Attitudes of Respiratory Therapists and Nurses About Measures to Prevent Ventilator-Associated Pneumonia: A Multicenter, Cross-Sectional Survey Study

A Murat Kaynar MD, Jacob J Mathew PharmD, Margaret M Hudlin MD, Dan J Gingras RRT, Ray H Ritz RRT, Michael R Jackson RRT, Robert M Kacmarek RRT PhD FAARC, and Marin H Kollef MD

OBJECTIVE: To understand the reported practices of and adherence to evidence-based guidelines for the prevention of ventilator-associated pneumonia (VAP) among respiratory therapists (RTs) and registered nurses (RNs) in academic and nonacademic intensive care units. METHODS: We conducted a multicenter, cross-sectional survey. We first obtained demographic information about health care professionals in a nonidentifiable method. We next questioned the practice patterns of RTs and RNs for preventing VAP based on evidence-supported guidelines. The participants were RTs and RNs working in academic and nonacademic intensive care units; 278 respondents participated in this study (172 RTs and 106 RNs). There were no interventions. RESULTS: The 3 major findings were: (1) both the RTs and the RNs reported that they frequently practice VAP-prevention measures, (2) the rate of adherence to ineffective measures (eg, routine changes of the ventilator circuit, disposable catheters) is also relatively high, which suggests that the evidence is not translated into bedside practice, (3) a substantial proportion of participants did not know the VAP rate in their institution, which might make it difficult to convince bedside practitioners to apply evidence-based practice, and might reflect a lack of infection-control/surveillance programs at hospitals. CONCLUSION: Consumers, the Centers for Disease Control and Prevention, and other organizations are currently trying to implement mandatory reporting of hospital infections, including VAP rate. Without a definition of VAP suited to individual institutions, an organized data-collection and reporting method, and team-based approaches to preventing and treating VAP, hospitals may not be able to meet these requests and track improvement efforts. Prevention measures need to be translated to bedside practice to improve the outcomes of critically ill patients. *Key words: prophylaxis, ventilator-associated pneumonia, guideline, adherence, compliance, prevention, behavioral modification, implementation, intensive care unit*. [Respir Care 2007;52(12):1687–1694. © 2007 Daedalus Enterprises]

A Murat Kaynar MD is affiliated with the Departments of Critical Care Medicine and Anesthesiology, University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania. Jacob J Mathew PharmD is affiliated with the Department of Anesthesiology and Critical Care Medicine and the Department of Pharmacy; Ray H Ritz RRT is affiliated with the Department of Respiratory Care, Beth Israel Deaconess Medical Center, Boston, Massachusetts. Margaret M Hudlin MD is affiliated with the Division of Surgical Critical Care, Department of Surgery, University of Massachusetts, Worcester, Massachusetts. Dan J Gingras RRT is affiliated with the Department of Respiratory Care, Women and Infants Hospital, Providence, Rhode Island. Michael R Jackson RRT is affiliated with Brigham and Women's Hospital, Boston, Massachusetts. Robert M Kacmarek, RRT PhD FAARC is affiliated with Respiratory Care Services, Massachusetts General Hospital, Boston, Massachusetts. Marin H Kollef MD is affiliated with the Department of Pulmonary and Critical Care Medicine, Washington University School of Medicine, St Louis, Missouri.

This research was performed at Beth Israel Deaconess Medical Center, Massachusetts General Hospital, Brigham and Women's Hospital, University of Massachusetts, Worcester, Massachusetts; and at meetings of the Society of Critical Care Medicine and the Rhode Island Society of Respiratory Care.

The authors report no conflicts of interest related to the content of this paper.

Correspondence: A Murat Kaynar MD, Departments of Critical Care Medicine and Anesthesiology, University of Pittsburgh School of Medicine, 3550 Terrace Street, Room 639 Scaife Hall, Pittsburgh PA 15261. E-mail: kaynarm@upmc.edu.

Introduction

The rate of nosocomial infections among critically ill patients approaches 40% and may be as high as 60% among those who remain in the intensive care unit (ICU) for more than 5 days.[1,2] These ICU-related infections are among the leading causes of higher morbidity, mortality, and health care costs, with an associated mortality rate approaching 30%.[3–5]

Ventilator-associated pneumonia (VAP) is considered to be one of the leading causes of morbidity and mortality due to nosocomial infections among ventilated patients. In a case-controlled study, patients with VAP remained in the ICU 4.3 d (95% confidence interval 1.5–7.0 d) longer than patients without VAP and showed a trend toward higher mortality (absolute risk increase 5.8%).[6] Other studies also found prolonged ICU stay (5–13 d), with mortality risk ranging from 0% to 50%.[7–16]

SEE THE RELATED EDITORIAL ON PAGE 1678.

