Original Article

Ventilator-associated pneumonia: impact of bacterial multidrug resistance on morbidity and mortality*

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Background: Ventilator-associated pneumonia is the most common nosocomial infection occurring in intensive care units.

Objective: To determinate the impact of multidrug-resistant bacteria on morbidity and mortality in patients with ventilator-associated pneumonia.

Method: Retrospective cohort study. Over 40 consecutive months, 91 patients on mechanical ventilation developed pneumonia. Cases were grouped into those caused by multidrug-resistant microorganisms and those caused by drug-sensitive microorganisms.

Results: Multidrug-resistant bacteria were isolated in 75 cases (82.4%) and drug-sensitive bacteria in 16 (17.6%). Clinical and epidemiological characteristics were not statistically different between the groups. *Staphylococcus aureus* was responsible for 27.5% of ventilator-associated pneumonia episodes and *Pseudomonas aeruginosa* for 17.6%. Early-onset ventilator-associated pneumonia occurred in 33 patients (36.3%) and late-onset in 58 (63.7%). Time on mechanical ventilation, length of intensive care unit stay and overall length of hospital stay were not statistically different between groups. Empirical treatment was considered inadequate in 42 patients with pneumonia caused by multidrug-resistant microorganisms (56%) and in 4 with pneumonia caused by drug-sensitive microorganisms (25%) ($p = 0.02$). Death occurred in 46 patients with pneumonia caused by multidrug-resistant microorganisms (61.3%) and in 4 with pneumonia caused by drug-sensitive microorganisms (25%) ($p = 0.008$).

Conclusion: Bacterial multidrug-resistance had no impact on morbidity but was associated with higher mortality.

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INTRODUCTION

Ventilator-associated pneumonia (VAP) is the most common nosocomial infection affecting patients in intensive care units (ICUs)[1-4]. The risk of VAP increases by 1% to 3% for each day on mechanical ventilation[5,6]. In a non-university hospital in Rio Grande do Sul, the use of mechanical ventilation was shown to create a relative risk for pneumonia of 3.44 when compared to the risk for non-ventilated patients[7].

The incidence of VAP is high and may vary from 6% to 52% depending on the population studied, the type of ICU and the diagnostic criteria used. This is due to the fact that, although VAP is a very serious infection, it is one of the most difficult to diagnosis in critically ill patients[1]. When compared to other nosocomial infections, such as those of he urinary tract and skin, in which mortality ranges from 1% to 4%, VAP becomes a significant predictor of mortality, which ranges from 24% to 50%, reaching more than 70% when the VAP is caused by multidrug-resistant microorganisms[6,8-11].

Considered epicenters of bacterial resistance, ICUs are the main source of upsurges in the numbers of multidrug-resistant bacteria. Among the risk factors, one that has been emphasized is antimicrobial agent abuse, which exerts selective pressure on certain groups of microorganisms, turning them resistant. In addition, the routine use of invasive techniques, as well as ICU overcrowding and the increased susceptibility in this population of patients, who are usually suffering from severe illnesses, further increase the risk of infection with multidrug-resistant microorganisms[12].

There is a consensus that bacterial resistance has played a significant role in the increasing mortality rates among severely ill patients[13,14,15]. However, the difficulties in updating empirical antimicrobial therapy arise from the dynamic nature of changing patterns of resistance. Bearing these difficulties in mind, the treatment for VAP is complex, requires an intimate knowledge of all therapeutic possibilities available, and must take into account the epidemiological and environmental context of each case[16]. Patterns of bacterial sensitivity vary, not only among hospitals, but also among units within the same hospital.

The objective of this study was to determine the impact of multidrug-resistant microorganisms on morbidity and mortality in patients developing VAP.

