2010) trials, sodium chloride instillation may decrease the incidence of VAP. Therefore, further research is needed to clarify the effect of routine use of sodium chloride instillation.

The main barriers (Table 4) were inadequate resources and disagreement with the results. Other barriers, such as patient discomfort and adverse effects, have been

described in previous medical (Cabana et al., 1999) and nursing studies (Ricart et al., 2003). Further reasons (Table 5) included lack of time (Cabana et al., 1999; De Wandel et al., 2010), lack of knowledge and skills, and forgetfulness. The lack of knowledge might be due to poor information about current guidelines (Cabana et al., 1999; El-Khatib et al., 2010) or inability to translate research findings into bedside practice (Kaynar et al., 2007).

It's important to evaluate critical care nurses' knowledge, attitudes and beliefs so that current practices can be improved (Ajzen, 2005). Some of the important components of formal infection control (e.g., continuous subglottic suctioning, use of protective gowns, and protection of patients' eyes and central venous catheters from secretions) were viewed as unnecessary by the nurses participating in this study and were used only when judged necessary. Overall, the reasonable level of knowledge and increased self-reported adherence to EBGs may be due to improved education, local guidelines, regular nursing duties and provision of sufficient information that is well implemented in practice. The main strengths of this study are the high response rate, which means the results closely represent the local target population, and the inclusion of nurses in different departments with a range of ICU experience (Polit and Beck, 2011). The results can be used to guide local practice and education, and contribute to the debate regarding the role of nurses' adherence and knowledge of methods in preventing VAP.

Conclusions

The average knowledge level was low. Professional experience was shown to be associated with better knowledge scores. A number of helpful barriers toward EBGs

were identified. There is an ongoing need for improvements in education and effective implementation strategies.

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Table 1 Guidelines and recommendations for nursing care for the prevention of VAP

Guidelines	Recommendations
The Institute of Healthcare Improvement (IHI 2006)	1. Elevation of the head of bed to between 30° and 45° 2. Daily "sedation vacations" and assessment of readiness to extubate 3. Peptic ulcer disease prophylaxis 4. Deep venous thrombosis prophylaxis
The Centers for Disease Control and Prevention (CDC 2003)	1. Wash hands after contact with mucous membranes, respiratory secretions, or objects contaminated with respiratory secretions. Wash hands before and after contact with patient. 2. Educate healthcare workers about nosocomial bacterial pneumonias and infection control procedures used to prevent these pneumonias 3. Wear gloves for handling respiratory secretions or objects contaminated with respiratory secretions 4. Provide subglottic suctioning before deflating the cuff of an endotracheal tube or before moving the tube 5. Elevate the head of the bed by 30◦ to 45◦ if not contraindicated 6. Develop and implement a comprehensive oral hygiene program to provide oropharyngeal cleaning and decontamination with or without an antiseptic agent 7. Use chlorhexidine gluconate antiseptic rinse during the perioperative period in adult patients who undergo cardiac surgery
A European Care Bundle (Rello et al. 2010)	1. No ventilator circuit tube changes unless specifically indicated 2. Strict hand hygiene using alcohol 3. Appropriate educated and trained staff 4. Sedation vacation and use of weaning protocols 5. Oral care with chlorhexidine

Table 2 The main demographic data of the study population (*n* = 101)

Nurse variables	*n* (%)
ICU experience	
< 1 yrs	14 (14.0)
1–5 yrs	34 (33.7)
6–10 yrs	11 (10.9)
>10 yrs	41 (40.6)
Education[1]	
Registered nurse	90 (89.1)
Nursing assistant	8 (7.9)
Employment	
Permanent	69 (68.3)
Non-Permanent	32 (31.7)

[1] Three participants did not respond to this section of study

Table 3 The responses provided by critical care nurses (*n* = 101) to multiple-choice questions regarding VAP prevention