The increase in the number of critically ill and immunocompromised patients, high VAP-associated mortality rate, and increasing drug resistance underscores the importance of using measures to prevent VAP.[17] There is no single method to prevent VAP, but multiple nonpharmacologic and pharmacologic interventions exist that could reduce its incidence and severity.[18–22] Two systematic reviews of published clinical trials, recommendations from the Centers for Disease Control and Prevention, and the consensus statement of the American Thoracic Society and Infectious Diseases Society of America identified these potential prevention measures.[23–25] The clinical trials, reviews, and expert guidelines have identified interventions that are widely accepted as being either effective or ineffective, but there is considerable variability in the physician-reported utilization of even effective prevention measures. A survey among French and Canadian ICU directors about adherence to VAP-prevention measures reported adherence by 65% of the French directors and only 30% among the Canadian directors, which suggests differences in practice within the same specialty.[26] In addition to the practice variability among physicians and different recommendations about prevention measures, which could lead to confusion among bedside practitioners (registered nurses [RNs] and respiratory therapists [RTs]), a recent study also questioned the clinical applicability of a commonly proposed prevention measure, elevation of the head of the bed to 45°.[27]

Prevention of VAP requires a collaborative effort, and both RNs and RTs play an essential role because of their frequent interactions with patients at the bedside. In this survey-based study, we aimed to understand the attitudes of bedside practitioners (RNs and RTs) from academic and nonacademic settings, with regard to preventing VAP through their reported adherence to guidelines. We defined "adherence" as "supporting a clinical practice and making behavior changes accordingly," and informed the participants about its definition.

Methods

We surveyed ICU RNs and RTs to learn about their self-reported rates of practicing various measures to prevent VAP. RNs and RTs were the study subjects because they spend substantially more time with mechanically ventilated patients. The survey and study were approved by the institutional review boards of the participating institutions. The surveys, which were administered during departmental staff meetings and professional meetings, were voluntary and confidential. The initial part of the study was conducted among critical care RNs and RTs who work in teaching hospitals in New England. We attempted to get a relatively high response rate to the surveys in teaching hospitals by offering the surveys during departmental retreats (ie, food and beverages were provided by the research team, regardless of whether a practitioner answered or did not answer the questionnaire).

The surveys were also provided to attendees at a recent international critical care conference (Society of Critical Care Medicine) and a regional respiratory care meeting (Rhode Island Society for Respiratory Care), with a goal of capturing practitioners from nonacademic centers and a larger sampling area. The attendees at these meetings were informed about our study by announcements made before the start of individual sessions. The meeting attendees, who were voluntarily interested in answering the surveys, were provided additionally with stamped envelops. The surveys were not provided to all of the meeting attendees, because of multiple parallel sessions during the conferences. The participants in the hospital settings were all involved with the care of ICU patients, and during the meeting announcements we invited attendees to participate in the survey if they routinely came into contact with ICU patients.

The survey consisted of 41 items, which included 33 items directed at specific VAP-prevention measures and 8 items on the respondent's demographic information and his or her estimates of and knowledge about VAP-related data in his or her institution. Of the 33 questions on VAP-prevention measures, 20 were on nonpharmacologic interventions and the rest were on pharmacologic strategies. The questions on pharmacologic interventions applied only to clinicians who had prescribing privileges, and thus did not apply to the groups we studied. We classified each intervention as "effective," "ineffective," or "strategies of equivocal or undetermined effectiveness," based on the

Table 1. Comparison of Recommendations About Nonpharmacologic Measures for Prevention of Ventilator-Associated Pneumonia