METHOD

The records of patients diagnosed with VAP during a 40-month period (from January 1999 to April 2002) were reviewed. Diagnoses were made by the attending physicians and endorsed by the Nosocomial Infection Control Committee of the *Complexo Hospitalar Santa Casa de Porto Alegre* (Santa Casa Hospital of Porto Alegre), a university hospital with 1700 beds. Patients in four clinical-surgical ICUs were studied. The study design was approved by the research ethics committee of the institution. Obtaining written informed consent was unnecessary since this was an observational and retrospective epidemiological study. It was established that only the first pneumonia episode would be taken into consideration, and therefore each patient would participate only once in the study.

Cases of clinically diagnosed VAP were defined as patients in which new progressive or persistent infiltrate was observed in chest X-rays, hemodynamic conditions were evaluated, fluid balance was continuously monitored in order to exclude the possibility of pulmonary edema (reduction in pulmonary infiltration after a treatment regimen other than antibiotic therapy was a criterion for exclusion), axillary temperature was > 37.5°C or < 35°C, blood leukocytosis (>10000/mL) with a deviation to the left or leukopenia (< 3000/mL) was found, there was an increase in purulent secretion via the endotracheal tube, Gram stain of the endotracheal aspirate revealed considerably increased staining in at least ten leucocytes per field, qualitative culture of the endotracheal aspirate was positive (obligatory inclusion criterion), and there was no other infection focus that would explain the infectious syndrome.

Upon admission to the ICU, data regarding age, gender, body mass index, principal illness, comorbidities, and factors that would indicate immunosuppression (neutropenia with cell counts lower than 500 cells/mL, neoplasia, human immunodeficiency virus, systemic erythematous lupus, previous transplant of a solid organ, use of e" 20 mg per day of corticosteroids during the 30 days prior to the onset of pneumonia, or use of other immunosuppressive drugs) were collected. Data relating to surgery and use of any antibiotic in the 30 days prior to the onset of VAP were also collected. In addition, previous history of and total time on mechanical ventilation, as well as length

of hospital stay (length of ICU stay and overall length of hospital stay) were established.

The empirical antimicrobial regimens consisted of the use of an antipseudomonal beta-lactam combined with an aminoglycoside. In some cases, beta-lactam was combined with a beta-lactamase inhibitor. When *Staphylococcus aureus* was suspected, vancomycin was included in the treatment. The minimum duration of treatment was fourteen days.

All patients were evaluated using the acute physiology and chronic health evaluation II (APACHE II) criteria[17] in the first 24 hours after admission to the ICU and using the multiple organ dysfunction score (MODS)[18], administered in accordance with the data collected during the 24 hours preceding the onset of pneumonia.

Microorganisms were considered multidrug-resistant if they were resistant to two or more classes of antimicrobial agents. When *S. aureus* was the isolated agent, it was characterized as resistant or sensitive to oxacillin. The criteria adopted for evaluating the inappropriateness of an empirical regimen of antibiotic therapy were those suggested by Kollef[34] for clinical research purposes: microbiological documentation of an infection which had not been effectively treated at the moment of its identification; no antimicrobial directed to the isolated agent or administration of an antimicrobial agent to which the isolated microorganism is resistant.

Clinical and laboratory data were submitted to statistical and univariate analysis. The Kolmogorov-Smirnov test was used in order to evaluate normality of the data, and the significance of the tests was based on Lilliefor's two-tailed probability. Continuous variables with normal distribution were compared using the Student's *t*-test, and values are expressed as means and standard deviations. Continuous variables with non-normal distribution were compared using the Wilcoxon-Mann–Whitney test, and values are expressed as medians, interquartile ranges, means and standard deviations. Categorical variables were compared using the chi-square test and Fisher's exact test. Some values were distributed into group percentages. Significance was defined as error type I less than 0.05 ($p < 0.05$). Data were analyzed using the Statistical Package for Social Sciences software, version 11.0 (SPSS 11.0).