Questions	Correct answers, n (%)
1. Oral vs. nasal route for endotracheal intubation	
Oral intubation is recommended	74 (73.3)
Nasal intubation is recommended	0 (0.0)
Both routes of intubation can be recommended	23 (22.8)
I do not know	2 (2.0)
2. Frequency of ventilator circuits changes	
It is recommended to change circuits every 48 hrs (or when clinically indicated)	14 (13.9)
It is recommended to change circuits every week (or when clinically indicated)	4 (23.8)
It is recommended to change circuits for every new patient (or when clinically indicated)	51 (50.5)
I do not know	1 (1.0)
3. Type of airway humidifier	
Heated humidifiers are recommended	11 (10.9)
Heat and moisture exchangers are recommended	49 (48.5)
Both types of humidifiers can be recommended	28 (27.7)
I do not know	13 (12.9)
4. Frequency of humidifier changes	
It is recommended to change humidifiers every 48 hrs (or when clinically indicated)	89 (88.1)
It is recommended to change humidifiers every 72 hrs (or when clinically indicated)	3 (3.0)
It is recommended to change humidifiers every week (or when clinically indicated)	5 (5.0)
I do not know	3 (3.0)
5. Open vs. closed suction systems	
Open suction systems are recommended	2 (2.0)
Closed suction systems are recommended	56 (55.4)
Both systems can be recommended [a]	41 (40.6)
I do not know	2 (2.0)
6. Frequency of change in suction systems	
Daily changes are recommended (or when clinically indicated)	64 (63.4)
Weekly changes are recommended (or when clinically indicated)	5 (5.0)
It is recommended to change systems for every new patient (or when clinically indicated)	27 (26.7)
I do not know	1 (1.0)
7. Endotracheal tubes with extra lumen for drainage of subglottic secretions	
These endotracheal tubes reduce the risk of VAP	54 (53.5)
These endotracheal tubes increase the risk of VAP	3 (3.0)
These endotracheal tubes do not influence the risk of VAP	5 (5.0)
I do not know	39 (38.6)
8. Kinetic vs. standard beds	
Kinetic beds increase the risk of VAP	0 (0.0)
Kinetic beds reduce the risk of VAP	62 (61.4)
The use of kinetic beds does not influence the risk of VAP	11 (10.9)
I do not know	28 (27.7)
9. Patient positioning	
Supine positioning is recommended	0 (0.0)
Semi-recumbent positioning is recommended	100 (99.0)
The position of the patient does not influence the risk of VAP	0 (0.0)
I do not know	1 (1.0)
10. Use of 0.12% chlorhexidine gluconate antiseptic oral rinse	
0.12% chlorhexidine gluconate antiseptic oral rinse reduce the risk of VAP	96 (95.0)
0.12% chlorhexidine gluconate antiseptic oral rinse increase the risk of VAP	1 (1.0)
0.12% chlorhexidine gluconate antiseptic oral rinse does not influence the risk of VAP	1 (1.0)
I do not know	3 (3.0)

[a] Supplementary question to Labeau et al.'s (2007) questionnaire. Correct answers are shown underlined.

Table 4 Critical care nurses' (*n* = 101) self-reported adherence to and barriers toward EBGs for prevention of VAP

Non-pharmacological strategies	Adhered to	Barriers toward EBGs					
		Disagree with the results	Inadequate Recourses	Adverse Effects	Costs	Patient discomfort	Other reason, what? [b]
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
1. Removal of nasogastric tube as soon as clinically feasible [a]	93 (92.1)	0 (0.0)	0 (0.0)	1 (1.0)	0 (0.0)	1 (1.0)	1 (1.0)
2. Enteral feeding protocol/ avoidance of gastric over distension [a]	90 (89.1)	1 (1.0)	1 (1.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (2.0)
3. Semi-recumbent positioning of the patient (30°–45°) [a]	95 (94.1)	0 (0.0)	1 (1.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
4. Humidification with heat and moisture exchangers [a]	95 (94.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.0)	0 (0.0)
5. Daily changes of heat and moisture exchangers [a]	95 (94.1)	0 (0.0)	1 (1.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
6. Chest physiotherapy [a]	79 (78.2)	0 (0.0)	11 (10.9)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.0)
7. Adequate hand hygiene between patients [a]	94 (93.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.0)
8. Use of a formal infection-control program [a]	93 (92.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.0)
9. Maintenance of adequate pressure in the endotracheal-tube cuff [a]	94 (93.1)	0 (0.0)	1 (1.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.0)
10. Scheduled drainage of condensate from ventilator circuits [a]	56 (55.4)	0 (0.0)	6 (5.9)	2 (2.0)	0 (0.0)	0 (0.0)	29 (28.7)
11. Continous subglottic suctioning [a]	28 (27.7)	1 (1.0)	6 (5.9)	0 (0.0)	3 (3.0)	1 (1.0)	44 (43.6)
12. Use of protective gowns during suctioning [a]	25 (24.8)	9 (8.9)	7 (6.9)	0 (0.0)	0 (0.0)	1 (1.0)	50 (49.5)
13. Pre-suctioning analgesic [a]	73 (72.3)	1 (1.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.0)	15 (14.9)
14. Pre-suctioning hyperoxygenation [a]	89 (88.1)	0 (0.0)	0 (0.0)	1 (1.0)	0 (0.0)	1 (1.0)	3 (3.0)
15. Face mask wearing during suctioning [a]	92 (91.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.0)	0 (0.0)
16. Sterility of suction catheter maintained until inserted into airway [a]	92 (91.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.0)	0 (0.0)
17. Protection of patients eyes and central venous catheter from secretions during suctioning	64 (63.4)	2 (2.0)	3 (3.0)	0 (0.0)	0 (0.0)	1 (1.0)	23 (22.8)
18. Two nurses perform suctioning [c]	47 (46.5)	0 (0.0)	27 (26.7)	0 (0.0)	0 (0.0)	1 (1.0)	13 (12.9)
19. Sodium chloride instillation [a]	69 (68.3)	3 (3.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (2.0)	18 (17.8)
20. Used catheter and gloves are disposed of in a manner that prevents contamination from secretions [a]	94 (93.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.0)	0 (0.0)
21. Sedation protocol[1]	86 (85.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.0)	2 (2.0)
22. Respirator and weaning protocols [a]	87 (86.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (2.0)	3 (3.0)
23. Avoidance of unnecessary reintubation [a]	92 (91.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.0)
24. Extubation protocol [a]	91 (90.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.0)
25. Patient positional treatment [a]	93 (92.1)	0 (0.0)	2 (2.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