VAP-Prevention Strategy	Source				
	Kollef (1999)[23]	CDC (2003)[28]	Dodek et al (2004)[24]	ATS/IDSA (2005)[25]	Kaynar (present study)
1. Removal of nasogastric or endotracheal tube as soon as clinically feasible	Effective	Recommended	ND	ND	Effective
2. Use of a formal infection-control program	Effective	Recommended	ND	Recommended	Effective
3. Adequate hand-washing between patient contacts	Effective	Recommended	ND	ND	Effective
4. Semi-recumbent positioning of the patient	Effective	Recommended	Recommended	Recommended	Effective
5. Avoidance of unnecessary reintubation	Effective	ND	ND	Recommended	Effective
6. Provision of adequate nutritional support	Effective	ND	ND	Recommended	Effective
7. Avoidance of gastric overdistention	Effective	Recommended	ND	ND	Effective
8. Oral (non-nasal) intubation	Effective	Nasotracheal intubation not recommended	Recommended	Recommended	Effective
9. Scheduled drainage of condensate from ventilator circuits	Effective	Recommended	ND	Recommended	Effective
10. Continuous subglottic suctioning	Effective	Equivocal	Recommended	Recommended	Effective
11. Maintenance of adequate pressure in endotracheal-tube cuff	Effective	Recommended	ND	Recommended	Effective
12. Use of protective gowns and gloves	Undetermined	Recommended	ND	ND	Undetermined
13. Humidification with heat-and-moisture exchanger	Undetermined	Recommended	Recommended	Not recommended	Undetermined
14. Humidification with heat-and-moisture exchanger with bacteriologic filter	Undetermined	ND	ND	ND	Undetermined
15. Postural changes	Undetermined	Not recommended	ND	ND	Undetermined
16. Routine changes of ventilator circuit	Ineffective	Not recommended	Not recommended	ND	Ineffective
17. Dedicated use of disposable suction catheters	Ineffective	Not recommended	ND	ND	Ineffective
18. Routine changes in in-line suction catheter	Ineffective	ND	Not recommended	ND	Ineffective
19. Daily changes of heat-and-moisture exchanger	Ineffective	Recommended	Weekly changes	ND	Ineffective
20. Chest physiotherapy	Ineffective	Not recommended	No recommendation	ND	Ineffective
21. Systemic search for maxillary sinusitis	ND	ND	No recommendation	ND	ND*
22. Timing of tracheostomy	ND	ND	No recommendation	ND	ND*
23. Kinetic beds	ND	ND	Consider	ND	ND*
24. Prone position	ND	ND	No recommendation	ND	ND*
25. Noninvasive ventilation	ND	Recommended	Use whenever possible	ND	ND*
26. Adequate staffing	ND	ND	Recommended	ND	ND*

* The present study did not include this item.

VAP = ventilator-associated pneumonia. CDC = Centers for Disease Control and Prevention. ATS = American Thoracic Society. IDSA = Infectious Diseases Society of America. ND = no data collected.

literature and the specifics of the interventions. Our interpretation of interventions and results from review articles and guidelines are presented in Table 1. If prevention measures were not used, we also asked for the reasons (the choices were: disagreement with results; resources not available; adverse effect; nursing convenience; cost; patient discomfort; no response; other; and combination of above).

Completed surveys were either collected immediately or received via mail. No surveys were received via e-mail or fax. Results were entered into a database (Access, Microsoft, Redmond, Washington). The data were analyzed with Fisher's exact test in statistics software (SPSS 10.0, SPSS, Chicago, Illinois) to compare the adherence rates between groups. Two-sided p values of < 0.05 were considered statistically significant. Odds ratio and 95% confidence intervals were calculated for the reasons for nonadherence.

Results

We received 278 responses from a total of 325 surveys administered during the study period; 172 respondents were RTs and 106 were RNs. Table 2 shows the respondents' years in clinical practice. Almost 50% of those surveyed (128/278) had worked in their profession for at least 20 years. The workplace distribution was more variable among the RTs than among the RNs. Most of the RTs (58%) worked in both medical and surgical ICUs, whereas the RNs worked in either medical or surgical units. Table 3 summarizes the respondents' estimation or knowledge of the number of mechanically ventilated patients in their respective ICUs and their awareness of facts about VAP. 43.9% of the respondents reported that 51–75% of their ICU patients were mechanically ventilated, and 43.2% of respondents did not know the average VAP rate at their institution or did not respond.

Table 2. Respondents' Years in Clinical Practice

Years in Practice	RNs (*n*, %)	RTs (*n*, %)	Total (*n*, %)
0–3	15 (14.2)	20 (11.6)	35 (12.6)
4–6	9 (8.5)	17 (9.9)	26 (9.4)
7–9	9 (8.5)	17 (9.9)	26 (9.4)
10–12	13 (12.3)	13 (7.6)	26 (9.4)
13–15	7 (6.6)	12 (7.0)	19 (6.8)
16–19	6 (5.7)	12 (7.0)	18 (6.5)
≥ 20	37 (34.9)	80 (46.5)	117 (42.1)
No response	10 (9.4)	1 (0.6)	11 (4.0)

