Prevention and Diagnosis of Ventilator-Associated Pneumonia*

A Survey on Current Practices in Southern Spanish ICUs

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Study objectives: **To assess the implementation of selected ventilator-associated pneumonia (VAP) prevention strategies, and to learn how VAP is diagnosed in the ICUs of Southern Spain.**
Design: **Multicentric survey.**
Setting: **The ICUs of 32 hospitals of the public health-care system of Southern Spain.**
Patients or participants: **Directors of ICUs.**
Interventions: **None.**
Measurements and results: **Twenty-eight ICUs (87.5%) returned completed questionnaires. Ventilator circuits were changed every 72 h or longer in 75% of ICUs. Use of heat and moisture exchangers and open endotracheal suction systems were reported in 96% of ICUs. Subglottic secretion drainage was never used, and 57% of ICUs checked endotracheal tube cuff pressure at least daily. Semirecumbent position was common (93%), and 67.5% of ICUs used frequently noninvasive ventilation. Continuous enteral feeding was reported in all ICUs. Sedative infusions were usually interrupted every day in 11% of ICUs. Seventy-five percent of ICUs had specific guidelines for antibiotic therapy of VAP, but rotation of antibiotics was uncommon (11%). Twenty-nine percent of ICUs diagnosed VAP without microbiological confirmation. The most used technique for microbiologic diagnosis was qualitative culture of endotracheal aspirates (42.8%). The centers with a larger structural complexity reported using VAP therapy guidelines more frequently than the smaller centers, but they did not utilized bronchoscopic techniques for diagnosing VAP.**
Conclusions: **Common prevention and diagnostic procedures in clinical practice, including large teaching institutions, significantly differed from evidence-based recommendations and reports by research groups of excellence. In addition, our study suggests that clinical practice for preventing and diagnosing VAP is variable and many opportunities exist to improve the care of patients receiving mechanical ventilation.** ***(CHEST 2005; 128:1667–1673)***

Key words: diagnosis; ICU; mechanical ventilation; prevention; survey; ventilator-associated pneumonia

Abbreviations: HME = heat and moisture exchanger; H_2 = histamine type-2 receptor; MV = mechanical ventilation; SDD = selective digestive tract decontamination; VAP ventilator-associated pneumonia

Nosocomial infections constitute a major complication in hospitalized patients, particularly in those who are severely ill and need intensive care.[1] Ventilator-associated pneumonia (VAP) is the most frequent nosocomial infection in the ICU,[2,3] and it complicates illness course by increasing mortality rate, hospital length of stay,[4] and costs for patients who acquire it. Therefore, the prevention of VAP is a major issue in ICU clinical practice since it may help improve clinical outcome and reduce costs. Patients do not often receive optimal medical care.[5] Clinical practice variations are frequent and have been described for several aspects of mechanical ventilation (MV).[6] Scientific evidence is useful for

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†A list of participants is given in the Appendix.

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clinicians and patients, and it is incorporated in many practice guidelines. Clinical practice guidelines[5] serve to assist in decision making and to reduce variations in practice. Several strategies (mostly evidence-based guidelines)[7–11] have been developed for preventing VAP. These preventive measures are mainly aimed to reduce oropharyngeal or gastric colonization, and to avoid aspiration of contaminated aerodigestive tract secretions.[9] A major issue also related to MV use is the diagnosis of VAP. Some researchers[12] believe that implementation of bronchoscopic techniques for the diagnosis of VAP may reduce antibiotic use and improve patient outcome. In spite of increasing evidence-based clinical guidelines,[13] the daily use of such guidelines appears to be variable and still limited. Some studies[10,14–16] have documented implementation of VAP prevention strategies and guidelines through surveys. Such surveys may serve to identify current practice related with VAP prevention in order to detect chances to improve it. Our objectives were to assess implementation rates of selected practices considered useful for preventing VAP in a region of Southern Spain, and to learn how VAP was diagnosed in this setting. We postulated that implementation rates of recommended practices for preventing and diagnosing VAP would be different from research reports and that there would be variability among ICUs of hospitals carrying for patients with different acuities.