RESULTS

A total of 91 patients developed VAP, and the cases were divided into two groups: those caused by multidrug-resistant bacteria (75 cases; 82.4%) and those caused by drug-sensitive bacteria (16 cases; 17.6%).

No statistically significant differences were found between the groups in terms of clinical and epidemiological characteristics such as gender, mean age, illness severity scores (MODS and APACHE II), patient immune status and nature of the case (surgical or clinical) (Table 1).

A total of 107 bacteria were isolated from the 91 patients with VAP. Of these, 74 strains (69.2%) were Gram-negative and 33 strains (30.8%) were Gram-positive. Of the total, 85 (79.4%) were considered multidrug-resistant microorganisms. In 77 (84.6%) of the cases of VAP, a single microorganism was isolated, whereas multiple agents were isolated in 14 cases (15.4%) (Table 2).

In the single-agent cases of pneumonia, the most common bacteria found was *S. aureus*, responsible for 25 cases (27.5%), 20 (80.0%) of which were caused by oxacillin-resistant strains. The second most common was *Pseudomonas aeruginosa*, provoking 16 isolated cases (17.6%), 9 (56.2%) of which were caused by multidrug-resistant strains. *Acinetobacter baumannii* was isolated in 8 cases (8.8%), 7 of which (87.5%) were caused by multidrug-resistant strains. Nonfermentative Gram-negative bacilli other than *P. aeruginosa* or *A. baumannii*, 7 of which (87.5%) were multidrug-resistant strains, were isolated in another 8 cases (8.8%). In 14 episodes, VAP probably had a polymicrobial origin and in all these cases, at least one of the causative agents was a multidrug-resistant microorganism.

A total of 33 patients (36.3%) developed pneumonia within the first 5 days on mechanical ventilation (early-onset VAP), whereas 58 (63.7%) developed pneumonia after the fifth day (late-onset VAP). Among the cases of early-onset pneumonia, multidrug-resistant bacteria were responsible for 25 (75.6%), compared with 50 (86.2%) of the cases of late-onset pneumonia. These values were not statistically different (Table 2).

Regarding immune status, 55 patients (60.4%) were considered immunocompetent and 36 (39.6%) were considered immunosuppressed. Multidrug-resistant microorganisms were

TABLE 1
Characteristics of the 91 patients with VAP

Characteristic	Multidrug-resistant microorganism (n=75)	Drug-sensitive microorganism (n=16)	*p*
Age (years)	62.0 ± 17.0	65.8 ± 14.1	0.12
Sex			
Male	46 (61.3)	10 (62.5)	0.93
Female	29 (38.7)	6 (37.5)	
Immunological status			
Immunocompetent	44 (58.7)	11 (68.7)	0.45
Immunosuppressed	31 (41.3)	5 (31.3)	
Time of VAP onset			
Early	25 (33.3)	8 (50.0)	0.21
Late	50 (66.7)	8 (50.0)	
Patient			
Clinical	45 (60.0)	10 (62.5)	0.85
Surgical	30 (40.0)	6 (37.5)	
Drug treatment prior to VAP			
Antibiotic use in the previous 30 days	45 (60.0)	8 (50.0)	0.46
No antibiotic use	30 (40.0)	8 (50.0)	
APACHE II	22.7 ± 7.6	19.4 ± 7.7	0.18
MODS	3.5 ± 2.8	2.8 ± 1.9	0.50

Values expressed as group mean and standard deviation, or, when appropriate, number of occurrences within the group and group percentage – n (%)
VAP: ventilator-associated pneumonia: APACHE II: Acute Physiology and Chronic Health Evaluation II; MODS: Multiple Organ Dysfunction Score

responsible for 44 (80.0%) of the cases in the first group and 31 (86.1%) of those in the second. These values were not statistically different.

Out of the total number of patients, 36 (39.6%) were admitted to the ICU after surgical procedure, whereas 55 (60.4%) received only clinical treatment. Multidrug-resistant microorganisms caused 30 (83.3%) of the VAP cases in the group of surgical patients and 45 (81.8%) of those in the group of clinical patients. These values were not statistically different.