RN = registered nurse
RT = respiratory therapist

Table 3. ICU-Specific Questions Related to Ventilated Patients

Question	Response	*n* (%)
What percentage of patients in your primary ICU do you estimate are mechanically ventilated?	0–25	16 (5.7)
	26–50	58 (20.9)
	51–75	122 (43.9)
	76–100	57 (20.5)
	Do not know	13 (4.7)
	No response	12 (4.3)
What percentage of your patients have recently received or are receiving antibiotics upon being admitted to your ICU?	0–15	17 (6.1)
	16–30	9 (3.2)
	31–45	14 (5.0)
	46–60	30 (10.8)
	61–75	29 (10.4)
	76–90	51 (18.3)
	90–100	57 (20.5)
	Do not know	57 (20.5)
	No response	14 (5.0)
What percentage of your patients who are mechanically ventilated are afflicted with VAP?	0–15	40 (14.4)
	16–30	56 (20.1)
	31–45	28 (10.1)
	46–60	11 (4.0)
	61–75	9 (3.2)
	76–90	12 (4.3)
	90–100	2 (0.7)
	Do not know	107 (38.5)
	No response	13 (4.7)
Upon positive identification of strains responsible for VAP in your patients, are the origins of these strains ever identified?	No	23 (8.3)
	Sometimes	73 (26.3)
	Yes	40 (14.4)
	Do not know	129 (46.4)
	No response	13 (4.7)

ICU = intensive care unit
VAP = ventilator-associated pneumonia

Overall, 83% of RNs and RTs reported adhering to effective practices (total of 11 strategies) (Table 4). Their reported adherence to individual strategies is presented in Table 5. The lowest reported adherence rates were to continuous subglottic suctioning (due primarily to lack of availability of resources) and scheduled drainage of condensate from the ventilator circuit (due primarily to other reasons). RTs reported a higher adherence rate than RNs to both of these interventions, and there was a statistically significant difference in the use of scheduled drainage of condensate from the ventilator circuit ($p < 0.05$). None of the other differences between groups in the application of effective strategies was statistically significant.

The overall reported adherence to nonpharmacologic strategies of equivocal or undetermined effectiveness was 79.8% for the 4 strategies listed. The only strategy with a low reported adherence rate was the use of humidification with heat-and-moisture exchanger with bacteriologic filter, primarily because of cost and lack of resources. The reported adherence rate of the RTs was higher than that of

Table 4. Comparison of Reported Adherence in Previous Studies Versus the Present Study*

Study	Clinician Type	Reported Adherence to Effective Intervention	Reported Adherence to Ineffective and Equivocal Interventions	Overall Reported Adherence
Kollef[23]	MD	74.8	54.4	63
Rello[30]	RN	ND	ND	77.7
Kaynar (present study)	RN	82.9	70.6	77.4
Kaynar (present study)	RT	83.2	69.2	76.9

*Although we could not do a statistical comparison, we observed a trend towards greater reported adherence to both effective and ineffective/equivocal strategies among RNs and RTs.
MD = physician
RN = registered nurse
ND = no data collected
RT = respiratory therapist

the RNs in the use of humidification with heat-and-moisture exchanger with bacteriologic filter and the use of protective gowns and gloves ($p < 0.05$), and the reported adherence rate of RNs was higher than that of RTs in the use of humidification with heat-and-moisture exchanger ($p < 0.05$).

Overall reported adherence to ineffective nonpharmacologic strategies was 61.6% for the 5 strategies. More RNs than RTs reported adherence to routine changes of the ventilator circuit (67.9% vs 46.5%, $p < 0.05$), as well as adherence to routine changes of the in-line suction catheter (67.9% vs 46.5%) and chest physiotherapy (69.8% vs 54%); both had statistically significant differences ($p < 0.05$). On the other hand, RTs reported a higher rate of adherence to daily changes of the heat-and-moisture exchanger ($p < 0.05$). Reasons for nonadherence are presented in Table 6.

We also compared the responses from academic and nonacademic settings. Because of the low number of respondent RNs who were working in nonacademic settings, we did not analyze their responses. Among the RTs, those in academic centers reported that they adhered to scheduled drainage (effective strategy) more frequently than did those in private practice ($p < 0.05$). Also, the RTs in private-practice settings more frequently reported that they routinely changed the ventilator circuit (ineffective strategy) and the in-line suction catheter (ineffective strategy) than did the RTs in academic settings ($p < 0.05$).

Discussion

Barriers to adherence to literature-supported evidence by physicians have been recognized for some time, but there is comparative scarcity of literature published about adherence to such evidence by RTs and RNs, who spend substantially more time with individual patients.[29,30] This was the main motivation in conducting our multicenter survey study.