Materials and Methods

We conducted a survey to determine the use of potential strategies for preventing VAP in the ICU. The need for informed consent was waived by the Ethics Board, which approved the study. The questionnaire included items about nonpharmacologic and pharmacologic strategies considered as useful for VAP prevention. These preventive measures were selected from evidence-based review studies.[7–11] Other practices related with MV use and diagnosis of VAP were also included as questions. We considered the diagnosis techniques utilized for VAP as an important problem in infection control for the ICU. The number of hospital and ICU beds and the number of ICU individual rooms were recorded for each center. The items of the questionnaire concerned the utilization frequency of the following measures: (1) ventilator circuit change frequency; (2) airway humidification system; (3) open or closed endotracheal suctioning systems; (4) subglottic secretion drainage; (5) daily checking of adequate pressure in the endotracheal tube cuff; (6) semirecumbent body positioning; (7) enteral nutrition; (8) noninvasive ventilation; (9) daily antiseptic oral rinse; (10) GI motility agents; (11) stress ulcer prophylaxis; (12) selective digestive tract decontamination (SDD); (13) daily interruption of sedative infusions; (14) specific guidelines for antimicrobial therapy of VAP; (15) antibiotics rotation; and ways of diagnosing VAP ([16] primarily clinical diagnosis vs microbiologic documentation, [17] microbiologic analysis: Gram stain/nonquantitative cultures vs quantitative cultures, [18] specimen types: endotracheal aspirates vs bronchoscopic sampling, *ie*, protected specimen brush or BAL). The questions about the implementation of these measures included two optional answers: commonly used, and seldom or never used.

The surveyed ICUs belong to the 32 hospitals of the public health-care system of Southern Spain (Andalucia, Ceuta, and Melilla), a national region with 7.8 million inhabitants representing approximately a fifth of the population of Spain. We mailed this questionnaire to ICU directors on September 1, 2003, after explaining by telephone the survey purpose and obtaining their acceptance. Participants were requested to check customary practices by direct observation. Nonrespondents were contacted again after 6 weeks, and then by an e-mail attaching another survey form. Completed forms were mailed to the principal investigator who checked them. Queries were sent back to surveyed ICUs for clarification. Collected data were then entered into a database and verified. Data sources were kept confidential. Data of surveyed ICUs were subsequently analyzed by classifying them in three categories according to their structural complexity: (1) teaching vs nonteaching hospitals, (2) number of hospital beds (500 beds as cut-off), and (3) number of ICU beds (< 10 beds vs ≥ 10 beds).

Statistical Analysis

Data are expressed as mean (SD) and percentages. Appropriate tests were used to evaluate differences between groups. All statistical tests were two tailed, and $p < 0.05$ was considered significant.

Results

All 32 ICUs were closed and had a full-time unit director. Of the 32 surveyed ICUs, 28 ICUs (87.5%) returned completed questionnaires. Characteristics of the participating ICUs are described in Table 1. The mean number of ICU individual rooms was 8.1 (SD, 7.9; total, 226 rooms). The proportion of ICU individual rooms with respect to total ICU beds was 51.2%. Such proportions were comparable among the three categories of ICUs.

Table 1—*Characteristics of Participating ICUs*

Variables	Data
ICU beds	
Total No.	441
Mean (SD)	15.8 (11.2)
Hospital type, No. (%)	
Teaching hospitals	15 (54)
Nonteaching hospitals	13 (46)
Hospital beds, No. (%)	
≥ 500	14 (50)
< 500	14 (50)
ICU beds, No. (%)	
≥ 10	14 (50)
< 10	14 (50)
Corresponding mean ICU beds (SD)	
≥ 500 hospital beds	22.2 (6.1)
< 500 hospital beds	7.3 (1.8)

