PREVALENCE OF HOSPITAL-ACQUIRED INFECTIONS CAUSED BY STAPHYLOCOCCUS AUREUS AND ANTIMICROBIAL SUSCEPTIBILITY PROFILE

RESUMEN
Objetivo: analizar la prevalencia de infecciones hospitalarias causadas por Staphylococcus aureus y su resistencia a los antimicrobianos. Método: estudio retrospectivo, documental, con enfoque cuantitativo. La investigación fue realizada con la recopilación de datos en registros médicos y fichas técnicas de la microbiología de un hospital en Campina Grande, estado de Paraíba, Brasil. Fueron analizadas las infecciones consideradas hospitalarias, de acuerdo con los criterios establecidos por el Ministerio de Salud, y que habian sido causadas por S. aureus. El estudio fue aprobado por el Comité de Ética, CAAE N° 0072.0.133.000-12. Resultados: se analizaron 1,056 registros de cultivos bacterianos con 358 (33.90%) positivos, de los cuales 183 (51.12%) estaban relacionadas a casos de infección de origen comunitario y 175 (48.88%) a casos de infección hospitalaria, de los cuales 26 (14.86%) habian sido causados por S. aureus, siendo 17 (65.38%) por methicillin-resistant Staphylococcus aureus - MRSA. Conclusión: hubo una alta prevalencia de infecciones MRSA en el hospital en cuestión, un hecho que alerta sobre la importancia y la urgencia de adoptar nuevas medidas de control de infecciones hospitalarias. Descriptores: Infección Hospitalaria; Staphylococcus aureus; MRSA; Antimicrobianos.

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ABSTRACT
Objective: to analyze the prevalence of hospital-acquired infections caused by Staphylococcus aureus and its resistance to antimicrobials. Method: retrospective and documentary study with a quantitative approach. The research was conducted with data collection in medical records and datasheets of the microbiology laboratory of a hospital in Campina Grande, State of Paraiba, Brazil. We analyzed the infections considered hospital-acquired, according to the criteria laid down by the Ministry of Health, and that were caused by S. aureus. The study was approved by the Ethics Committee, CAAE No. 0072.0.133.000-12. Results: we analyzed 1,056 medical records of bacterial cultures including 358 (33.90%) positive cases, of which 183 (51.12%) were related to infection cases of community origin and 175 (48.88%) to hospital-acquired cases, with 26 (14.86%) caused by S. aureus, being 17 (65.38%) caused by methicillin-resistant Staphylococcus aureus - MRSA. Conclusion: there was high prevalence of MRSA infections in the hospital under study, warning about the relevance and urgency in the adoption of new measures of hospital infections control. Descriptors: Hospital Infection; Staphylococcus aureus; MRSA; Antimicrobials.
INTRODUCTION

Hospital-acquired infections (HAI) are caused by the imbalance of the human microbiota and they can arise from invasive procedures and contact with the hospital microbiota. Nowadays, these infections represent a serious public health problem in Brazil and in the world, increasing the time of hospitalization, morbidity and mortality of patients and causing changes in the patterns of microbial resistance with consequent increase in assistance costs.\(^1\)\(^-\)\(^3\)

In Brazil, about 5 to 15\% of hospitalized patients contract some HAI.\(^5\) From approximately 40 million hospitalizations per year in the United States of America (USA), it is estimated that two million patients (about 5\% of the total) acquire HAI and approximately 88 thousand deaths are related to these infections.\(^6\)\(^-\)\(^7\)

*Staphylococcus aureus* is an important etiologic agent associated to infections acquired both in the community and hospitals, and it has become a paradigm of bacterial infections. It is considered one of the major human pathogens, particularly by its high frequency and pathogenicity that enables it to cause diseases, both in immunocompromised and healthy individuals, in addition to its easy intra-hospital dissemination associated with antimicrobial resistance.\(^8\)\(^-\)\(^9\)\(^-\)\(^10\) The most extraordinary feature of *S. aureus* is its high ability to acquire resistance to antibiotics. No other bacterial species, with similar level of virulence in the human body, has such degree of flexibility to withstand and survive antimicrobial therapy.\(^10\)\(^-\)\(^11\)

About 70\% of the *S. aureus* isolates of HAI in the main Brazilian hospitals are methicillin-resistant. These are called methicillin-resistant *Staphylococcus aureus* (MRSA). The classical strains of MRSA are resistant to other drugs indicated for the treatment of *Staphylococcus*, such as clindamycin, erythromycin, and tetracycline, and less frequently gentamicin and sulfamethoxazole-trimethoprim. Antibiogram testing should be performed in order to determine the bacterial sensitivity to these and other drugs, aiming at a proper and specific antibiotic therapy. However, all beta-lactam antibiotics (penicillins, cephalosporins, carbapenems) are considered resistant, regardless of the antibiogram results, which restricts considerably the therapeutic options.\(^7\)\(^-\)\(^11\)\(^-\)\(^12\)