In survey-based studies (postal or electronic delivery), response rates of 30–40% are acceptable return rates, whereas we had a higher return rate with our survey (approximately 85%).[31] We believe that our approach of informal gatherings (ie, food and beverages) at the participating hospitals as well as at the meetings to introduce our project did contribute to the high response rate. We would like to emphasize that none of the authors forced any RT or critical care RN to answer the surveys. We reminded the participants at the teaching hospitals about the surveys, but could not remind the meeting participants, because we had only one-time interaction with them.

In this study we did not perform a pilot study, other than getting the feedback from a few initial participants and the authors about the wording of the survey. We used the Centers for Disease Control and Prevention recommendations with regard to the effectiveness category for the majority of measures. We also referred to the 2005 American Thoracic Society and Infectious Diseases Society of America guidelines and used our judgment on few instances such as continuous subglottic suctioning. This measure is recommended by the American Thoracic Society, whereas the Centers for Disease Control and Prevention has a more neutral position. VAP-prevention measures 21–26 in Table 1 were not used in the survey, because these items did not have any strong evidence.

In the survey we defined "adherence" as "supporting a clinical practice and making behavior changes accordingly" and included it in the introductory section of the surveys. As the research team, we also defined the phrase "disagreement with results" to include both disagreement with published literature as well as anecdotal evidence, as they both may influence the behavior of a practitioner.

The finding that over 40% of the participants had worked in their profession for 20 years or more may reflect an aging workforce more than a selection bias among conference attendees. The average age of RTs in California in 2003 was 40 years,[32] and in North Carolina in 2004 the average age was 42 years.[33] According to the American Association for Respiratory Care, the mean age of RTs rose from 40 in 2000 to 44.59 in 2005.[34]

In the present study we found that most RNs and RTs report practicing effective VAP-prevention measures. The reported adherence rates for effective measures were > 85% for most of the effective strategies, other than scheduled drainage of circuit condensate and continuous subglottic suctioning. These overall adherence rates to effective strategies were similar to those reported in previously published studies of cohorts of nurses and physicians, primarily in Europe (see Table 4).[29,30] In comparing the practice

Table 5. Reported Adherence to VAP Prevention Strategies

Strategy	Effectiveness Per Evidence	Adherence (*n*, %)			p
		RNs (*n* = 106)	RTs (*n* = 172)	Overall (*n* = 278)	
Removal of nasogastric or endotracheal tube as soon as clinically feasible	Effective	99 (93.4)	160 (93.0)	259 (93.2)	0.99
Use of a formal infection-control program	Effective	86 (81.1)	152 (88.4)	238 (85.6)	0.11
Adequate hand washing between patient contacts	Effective	104 (98.1)	167 (97.1)	271 (97.5)	0.71
Semi-recumbent positioning of the patient	Effective	98 (92.5)	140 (81.4)	238 (85.6)	0.01
Avoidance of unnecessary reintubation	Effective	102 (96.2)	162 (94.2)	264 (95.0)	0.58
Provision of adequate nutritional support	Effective	94 (88.7)	140 (81.4)	234 (84.2)	0.13
Avoidance of gastric overdistention	Effective	98 (92.5)	151 (87.8)	249 (89.6)	0.23
Oral (non-nasal) intubation	Effective	100 (94.3)	159 (92.4)	259 (93.2)	0.63
Scheduled drainage of condensate from ventilator circuits	Effective	60 (56.6)	135 (78.5)	195 (70.1)	< 0.001
Continuous subglottic suctioning	Effective	25 (23.6)	51 (29.7)	76 (27.3)	0.33
Maintenance of adequate pressure in endotracheal-tube cuff	Effective	101 (95.3)	158 (91.9)	259 (93.2)	0.33
Use of protective gowns and gloves	Undetermined	84 (79.2)	164 (95.3)	248 (89.2)	< 0.001
Humidification with heat and moisture exchanger	Undetermined	96 (90.6)	128 (74.4)	224 (80.6)	< 0.001
Humidification with heat and moisture exchanger with bacteriologic filter	Undetermined	54 (50.9)	120 (69.8)	174 (62.6)	0.002
Postural changes	Undetermined	96 (90.6)	146 (84.9)	242 (87.1)	0.2
Routine changes of ventilator circuit	Ineffective	72 (67.9)	80 (46.5)	152 (54.7)	< 0.001
Dedicated use of disposable suction catheters	Ineffective	80 (75.5)	141 (82.0)	221 (79.5)	0.22
Routine changes of in-line suction catheters	Ineffective	86 (81.1)	120 (69.8)	206 (74.1)	0.05
Daily changes of heat and moisture exchangers	Ineffective	32 (30.2)	79 (45.9)	111 (39.9)	0.01
Chest physiotherapy	Ineffective	74 (69.8)	93 (54.0)	167 (60.1)	0.01