When length of hospital stay prior to VAP was compared between the patients with pneumonia caused by multidrug-resistant bacteria and those with pneumonia caused by drug-sensitive microorganisms, no statistically significant differences were found in length of hospital stay (15.0; 19.0; 18.9 ± 13.1 days vs. 12.5; 16.7; 14.9 ± 10.0 days, $p = 0.28$) or in length of ICU stay (9.0; 7.0; 11.7 ± 7.9 days vs. 7.0; 10.2; 10.4 ± 8.2 days, $p = 0.35$).

Comparing VAP caused by multidrug-resistant bacteria with VAP caused by drug-sensitive bacteria, time on mechanical ventilation (15.0; 20.0; 21.4 ± 22.0 days vs. 13.5; 15.2; 22.4 ± 30.7 days, $p = 0.81$), length of ICU stay (26.0; 24.0; 34.0 ± 26.1 days vs. 28.0; 20.5; 38.1 ± 34.2 days, $p = 0.77$) and overall hospital stay (43.0; 40.0; 52.2 ± 40.0 days vs. 40.5; 24.5; 54.6 ± 38.6 days, $p = 0.56$) did not differ from the statistical point of view (Figures 1, 2 and 3).

All patients received empirical antimicrobial treatment. In the group of patients with pneumonia caused by multidrug-resistant bacteria, the empirical treatment regimen was shown to be inappropriate in 42 cases (56%), whereas in the group of patients with pneumonia caused by drug-sensitive bacteria, only 4 cases (25%) were treated inappropriately. This difference was statistically significant ($p = 0.02$) (Figure 4).

When the patients who were discharged were compared with those who died, no statistically significant differences were found in length of hospital stay prior to VAP (13.0; 17.5; 18.3 ± 14.3 days vs. 17.0; 15.0; 18.1 ± 11.2 days, $p = 0.53$) or in length of ICU stay prior to VAP (9.0; 8.5; 11.4 ± 8.5 days vs. 9.0; 7.2; 11.5 ± 7.6 days, $p = 0.73$).

TABLE 2
Microorganisms isolated and time of VAP onset

Microorganism	Early-onset VAP (n = 33)		Late-onset VAP cases (n = 58)		Total (n = 91)
	Multidrug-resistant n (%)	*Sensitive n* (%)	*Multidrug-resistant n* (%)	*Sensitive n* (%)	*n* (%)
Gram-positive	8 (8.8)	4 (4.4)	**14 (15.4)**	1 (1.1)	**27 (29.7)**
Oxa-S *Staphylococcus aureus*	4 (4.4)	-	1 (1.1)	5 (5.5)	
Oxa-R *Staphylococcus aureus*	8 (8.8)	-	12 (13.2)	-	20 (22.0)
coag-neg *Staphylococcus sp.*	-	-	1 (1.1)	-	1 (1.1)
Enterococcus faecalis	-	-	1 (1.1)	-	1 (1.1)
Gram-negative	10 (11.0)	5 (5.5)	30 (33.0)	5 (5.5)	50 (54.9)
NFGNB					
Pseudomonas aeruginosa	3 (3.3)	3 (3.3)	6 (6.6)	4 (4.4)	16 (17.6)
Acinetobacter baumannii	2 (2.2)	-	5 (5.5)	1 (1.1)	8 (8.8)
Pseudomonas sp.	-	-	1 (1.1)	-	1 (1.1)
Moraxella catarrhalis	-	-	1 (1.1)	-	1 (1.1)
Stenotrophomonas maltophilia	-	-	1 (1.1)	-	1 (1.1)
Other NFGNB*	3 (3.3)	1 (1.1)	4 (4.4)	-	8 (8.8)
Escherichia coli	-	-	3 (3.3)	-	3 (3.3)
Enterobacter cloacae	1 (1.1)	1 (1.1)	1 (1.1)	-	3 (3.3)
Enterobacter sp.	-	-	1 (1.1)	-	1 (1.1)
Serratia marcescens	-	-	3 (3.3)	-	3 (3.3)
Klebsiella pneumoniae	-	-	1 (1.1)	-	1 (1.1)
Proteus mirabilis	1 (1.1)	-	2 (2.2)	-	3 (3.3)
Klebsiella oxytoca	-	-	1 (1.1)	-	1 (1.1)
Polymicrobial**	**6 (6.6)**	-	**8 (8.8)**	-	**14 (15.4)**