Utilization of VAP Prevention Nonpharmacologic Strategies

Ventilator circuits were changed every 72 h or longer in 75% of ICUs. A disposable heat and moisture exchanger (HME) was the most reported type of airway humidification system (96% of ICUs) used in patients receiving MV. Ninety-six percent of ICUs reported frequent use of open endotracheal suction systems. One ICU reported using a closed suctioning systems solely, and 26% used both closed and open endotracheal suction systems. No ICU reported using subglottic secretion drainage in patients receiving MV. An adequate pressure level in endotracheal tube cuffs was confirmed at least daily in only 57% of these ICUs. Semirecumbent position was common in the patients of 93% of surveyed ICUs. All ICUs responded that they used enteral route for nutritional support. Eighteen percent of ICUs utilized both enteral and parenteral nutrition. Intermittent enteral feeding was never reported. Noninvasive ventilation was frequently reported when indicated for respiratory support in patients of 67.5% of surveyed ICUs. Use rates of these nonpharmacologic strategies were not different among the three categorized types of surveyed ICUs (Table 2).

Utilization of VAP Prevention Pharmacologic Strategies

Oral washes with antiseptic solutions were performed daily in patients receiving MV in 93% of ICUs. Patients receiving MV received GI motility agents daily in 39% of ICUs. All ICUs reported that their intubated patients received stress ulcer prophylaxis. The drug used less commonly was sucralfate (11%), and the most frequently used antiulcer drugs were histamine type-2 (H_2) receptor antagonists (56%). Only one ICU (3.6%) performed SDD in patients receiving MV. Only 11% of questionnaires reported that sedative infusions were usually interrupted every day. Rotation of antibiotics was carried out in 11% of ICUs. There were specific guidelines for antimicrobial therapy of VAP in 75% of the ICUs studied. The presence of such guidelines was significantly more frequent in the ICUs of more complex centers (hospitals that had teaching tasks, > 500 beds, and ICUs with ≥ 10 beds) [Table 2]. Adherence rates with the other pharmacologic strategies were similar among the different structural subgroups of ICUs (Table 2).

Diagnosis of VAP

The survey included some questions about the methods used for diagnosing VAP. Twenty-nine percent of ICUs responded that VAP diagnoses were made clinically (*ie*, fever, leukocytosis, and abnormal chest radiographic images), omitting microbiological data. The majority of ICUs (71.2%) usually used clinical data combined with microbiological results for diagnosing VAP. However, in tracheal aspirates, qualitative cultures were more frequent than quantitative cultures. The techniques that were prefera-

Table 2—*Utilization of Strategies for Preventing VAP and Diagnostic Techniques Among Different Structural Types of Surveyed Hospitals*

Variables	Adherence, %					
	Teaching Hospital (n = 15)	Nonteaching Hospitals (n = 13)	> 500-Bed Hospital (n = 14)	≤ 500-Bed Hospital (n = 14)	> 10-Bed ICU (n = 14)	≤ 10-Bed ICU (n = 14)
VAP prevention strategies						
Ventilator circuit change every 72 h or longer	80	62	79	64	79	64
Humidification with HMEs	100	92	100	93	100	93
Open endotracheal suction system	93	100	93	100	100	92
Subglottic secretion drainage	0	0	0	0	0	0
Control of pressure in endotracheal tube cuff	47	69	43	71	43	71
Semirecumbent body position	93	92	93	93	93	93
Noninvasive ventilation	71	69	77	64	69	71
Antiseptic oral rinse	93	92	93	93	93	93
Selective digestive decontamination	0	7.7	7.1	0	7.1	0
Daily interruption of sedative infusions	20	0	21	0	14	7.1
Specific guidelines for antimicrobial therapy of VAP	93	54*	93	57*	93	57*
Antibiotic cycling	14	7.7	15	7.1	7.7	14
VAP diagnostic techniques						
Qualitative cultures of endotracheal aspirates	40	46	43	43	43	43
Quantitative cultures of endotracheal aspirates	20	7.7	21.4	7.1	21.4	7.1
Bronchoscopic procedures	0	30.7*	0	28.6*	0	28.6*

*$p < 0.05$.

bly utilized for microbiologic diagnosis are shown in Figure 1 and Table 2. Bronchoscopic techniques were not used for diagnosing VAP in the ICUs of the more complex hospitals, and only in a minority of the others (Table 2).