VAP = ventilator-associated pneumonia
RN = registered nurse
RT = respiratory therapist

patterns described in previous publications from Europe with those in the current study, we took into consideration that RTs in the institutions we surveyed are part of an ICU care team, whereas in Europe RTs' responsibilities are carried out by RNs and physicians. While assessing the reported adherence rates of RTs and RNs to the evidence, we want to underline the "practicality" aspect of the evidence-based measures. A commonly suggested and frequently studied measure in VAP prevention, elevation of the head of the bed to 45°, was recently shown by van Nieuwenhoven et al[27] to be "practically" not achievable, despite having dedicated research nurses following and intervening with the bed angles.

More interesting are the high rates of adherence to ineffective strategies and strategies of undetermined effectiveness, which suggest either that the evidence had not been translated into practice or that there are other barriers to this process. Four of the 5 ineffective measures against VAP in essence violate the maintenance of a closed respiratory circuitry; strikingly, 62.05% of RTs and RNs adhered to these 4 ineffective items. We believe that adherence to ineffective therapies may cause undue harm to our patients by increasing the risk of VAP, though they are being performed with good intentions.

The degree of nonadherence was independent of evidence for both the effective and the ineffective/effectiveness-undetermined measures. The published literature based on surveys of the adherence of physicians to the evidence-based guidelines for prevention of VAP, similar to the present study, demonstrated that both effective and ineffective strategies are routinely incorporated into patient care. The results may suggest inadequate translation of the findings of randomized trials into clinical practice. We observed a similar pattern in our study, but a lower adherence to ineffective strategies than to effective strategies. As we studied the reasons for nonadherence, clinician convenience was a striking reason in the category of scheduled drainage of circuit condensate. During our interactions with the practitioners, we realized that most of the available wire-heated ventilator circuits lack a convenient drainage port, which makes it difficult to drain the condensates without interrupting a closed circuit. This reminded us about the importance of applying and reviewing the guidelines within the context of available resources

Table 6. Reasons for Reported Nonadherence

Reason	RNs (%)	RTs (%)	Odds Ratio	95% CI
Disagreement	2.9	11.3	0.23	0.12–0.43
Not available	8.3	6.9	1.22	0.68–2.22
Adverse effect	1.4	5.7	0.23	0.11–0.48
Health care provider convenience	5.2	4.0	1.31	0.34–4.9
Cost	4.0	6.3	0.62	0.33–1.17
Patient discomfort	2.6	1.5	1.75	0.72–4.2
Other	33.5	24.6	1.54	0.83–2.85
No response	12.0	11.5	1.05	0.45–2.48
Combination of above	27.8	19.9	1.55	0.8–2.9

RN = registered nurse
RT = respiratory therapist
OR = odds ratio
CI = confidence interval

and the local institution. Both continuous subglottic suctioning and formal infection-control programs were not adhered to because of lack of availability. In the United Kingdom, the National Health Service established the National Institute for Clinical Excellence in 1999, to follow the implementation of evidence-based medicine and guidelines suggested by the National Health Service.[35] The National Institute for Clinical Excellence published a report in 2004 of their findings that implementation of evidence was variable and that measures were adopted if there was strong professional support, convincing evidence, no increased cost, a good tracking record for compliance at the institution, and institutional willingness to participate in the efforts. The evidence incorporated into a clinical guideline had to be adaptable to the local institution and continuously revised.

The relatively high percentage of our respondent RTs and RNs who were unaware of the VAP rate at their institution may reflect a lack of infection-control programs. Many centers are still trying to decide on a reliable VAP-diagnosis method, so it is not unexpected that most practitioners in our survey were not aware of their institutional VAP rate. We believe that determining the VAP rate would increase the awareness about the problem and therefore facilitate efforts in VAP prevention.

An important shortcoming of this type of a survey study is the potential for "respondents' bias." In this survey study we are reporting what the participants say they do ("report"), and not what their actual practice is. We were aware of the possibility of "respondents' bias," but could not address this directly without information about actual VAP prevention practices. Unless the study includes an observer of actual practice, a respondent's answer to any question may be an opinion rather than actual practice. In the current study, 97.5% of respondents reported adequate hand-washing between patient contacts, to reduce the rate of acquired nosocomial infections in ICUs. This contrasts with repeated reports that compliance with hand-washing in the ICU setting remains low.[36,37] An additional concern is that respondents might have misinterpreted individual items on the survey. Because we could not discuss each item in detail with each individual, we cannot be sure that all respondents properly understood each item.