VAP: ventilator-associated pneumonia; Oxa-R: oxacillin-resistant; Oxa-S: oxacillin-sensitive; coag-neg: coagulase-negative; NFGNB: Nonfermentative gram-negative bacilli

*Non-fermentative gram-negative bacilli, other than *Pseudomonas aeruginosa* or *Acinetobacter baumannii*

**12 (85.7%) were caused by the combination of two microorganisms and 2 (12.5%) by three microorganisms

Among the patients with VAP caused by multidrug-resistant bacteria, death occurred in 46 (61.3%), compared with 4 (25%) among patients with VAP caused by drug-sensitive bacteria. This difference was statistically significant ($p = 0.008$) (Figure 5).

DISCUSSION

In the present study, the majority of the patients (82.4%) presented VAP caused by multidrug-resistant microorganisms. Within this group, mortality rate was higher (61.3% vs. 25%, $p = 0.008$). However, some methodological aspects merit analysis.

First, although the lack of quantitative culture for processing samples of endotracheal secretion is open to criticism, the population studied is representative of the reality found in most ICUs, where pneumonia is diagnosed based on clinical evidence, and etiologic agents are identified through qualitative analysis alone. Considering the high negative predictive value of endotracheal aspirate in the diagnosis of VAP, we used the obligatory criteria of culture positivity and clinic evidence. The noninvasive method of material collection also illustrates the reality of the situation, since the fiber bronchoscope is not always available when clinical suspicion arises. On the other hand, there is a lack of reliable data demonstrating the superiority of invasive methods over noninvasive methods for the diagnosis of VAP. Ruiz et al.[19] found no difference in mortality rates between patients treated with invasive methods and those treated with noninvasive methods. A study conducted by Fagon et al.[20], including the highest number of patients with VAP studied to date, showed a reduction in mortality in patients treated with invasive methods on day 14 of treatment, although not differing from the results obtained on day 28. In the present study,

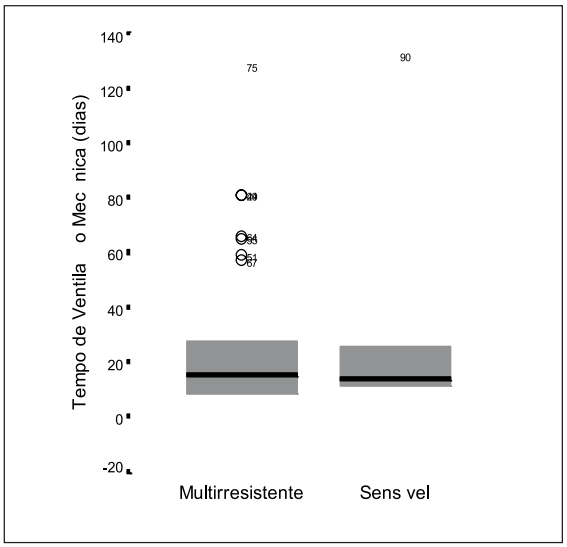

Figure 1. Total time on mechanical ventilation regarding the sensitivity of the microorganism causing the VAP, expressed as median, interquartile range and standard deviation
VAP: Ventilator-associated pneumonia