[a] Missing values, [b] See Table 5, [c] Open endotracheal suctioning

Table 5 Critical care nurses' self-reported reasons for barriers toward EBGs for prevention of VAP (i.e., the "Other reasons" from the Table 4)

Item	Self-reported nonadherence toward non-pharmacological strategies	Barriers	*n* (%)
1.	Removal of nasogastric tube as soon as clinically feasible	No reason	1 (100.0)
2.	Enteral feeding protocol/ avoidance of gastric over distension	Forgetfulness	1 (50.0)
		If needed	1 (50.0)
6.	Chest physiotherapy	If needed	1 (100.0)
7.	Adequate hand hygiene between patients	Lack of staff	1 (100.0)
8.	Use of a formal infection-control program	No reason	1 (100.0)
9.	Maintenance of adequate pressure in the endotracheal-tube cuff	Lack of knowledge	1 (100.0)
10.	Scheduled drainage of condensate from ventilator circuits	Lack of skills	20 (74.1)
		Job discretion	3 (11.1)
		Forgetfulness	2 (7.4)
		Lack of guidance	2 (7.4)
11.	Continous subglottic suctioning	Lack of knowledge	16 (53.3)
		Lack of routine use	11 (36.7)
		Considered unnecessary	1 (3.3)
		If needed	2 (6.7)
12.	Use of protective gowns during suctioning	If needed	13 (23.6)
		No reason	11 (20.0)
		Lack of guidance	7 (12.7)
		Lack of time	6 (10.9)
		Considered unnecessary	6 (10.9)
		Lack of knowledge	5 (9.1)
		Stored at a long distance from where needed	3 (5.5)
		Forgetfulness	2 (3.6)
		Laziness	2 (3.6)
13.	Pre-suctioning analgesic	If needed	14 (63.6)
		Lack of time	4 (18.2)
		Job discretion	2 (9.1)
		Lack of guidance	1 (4.5)
		Forgetfulness	1 (4.5)
14.	Pre-suctioning hyperoxygenation	If needed	2 (50.0)
		Forgetfulness	1 (25.0)
		Contraindications	1 (25.0)
17.	Protection of patients eyes and central venous catheter from secretions during suctioning	Lack of skills	14 (53.8)
		Forgetfulness	4 (15.4)
		Lack of guidance	3 (11.5)
		If needed	2 (7.7)
		Lack of time	2 (7.7)
		Considered unnecessary	1 (3.8)
18.	Two nurses perform suctioning [a]	Lack of staff	6 (42.9)
		If needed	4 (28.6)
		Lack of time	3 (21.4)
		Closed suction system	1 (7.1)
19.	Sodium chloride instillation	If needed	22 (88.0)
		Lack of guidance	1 (4.0)
		Lack of time	1 (4.0)
		Lack of outcome expectancy	1 (4.0)
21.	Sedation protocol	Lack of skills	1 (50.0)
		If needed	1 (50.0)
22.	Respirator- and weaning protocol	Lack of skills	1 (50.0)
		Guidance disagrees	1 (50.0)
23.	Avoidance of unnecessary reintubation	No reason	1 (100.0)
24.	Extubation protocol	Lack of skills	1 (50.0)
		Lack of time	1 (50.0)

[a] Open endotracheal suctioning