The resistance mechanism of MRSA is related to the change of penicillin-binding proteins (PBPs) encoded by the gene mecA. The presence of PBP2a makes methicillin and penicillin-resistant penicillinase compounds (PPT) have low affinity for the binding site in the bacteria, cell wall, and consequently, are no longer effective. The PPT Group is comprised of the following drugs: oxacillin; methicillin; nafcillin; cloxacillin; and dicloxacillin.\(^17\)

In Brazil, several studies have shown the prevalence of hospital-acquired infections caused by *S. aureus* ranging from 17 to 26\%, and approximately 70 to 100\% are caused by multidrug-resistant samples.\(^13\)\(^-\)\(^14\) This way, considering the spread of multidrug-resistant bacteria, there is a need for the adoption of monitoring programs involving, among other measures, the assessment of the sensitivity profile of the isolates, using appropriate methodologies recommended by reference bodies.\(^13\)\(^-\)\(^14\) Consequently, this study aims to analyze the prevalence of HAI caused by *Staphylococcus aureus* and its resistance to antimicrobials.

METHOD

This is a retrospective, documentary and descriptive study with quantitative approach, conducted from April 2009 to March 2011. The research was carried out through the collection of data in records and datasheets of the microbiology laboratory of a hospital in Campina Grande, State of Paraíba, Brazil. We analyzed the infections considered hospital-acquired—according to the criteria laid down by the Ministry of Health—that were caused by *S. aureus*.\(^14\)

According to the records, the biological materials collected were urine and secretions from surgical wounds or not and tracheal aspirate, in addition to biomaterials as tips of catheters and drains. All were collected in accordance with the requirements of standard hospital procedures described in Ordinance No. 2,616 of Ministry of Health, May 1998.\(^14\) The cultures and microbial identification were carried out according to routine techniques of the microbiology laboratory of the hospital under study.\(^15\)\(^-\)\(^16\) Antimicrobial sensitivity testing was performed by disk diffusion technique, in accordance with the recommendations of the Clinical and Laboratory Standards Institute (CLSI), and the strains that showed resistance to oxacillin and cefoxitin were considered MRSA.\(^17\)

The project was approved by the Committee of Ethics in Research Involving Humans of the State University of Paraíba, No. 0072.0.133.000-12. This study was carried out in accordance with the ethical aspects of research recommended by Resolution 196/96 of the National Council of Health/Ministry of
Health, respecting the confidentiality and secrecy of the subjects studied.

RESULTS AND DISCUSSION

We analyzed 1,056 cultures according to information obtained from laboratory datasheets and medical records of patients of a hospital in Campina Grande, State of Paraíba, Brazil. Of these, 358 (33.90%) cultures presented bacterial growth, among which 183 (51.12%) characterized cases of infection of community origin and 175 (48.88%) were cases of HAI. These values can vary from hospital to hospital and differ from reports of other authors who found 36.8% of infections of community origin and 63.2% of hospital origin.18

According to the morphotintorial characteristics of the HAI-causing bacteria, it was found that 125 (71.43%) were identified as gram-negative bacilli and 34 (19.43%) as gram-positive cocci. We also observed that 16 (9.14%) HAI presented more than one morphological type of etiological agent, being considered polymicrobial infections. These data are in line with accounts from other authors who found gram-negative bacilli and gram-positive cocci in 71.9% and 23.6%, respectively.9,4

Among the 175 cases of HAI, 26 (14.86%) were caused by S. aureus. This value is also very close to those found by other authors, who reported an average prevalence rate of 16.3% of this microorganism, highlighting it as one of the main etiological agents involved in clinical cases of HAI.20,21 This data corroborates with studies conducted in other Brazilian institutions that showed values ranging between 17% and 26%.19,20,21 Of 26 HAI cases with S. aureus as etiological agent, 17 (65.38%) were caused by MRSA and 9 (34.62%) by MSSA (meticillin-sensitive). In a previous study conducted in the State of Paraná, it was found an average MRSA prevalence rate of 70.75%. This value is similar to those obtained in other studies also conducted in Brazil, which demonstrated MRSA rates ranging from 40 to 80%.11,19,22 The incidence of S. aureus resistance to meticillin has been growing, mainly in tertiary or university hospitals.21,23

We observed that among HAI caused by S. aureus, 6 (23.08%) were associated with other microorganisms, being therefore regarded as polymicrobial cultures.