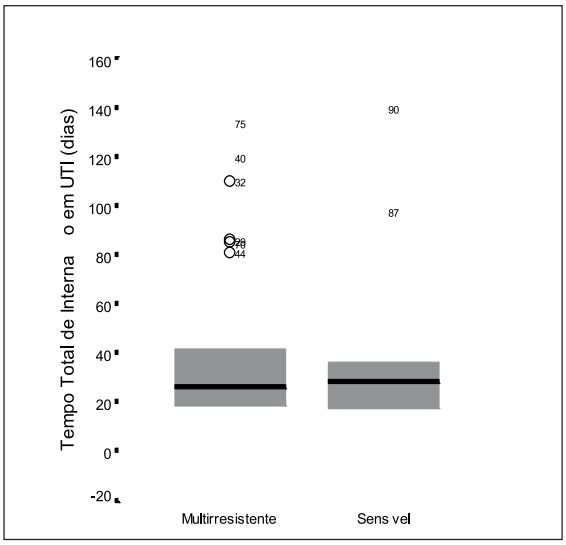

Figure 2. Overall length of intensive care unit stay in relation to the sensitivity of the microorganism causing the VAP, expressed as median, interquartile range and standard deviation
VAP: Ventilator-associated pneumonia

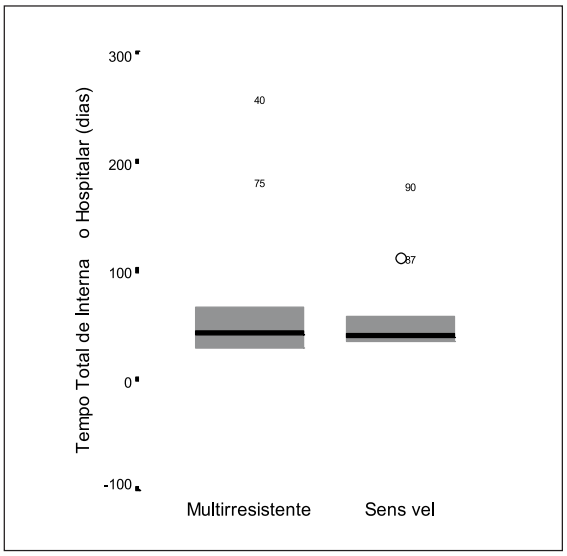

Figure3. Overall length of hospital stay in relation to the sensitivity of the microorganism causing the VAP, expressed as median, interquartile range and standard deviation
VAP: Ventilator-associated pneumonia

quantitative culture for analysis of endotracheal aspirate was not used in the group designated clinical management. A recently published meta-analysis[21] suggested that clinical criteria represent the best reference for everyday clinical practice. The same authors state that studies evaluating the accuracy of diagnostic tests should not include such tests in the definition of VAP.

Second, the fact that this is a retrospective study should be addressed. Despite the fact that the clinical and laboratory criteria were made as rigid as possible (in an attempt to rule out other causes of the pulmonary infiltrate and other sites of infection), it is possible that the incidence of VAP was overestimated, especially since quantitative culture, bronchoalveolar lavage and protected specimen brush, although all highly recommendable, were not used. Another differential diagnosis which should always be considered is purulent tracheobronchitis. Therefore, in addition to the use of quantitative culture when available, it is important to exclude edema as the cause of pulmonary infiltrate.

Third, it should be taken into account that the sample size and the prevalence of patients with multidrug-resistant bacteria may, alone, explain the higher tendency for mortality in the study, since clinical characteristics and severity did not differ between the two groups.