Discussion

This study demonstrates that implementation rates of certain recommended practices for the prevention and diagnosis of VAP are nonoptimal in many ICUs. It has also shown some practice variability among hospitals of different levels of complexity of care. The gap between research and clinical practice suggest that opportunities exist to improve the care of many intubated patients.

Besides the recently updated guidelines[7] from the Centers for Disease Control and Prevention, several evidence-based recommendations[8–11] for preventing VAP have been issued. Some studies[10,14–16] have documented by surveys the adherence to these evidence-based strategies. This study was aimed at learning what ICUs were currently doing to prevent the appearance of VAP. We selected several recommendations reported for VAP prevention[7–11] to determine rate of use in clinical practice. Some of the preventive strategies we questioned (*ie*, infrequent ventilator circuit changes, and semirecumbent posture) were, coincidentally, recommended in various guidelines or reviews,[7–11] but other selected interventions were stated only in isolated works.[9–11] The diagnosis of VAP was not microbiologically confirmed in a significant number of these ICUs.

A low rate of utilization of closed endotracheal suction systems and no use of subglottic secretion drainage were reported. Studies regarding the use of closed rather than open suction systems have attributed lower costs and more safety to the first system, but these studies are inconclusive[17] and the technique does not seem to prevent VAP.[18] However, subglottic secretion drainage appears effective in preventing early onset VAP,[19] as confirmed by a recent metaanalysis[20] of randomized trials that compared subglottic secretion drainage with standard endotracheal tube care, although a poor implementation rate has been also documented in other studies.[10,14] Another worthy preventive strategy, maintenance of adequate pressure in the endotracheal tube cuff,[9,21] was usually ensured in only approximately one half of patients receiving MV. Widespread use of HMEs was documented. The use of this humidification system has been considered as an unresolved issue by the Centers for Disease Control and Prevention,[7] and it has not been recommended in their guideline. Although the use of a HME is estimated to be a strategy of undetermined effectiveness,[9,17] its utilization is recommended for clinical use in some guidelines and reviews.[8–10]

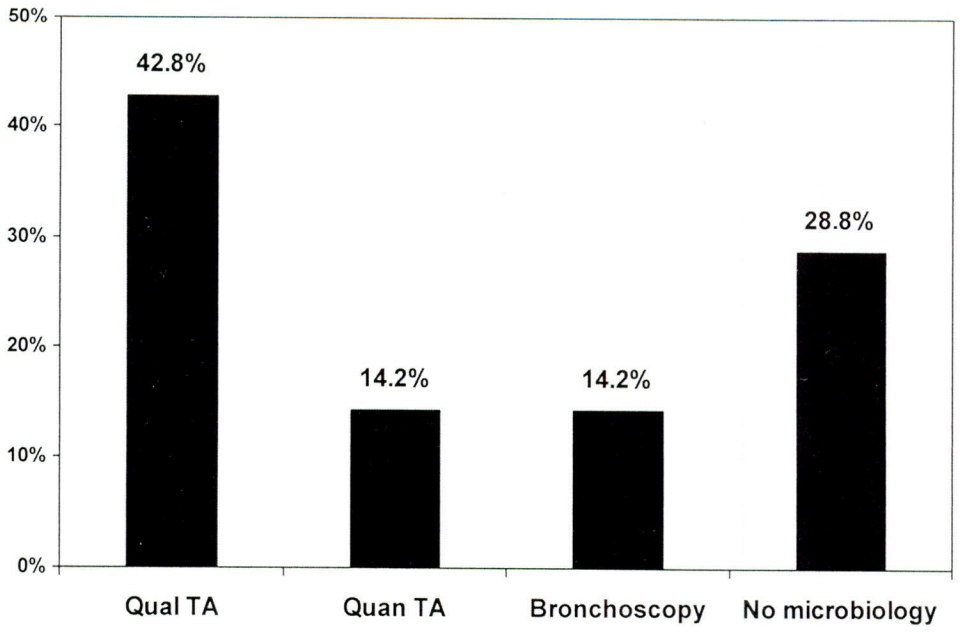

Figure 1. Techniques preferably used for microbiologic diagnosis of VAP in the 28 surveyed ICUs. Qual TA = qualitative cultures of endotracheal aspirates; Quan TA = quantitative cultures of endotracheal aspirates; bronchoscopy = used bronchoscopic techniques; no microbiology = no microbiologic diagnosis. Qual TA was the most utilized diagnostic technique ($p < 0.05$).