It was evidenced that MSSA infections were more prevalent in females (7 - 77.78%) and between the ages of 11-19 and 20-39 years, with the same prevalence rate (3 - 33.33%). MRSA infections were more frequent in males (9 - 52.95%) and within the age group of 60 years (7 - 41.17%) (Table 1). This fact has also been documented by other authors that revealed similar percentages of HAI related to gender, with 43.7 and 56.30% of cases occurring in males and females, respectively.24 They also described S. aureus as a common pathogen that affects individuals of all ages, especially young people and older adults.23,24

Several clinical specimens and biomaterials were collected for culture, confirming the prevalence of MSSA in 7 (77.78%) surgical wound secretions, followed by 1 (11.11%) in biomaterials and pleural fluid. With respect to the prevalence of MRSA, we observed 5 (29.41%) cases in orotracheal secretions and in biomaterials, 1 (5.88%) in urine, and 3 (17.65%) in other clinical specimens (Table 2). We considered as positive the orotracheal secretions cultures (quantitative) that presented bacterial growth over 105 units forming colonies, characterizing hospital pneumonia, based on laboratory data; since although orotracheal secretions cultures

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>MSSA (n=9)</th>
<th>MRSA (n=17)</th>
<th>Total (n=26)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 10</td>
<td>Female n (%)</td>
<td>Male n (%)</td>
<td>Female n (%)</td>
</tr>
<tr>
<td>0 - 10</td>
<td>1 (11.10%)</td>
<td>0 (0%)</td>
<td>1 (5.88%)</td>
</tr>
<tr>
<td>11 - 19</td>
<td>3 (33.33%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>20 - 39</td>
<td>3 (33.33%)</td>
<td>0 (0%)</td>
<td>3 (17.64%)</td>
</tr>
<tr>
<td>40 - 59</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>2 (11.77%)</td>
</tr>
<tr>
<td>≥60</td>
<td>0 (0%)</td>
<td>2 (22.24%)</td>
<td>2 (11.77%)</td>
</tr>
<tr>
<td>Total</td>
<td>7 (77.78%)</td>
<td>2 (22.22%)</td>
<td>8 (47.05%)</td>
</tr>
</tbody>
</table>

Several authors have reported the prevalence of S. aureus isolation in HAI processes; however, they highlight discrete differences in percentage values, depending on the diversity of clinical specimens collected and used in microbiological testing.17,27 Among the clinical specimens used in research on HAI, the following data with higher prevalence were found: miscellaneous secretions (33.6%); followed by blood (23.6%);
urine (17%); surgical wound secretions (10.3%); and catheters tips (9.9%).\textsuperscript{18,22,27} These data are similar to those found in this study (Table 2).

Table 2 shows that 6 (23.07%) patients had contaminated catheters, which predisposes to the indication of antibiotic therapy for bacteremia or septicemia. This number of contaminated catheters—considered high—raises attention to eventual shortcomings in the processes used for antisepsis of patient’s skin and/or catheter sterilization in hospitals. The small number of blood cultures requested by the service of the hospital under study can justify the absence of blood infections in the period assessed.

Table 2. Distribution of MSSA and MRSA isolates of HAI in a hospital in Campina Grande (PB), according to the type of material used for culture.

<table>
<thead>
<tr>
<th>Material used</th>
<th>MSSA n (%)</th>
<th>MRSA n (%)</th>
<th>Total n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgical wound secretion</td>
<td>7 (77.78)</td>
<td>3 (17.66)</td>
<td>10 (38.46)</td>
</tr>
<tr>
<td>Biomaterials*</td>
<td>1 (11.11)</td>
<td>5 (29.41)</td>
<td>6 (23.07)</td>
</tr>
<tr>
<td>Orotracheal secretion</td>
<td>0 (0.00)</td>
<td>5 (29.41)</td>
<td>5 (19.23)</td>
</tr>
<tr>
<td>Pleural fluid</td>
<td>1 (11.11)</td>
<td>0 (0.00)</td>
<td>1 (3.85)</td>
</tr>
<tr>
<td>Urine</td>
<td>0 (0.00)</td>
<td>1 (5.88)</td>
<td>1 (3.85)</td>
</tr>
<tr>
<td>Other**</td>
<td>0 (0.00)</td>
<td>3 (17.65)</td>
<td>3 (11.54)</td>
</tr>
<tr>
<td>Total</td>
<td>9 (100%)</td>
<td>17 (100%)</td>
<td>26 (100%)</td>
</tr>
</tbody>
</table>

Caption: Biomaterials: Tips of catheters and drains; *Others: Secretions: wounds, eyes and ears.