Although Gram-negative bacilli are the most prevalent microorganisms, *S. aureus*, in isolation, was the most common bacteria, and 86.7% of the *S. aureus* bacilli were resistant to oxacillin. This high

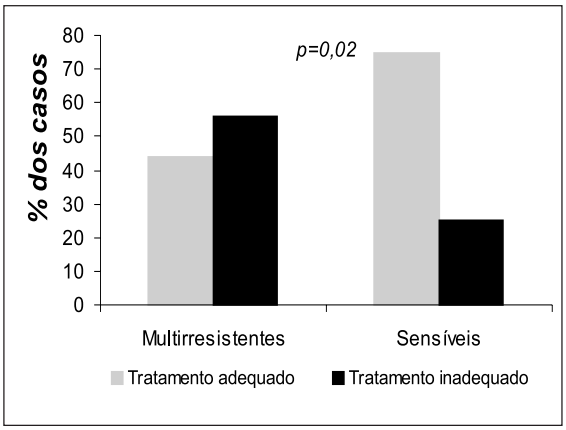

Figura 4. Relationship of the sensitivity of the microorganism causing VAP to the empirical antimicrobial treatment
VAP: Ventilator-associated pneumonia

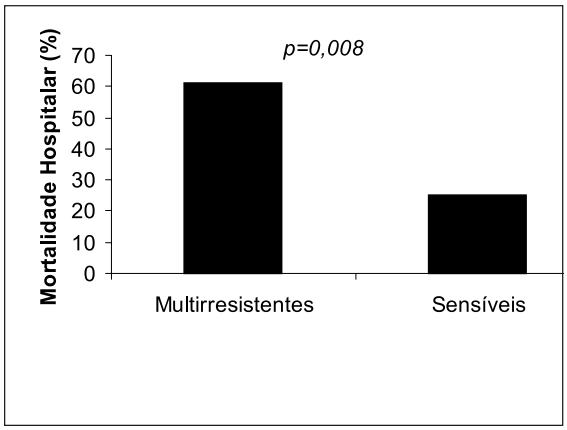

Figura 5. Relationship between the sensitivity of the microorganism causing VAP and hospital mortality
VAP: Ventilator-associated pneumonia

rate of resistance to oxacillin corroborates the guidelines established by the Brazilian Consensus on Pneumonia, in which all *S. aureus* strains are considered resistant to oxacillin for the purposes of designing empirical treatment regimens for nosocomial pneumonia, especially cases related to mechanical ventilation. In an elegant study designed to compare quantitative culture of bronchoalveolar lavage fluid with quantitative culture of postmortem lung biopsy samples, Balthazar et al.[23] also found *S. aureus* to be the most common causative agent. Data from the Sentry[24] program, however, show that, in samples collected in various Brazilian hospitals, *S. aureus* was the second most prevalent microorganism (19.6%), and that approximately half of the strains belonged to the oxacillin-resistant group of *S. aureus*. Carrilho[25] also demonstrated that *S. aureus* was the second most common bacteria in nosocomial ICU pneumonia in a university hospital in the North of Paraná. Korn et al.[26] studied 100 patients admitted to two ICUs and observed that, at the time of admission, 46 were colonized by oxacillin-resistant *S. aureus* and, after admission, 28 became colonized with the same bacteria, and 16 developed respiratory or urinary infections. The authors found no risk factors in the evaluated sample, but called attention to the fact that 20% of the patients colonized at admission had not been previously admitted to the ICU and had not been transferred from another hospital ward.

In evaluating the usefulness of bronchoalveolar lavage in patients under empirical treatment for VAP and considered treatment failure in a clinical ICU in São Paulo, Gomes et al.[27] found the main causative agents of pneumonia to be *A. baumannii* (37.1%), *P. aeruginosa* (17.7%) and oxacillin-resistant *S. aureus* (16.1%). The most common agent reported by the Sentry[24] program was *P. aeruginosa*, which proved resistant to most of the antibiotics tested. In the present study, *P. aeruginosa* was the second most prevalent agent and 15.9% of the strains were considered multidrug-resistant. *A. baumannii*, isolated in 8 patients, proved multidrug-resistant in 7. Although *Stenotrophomonas maltophilia* was isolated in only 2 patients, it merits analysis since it has been increasingly identified in nosocomial respiratory infections, especially in transplanted patients and patients with neoplasias. Similar to other nonfermentative species, *S. maltophilia* is intrinsically resistant to several antibiotics commonly used in empirical treatment regimens for nosocomial pneumonia. Nevertheless, the treatment of choice for infections caused by this agent, the trimethoprim-sulfamethoxazole combination, is not among the various antimicrobial regimens used empirically[28].