Most of the surveyed ICUs directors responded that their patients usually were in a semirecumbent body position, which appears to be good clinical practice.[7–11] Two multicentric surveys in ICUs of France and Canada that questioned the use of ventilator circuit and secretion management reported a lower rate of use of this body position (58% in France, and 30% in Canada).[14]

Intermittent enteral feeding was not used in the surveyed ICUs. This feeding method decreases intragastric pH and may reduce VAP occurrence, although further research is required.[11]

Noninvasive ventilation use has reported in many of surveyed ICUs. Although noninvasive ventilation is not yet utilized commonly in patients receiving MV,[6] nor is it still widely recommended for VAP prevention,[7–11] it reduces the need for endotracheal intubation,[22] thus decreasing the risk of VAP.

Antiseptic oral rinses were used daily for patients receiving MV in most of these ICUs. Oral decontamination with clorhexidine reduces the frequency of VAP in subsets of high-risk patients. Therefore, this strategy is recommended for clinical use.[9] Nevertheless, the antiseptics used for oral washing in our patients were not specified. Oral care practice, although perceived as a high priority in the ICU, is not suitably implemented.[23] Every patient admitted in the surveyed ICUs commonly received antiulcer drugs, and the most common and least common drugs utilized were H_2 antagonists and sucralfate, respectively. H_2 antagonists decrease gastric acidity, which might enhance bacterial colonization and serve as a VAP source.[9] Several metaanalyses[11] of controlled trials of SDD have found a significant reduction in VAP rates using this oropharynx and stomach sterilization method. Nevertheless, emergence of antibiotic resistance related with SDD has been argued against its widespread use.[8–11] SDD utilization was uncommon in the ICUs studied.

Daily interruption of sedative infusions in critically ill patients receiving MV decreases the duration of MV and reduces the length of ICU stay.[24] Consequently, this practice can be considered worthy for reducing VAP risk and its occurrence. A minority of the ICUs reported stopping sedative infusions every day.

Antibiotic policy is a major issue in nosocomial infection control, and practice guidelines[25] for antimicrobial therapy attempting to restrict antibiotic use are expected to help in preventing antibiotic-resistant infections. Furthermore, antibiotic utilization strategies such as rotating antibiotic classes have been recommended in some VAP prevention guidelines.[9] Most of the surveyed ICU directors responded that they had designed and implemented guidelines for antimicrobial therapy of VAP, but few of these ICUs reported rotating antibiotics. The ICUs of hospitals with greater structural complexity had implemented more frequently VAP therapy guidelines than the smaller centers.

The frequency of VAP occurrence in Spanish ICUs is high,[3,26] particularly in the region where our study was carried out.[27] It represents a major problem in this health-care setting, which deserves control efforts.

A significant finding in this study was that approximately 3 of 10 ICUs reported making VAP diagnoses without microbiological confirmation. A recent report[28] suggested that antibiotic de-escalation was not possible to implement in patients with unknown microbiologic diagnosis, emphasizing the importance of microbiologic workup. Moreover, when microbiologic analysis was added to support VAP diagnosis, more accurate diagnostic techniques such as quantitative cultures from endotracheal aspirates and bronchoscopic procedures were not frequently performed. Surprisingly, implementation of such invasive techniques was only reported in the ICUs of less complex hospitals. A relationship between hospital structural level and extreme resource use has been demonstrated, but its probability is higher in hospitals with greater complexity.[29] A high response rate has been obtained in our study, and the distribution of surveyed ICUs according to size and complexity of care is representative. Although previous studies[10,14–16] have also surveyed the adherence to many VAP prevention strategies, other related questions as interruptions of sedative infusions and VAP-case definitions were also included in our survey. An adequate control and treatment of VAP ought to require an accurate definition of cases which may help to reduce use of antibiotics.[12] To our knowledge, this study is the first that surveys simultaneously both VAP prevention and diagnosis practice.