Conclusions

In summary, in this multicenter, cross-sectional survey of RNs and RTs who work with critically ill patients, the respondents claimed that they used effective VAP-prevention measures almost as frequently as they used ineffective therapies. This finding may suggest a problem of overall translation of evidence to bedside practice. Also, a substantial proportion of the respondents did not know the VAP rate at their institution, which makes it difficult for the institution and individual practitioners to justify measures taken against VAP and the possible success achieved by these measures.

ACKNOWLEDGMENTS

We thank Nancy K Voynow, Editorial Service, Brigham and Women's Hospital, Boston, Massachusetts, for her editorial assistance.

REFERENCES

1. Potgieter PD, Linton DM, Oliver S, Forder AA. Nosocomial infections in a respiratory intensive care unit. Crit Care Med 1987;15(5):495–498.
2. Vincent JL, Bihari DJ, Suter PM, Bruining HA, White J, Nicolas-Chanoin MH, et al. The prevalence of nosocomial infection in intensive care units in Europe. Results of the European Prevalence of Infection in Intensive Care (EPIC) Study. JAMA 1995;274(8):639–644.
3. Girou E, Stephan F, Novara A, Safar M, Fagon JY. Risk factors and outcome of nosocomial infections: results of a matched case-control study of ICU patients. Am J Respir Crit Care Med 1998;157(4 Pt 1):1151–1158.
4. Bueno-Cavanillas A, Delgado-Rodriguez M, Lopez-Luque A, Schaffino-Cano S, Galvez-Vargas R. Influence of nosocomial infection on mortality rate in an intensive care unit. Crit Care Med 1994;22(1):55–60.
5. de Clercq H, De Decker G, Alexander JP, Huyghens L. Cost evaluation of infections in intensive care. Acta Anaesthesiol Belg 1983;34(3):179–189.
6. Heyland DK, Cook DJ, Griffith L, Keenan SP, Brun-Buisson C. The attributable morbidity and mortality of ventilator-associated pneumonia in the critically ill patient. The Canadian Critical Trials Group. Am J Respir Crit Care Med 1999;159(4 Pt 1):1249–1256.
7. Fagon JY, Chastre J, Hance AJ, Montravers P, Novara A, Gibert C. Nosocomial pneumonia in ventilated patients: a cohort study evaluating attributable mortality and hospital stay. Am J Med 1993;94(3):281–288.