The use of broad-spectrum antibiotics, resulting in higher selective pressure, together with the difficulties in implementing measures to control nosocomial infections, have been seen as responsible for the emergence of increasingly resistance of causative agents. General control measures, such as hand washing, identifying

colonized patients and using contact precaution, although neglected, have the important objective of avoiding dissemination of microorganisms by health professionals and visitors[27]. On the other hand, use of the ideal strategy (that of reducing the antimicrobial spectrum after isolation and identification of the agent) creates a certain apprehension among members of the treatment team, who tend to maintain the treatment unchanged due to the improvement presented by the patient, thereby fomenting the emergence of multidrug-resistant microorganisms. This is due to the fact that longer duration of exposure to an antimicrobial agent increases the chance of colonization and infection by these multidrug-resistant microorganisms[26].

Isolation of more than one agent occurred in 14 pneumonia cases. The decision to designate these as possible cases of polymicrobial pneumonia was related to the limitation of the method used for collecting respiratory secretions (as previously discussed). Combes et al.[30] showed the incidence of polymicrobial VAP to be 48%, although no differences in morbidity and mortality were found.

Using logistic regression, Trouillet et al.[31] identified three variables associated with a higher chance of developing VAP caused by multidrug-resistant microorganisms: time on mechanical ventilation, previous use of antibiotics and previous use of broad-spectrum antibiotics. In the present study, no correlations were found between multidrug-resistant VAP and time on mechanical ventilation, length of hospital stay or length of ICU stay. However, time on ventilation and length of hospital stay were longer for patients who developed pneumonia caused by drug-sensitive microorganisms. This is probably due to a higher mortality in the group of patients with pneumonia caused by multidrug-resistant microorganisms. No correlation was found between multidrug-resistant VAP and previous use of antibiotics. These findings are quite likely related to the small number of cases studied as well as to the predominance of cases caused by multidrug-resistant microorganisms.

Data in the literature demonstrate that VAP caused by multidrug-resistant microorganisms is associated with higher mortality. In such patients, higher numbers of inappropriate treatments have occurred. Chastre & Fagon[32] demonstrated, by combining several studies, that initial empirical treatment seems to play an important role in the prognosis of these patients. The prognosis for VAP caused by antibiotic-sensitive aerobic Gram-negative bacilli is considered to be worse than for that caused by antibiotic-sensitive gram-positive bacilli. Mortality related to pneumonia caused by pseudomonas is especially high, usually above 70% to 80%. Kollef et al.[33] showed that patients with VAP caused by microorganisms that are considered high risk (*P. aeruginosa, Acinetobacter spp. and S. maltophilia*) presented higher mortality when compared to patients with late-onset pneumonia caused by other agents.

It can be concluded that bacterial multidrug-resistance is related to higher mortality, as demonstrated in this and other studies [11,13,20,31,32,33]. If, among the various prognostic factors, appropriate empirical treatment with antibiotics is becoming increasingly more important, the challenge in the creation of empirical systems is ongoing, since the bacteria may modify its resistance mechanisms in the same patient during the various phases of treatment. Although this study illustrates the true manner in which VAP diagnosis is made in most ICUs, the addition of quantitative culture, with the respective cutoff points for each type of material, is important for achieving greater specificity, although this does not necessarily result in a definitive diagnosis. In view of this fact, prevention seems to be the most sensible course of action. Therefore, prophylactic strategies, some as simple as hand washing, should be implemented with greater frequency.

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