Limitations of this study include the fact that the questionnaires were sent to ICU directors who reported stated practice, but direct observations of patient care were not made. Other limitations are that motives for noncompliance with selected strategies were not asked. Nor was implementation checked for other VAP prevention recommendations. Reasons as to why these recommendations were not used have been inquired in two surveys.[14,16] Significant barriers to adherence could be disagreement with the conclusions of source studies, resources paucity, high costs, nurse inconvenience, potential adverse events, and patient discomfort.[14,16] Lastly, since the setting of the study was limited to part of Spain, it could also limit the generalizability of the results to other geographic areas. However, we believe that this study will be useful for many practitioners and health officers in Spain.

In summary, similar to other reports, the results of

our survey documented a distance between routine and optimal practice that reflects the gap between research and practice.[30] Certain interventions may promote behavioral change among health professionals.[30] Interestingly, an education program aimed at ICU infection control can assist in decreasing the incidence of VAP and its costs.[31] Our findings confirm that real world is very different from what is expected, and the implementation of evidence-based preventive and microbiological diagnosis recommendations for VAP is very different when compared with research reports by groups of excellence. Therefore, the current findings may help us to identify opportunities to improve clinical practice in ICU patients with MV by aiming to prevent VAP. It would also be worthwhile to get a more accurate diagnosis of VAP in order to provide an adequate treatment, de-escalate antibiotics, and contribute to better infection control. Although we realize how difficult the implementation of guidelines can be,[30] an effective implementation of preventive-care guidelines could produce greater improvement in patient care than some new technologies.[32]

Appendix

The Infections and Sepsis Group of the Sociedad Andaluza de Medicina Intensiva, Hospitals of the Servicio Andaluz de Salud.

Blasco, J. (Hospital de Antequera, Málaga); Cobos, P. (Hospital de Baza, Granada); De la Torre, M.V. (Hospital Clínico Virgen de la Victoria, Málaga); Del Campo, E. (Hospital de Andujar, Jaén); Delgado, F.J. (Hospital de Huelcar-Overa, Almería); Doblas, A. (Hospital Juan Ramón Jiménez, Huelva); Domínguez, J.M. (Hospital de Traumatología Virgen del Rocío, Sevilla); Gil, J. (Hospital Clínico de Puerto Real, Cádiz); Guzmán, T. (Hospital Clínico Virgen Macarena, Sevilla); Huertos, M.J. (Hospital Clínico de Puerto Real, Cádiz); Jareño, A. (Hospital de Jerez, Jerez de la Frontera); León, C. (Hospital Universitario Virgen de Valme, Sevilla); Martín, J.C. (Hospital Torrecardenas, Almería); Martínez, J.C. (Hospital Infanta Elena, Huelva); Mateo, J.I. (Hospital de Ronda, Málaga); Muñoz, E. (Hospital de Osuna, Sevilla); Murillo, F. (Hospitales Universitarios Virgen del Rocío, Sevilla); Ortiz, C. (Hospital General Universitario Virgen del Rocío, Sevilla); Quesada, G. (Hospital Universitario Carlos Haya, Málaga); Rodríguez, M. (Hospital Universitario Virgen de las Nieves, Granada); Rucabado, L. (Hospital General Ciudad de Jaén, Jaén); Ruiz, M. (Hospital de Poniente, Almería); Ruiz-Cabello, M.A. (Hospital Civil, Ceuta); Sánchez, M.M. (Hospital de Ubeda, Jaén); Sancho, H. (Hospital Universitario Reina Sofía, Córdoba); Sanz, A. (Hospital de Motril, Granada); Sierra, R. (Hospital Universitario Puerta del Mar, Cádiz); Torres, L.M. (Hospital Clínico San Cecilio, Granada); Val, M.I. (Hospital Comarcal, Melilla); Zaya, B. (Hospital de Marbella, Málaga).

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