8. Baker AM, Meredith JW, Haponik EF. Pneumonia in intubated trauma patients. Microbiology and outcomes. Am J Respir Crit Care Med 1996;153(1):343–349.
9. Cunnion KM, Weber DJ, Broadhead WE, Hanson LC, Pieper CF, Rutala WA. Risk factors for nosocomial pneumonia: comparing adult critical-care populations. Am J Respir Crit Care Med 1996;153(1): 158–162.
10. Craig CP, Connelly S. Effect of intensive care unit nosocomial pneumonia on duration of stay and mortality. Am J Infect Control 1984; 12(4):233–238.
11. Kappstein I, Schulgen G, Beyer U, Geiger K, Schumacher M, Daschner FD. Prolongation of hospital stay and extra costs due to ventilator-associated pneumonia in an intensive care unit. Eur J Clin Microbiol Infect Dis 1992;11(6):504–508.
12. Papazian L, Bregeon F, Thirion X, Gregoire R, Saux P, Denis JP, et al. Effect of ventilator-associated pneumonia on mortality and morbidity. Am J Respir Crit Care Med 1996;154(1):91–97.
13. Kollef MH. Ventilator-associated pneumonia. A multivariate analysis. JAMA 1993;270(16):1965–1970.
14. Jarvis WR, Edwards JR, Culver DH, Hughes JM, Horan T, Emori TG, et al. Nosocomial infection rates in adult and pediatric intensive care units in the United States. Am J Med 1991;91(3B):185S–191S.
15. George DL. Epidemiology of nosocomial pneumonia in intensive care unit patients. Clin Chest Med 1995;16(1):29–44.
16. Chastre J, Fagon JY. Ventilator-associated pneumonia. Am J Respir Crit Care Med 2002;165(7):867–903.
17. Doebbeling BN, Stanley GL, Sheetz CT, Pfaller MA, Houston AK, Annis L, et al. Comparative efficacy of alternative hand-washing agents in reducing nosocomial infections in intensive care units. N Engl J Med 1992;327(2):88–93.
18. Tablan OC, Anderson LJ, Arden NH, Breiman RF, Butler JC, McNeil MM. Guideline for prevention of nosocomial pneumonia. Infect Control Hosp Epidemiol 1994;15(9):587–627.
19. Boyce JM, White RL, Spruill EY, Wall M. Cost-effective application of the Centers for Disease Control guideline for prevention of nosocomial pneumonia. Am J Infect Control 1985;13(5):228–232.
20. Joiner GA, Salisbury D, Bollin GE. Utilizing quality assurance as a tool for reducing the risk of nosocomial ventilator-associated pneumonia. Am J Med Qual 1996;11(2):100–103.
21. Kelleghan SI, Salemi C, Padilla S, McCord M, Mermilliod G, Canola T, Becker L. An effective continuous quality improvement approach to the prevention of ventilator-associated pneumonia. Am J Infect Control 1993;21(6):322–330.
22. Gaynes RP, Solomon S. Improving hospital-acquired infection rates: the CDC experience. Jt Comm J Qual Improv 1996;22(7):457–467.
23. Kollef MH. The prevention of ventilator-associated pneumonia. N Engl J Med 1999;340(8):627–634.
24. Dodek P, Keenan S, Cook D, Heyland D, Jacka M, Hand L, et al. Evidence-based clinical practice guideline for the prevention of ventilator-associated pneumonia. Ann Intern Med 2004;141(4):305–313.
25. American Thoracic Society, Infectious Diseases Society of America. Guidelines for the management of adults with hospital-acquired, ventilator-associated, and healthcare-associated pneumonia. Am J Respir Crit Care Med 2005;171(4):388–416.
26. Cook D, Ricard JD, Reeve B, Randall J, Wigg M, Brochard L, Dreyfuss D. Ventilator circuit and secretion management strategies: a Franco-Canadian survey. Crit Care Med 2000;28(10):3547–3554.
27. van Nieuwenhoven CA, Vandenbroucke-Grauls C, van Tiel FH, Joore HC, van Schijndel RJ, van der Tweel I, et al. Feasibility and effects of the semirecumbent position to prevent ventilator-associated pneumonia: a randomized study. Crit Care Med 2006;34(2):396–402.
28. Tablan OC, Anderson LJ, Besser R, Bridges C, Hajjeh R; Healthcare Infection Control Practices Advisory Committee; Centers for Disease Control and Prevention. Guidelines for preventing health-care-associated pneumonia, 2003 recommendations of the CDC and the Healthcare Infection Control Practices Advisory Committee. MMWR Recomm Rep 2004;53(RR-3):1–36; Respir Care 2004;49(8):926–939.
29. Ricart M, Lorente C, Diaz E, Kollef MH, Rello J. Nursing adherence with evidence-based guidelines for preventing ventilator-associated pneumonia. Crit Care Med 2003;31(11):2693–2696.
30. Rello J, Lorente C, Bodi M, Diaz E, Ricart M, Kollef MH. Why do physicians not follow evidence-based guidelines for preventing ventilator-associated pneumonia? A survey based on the opinions of an international panel of intensivists. Chest 2002;122(2):656–661.
31. Brems C, Johnson ME, Warner T, Roberts LW. Survey return rates as a function of priority versus first-class mailing. Psychol Rep 2006; 99(2):496–501.
32. UCSF Center for the Health Professions. Respiratory care practitioners in California. http://www.futurehealth.ucsf.edu/pdf_files/resp_therapy_issuebrief.pdf. Accessed Oct 8, 2007.
33. Council for Allied Health in North Carolina. The state of allied health in North Carolina: a focus on the respiratory therapy workforce. http://www.shepscenter.unc.edu/hp/oldsite/resptherapy04.pdf. Accessed Oct 10, 2007.
34. American Association for Respiratory Care. Respiratory care human resources survey 2005. Dallas:AARC;2005.
35. Sheldon TA, Cullum N, Dawson D, Lankshear A, Lowson K, Watt I, et al. What's the evidence that NICE guidance has been implemented? Results from a national evaluation using time series analysis, audit of patients' notes, and interviews. BMJ 2004;329(7473): 999–1003.
36. Salemi C, Canola MT, Eck EK. Hand washing and physicians: how to get them together. Infect Control Hosp Epidemiol 2002;23(1):32–35.
37. Pittet D, Stéphan F, Hugonnet S, Akakpo C, Souweine B, Clergue F. Hand-cleansing during postanesthesia care. Anesthesiology 2003; 99(3):530–535.