Nosocomial pneumonia represents a significant cause of death from hospital-acquired infections and it generally occurs 48 hours or more after hospital admission.\textsuperscript{28} It is known that devices such as catheters and drains that assist or monitor basic body functions contribute much to the success of medical treatments; however, after crossing natural defensive barriers, these devices provide the access of microorganisms into fluids and tissues that are normally sterile, this way raising the rates of HAI, in particular caused by MRSA.\textsuperscript{29}

It was observed that HAI caused by MSSA occurred, in descending order, in surgical clinic units (4 · 44.45%), maternities (3 · 33.33%), and ICUs (2 · 22.22%) (Table 3). These data differ with reports of other authors, depending on the diversity of the hospital sectors analyzed; however, they converge with the prevalence of isolated microorganisms.\textsuperscript{3,7,9,28}

Table 3. Distribution of patients with HAI caused by MSSA and MRSA in a hospital in Campina Grande (PB), according to hospital sectors.

<table>
<thead>
<tr>
<th>Hospital sector</th>
<th>MSSA n (%)</th>
<th>MRSA n (%)</th>
<th>Total n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICU</td>
<td>2 (22.22%)</td>
<td>15 (88.24%)</td>
<td>17 (65.38%)</td>
</tr>
<tr>
<td>Surgical clinic</td>
<td>4 (44.45%)</td>
<td>0 (%)</td>
<td>4 (15.39%)</td>
</tr>
<tr>
<td>Maternity</td>
<td>3 (33.33%)</td>
<td>1 (5.88%)</td>
<td>4 (15.39%)</td>
</tr>
<tr>
<td>Oncology</td>
<td>0 (%)</td>
<td>1 (5.88%)</td>
<td>1 (3.84%)</td>
</tr>
<tr>
<td>Medical clinic</td>
<td>0 (%)</td>
<td>0 (%)</td>
<td>0 (%)</td>
</tr>
<tr>
<td>Pediatrics</td>
<td>0 (%)</td>
<td>0 (%)</td>
<td>0 (%)</td>
</tr>
<tr>
<td>Total number of cases</td>
<td>9 (100%)</td>
<td>17 (100%)</td>
<td>26 (100%)</td>
</tr>
</tbody>
</table>

In our study, HAI caused by MRSA prevailed in the ICU with 15 (88.24%) cases. This data corroborate reports of another study in which the prevalence of MRSA in the ICU was 83.1%.\textsuperscript{7} It is known that in ICUs patients have five to ten times more likely to contract HAI and that these may represent about 20 to 30% of total infections in a hospital.\textsuperscript{15,13} In Brazil, the beds intended for UTIs represent less than 2% of hospital beds available; however, they contribute with more than 25% of the infections and with high level of deaths.\textsuperscript{1}

The susceptibility profile of MSSA regarding antimicrobials routinely used in the hospital, showed that 8 (88.89%) of strains presented resistance to aztreonam and 4 (44.44%) to tetracycline and penicillin. Other antimicrobials, also indicated for gram-positive microorganisms, showed lower percentage of resistant strains, being 2 (22.2%) resistant to erythromycin and azithromycin, and 1 (11.1%) resistant to chloramphenicol and ciprofloxacin (Table 4). It was also observed that the 17 (100%) MRSA strains presented resistance to aztreonam and penicillin G, 15 (88.2%) were resistant to cephalaxin, and 14 (82.35%) were resistant to cephalotin, ciprofloxacin, azithromycin, clindamycin, and erythromycin (Table 4).

In Brazil, more than 70% of the isolated strains of Staphylococcus, whether from the community or hospital environments, are resistant to penicillins (G, ampicillin, and amoxicillin); therefore, these antimicrobials should not be empirically indicated for the treatment of staphylococcal infections.\textsuperscript{22} Several authors, who have documented high resistance rates, point to the need for antibiogram testing before indicating these antimicrobials.\textsuperscript{7,10,22}
Assessment of resistance to aminoglycosides is important, since this class of antibiotics can be associated with β-lactam antibiotics and glycopeptides for treatment of serious infections, and they are used very often in the clinical practice of the hospital studied. We found that the average rate of resistance to gentamicin was 14 (82.35%) and 12 (70.59%) to amikacin. These rates were higher than those found by other authors that detected around 67% of resistance to gentamicin and amikacin.18

Ciprofloxacin, belonging to quinolone antibiotics, presented a resistance rate of 14 (82.35%), which was higher in comparison to rates found in other studies.19,29,30 Staphylococcus spp. can develop resistance during prolonged therapy with quinolones, becoming resistant within three to four days after the beginning of treatment.

Penicillin presented 100% of resistance rate in MRSA strains, which is a result (91.11%) similar to those found by other authors21-2 in hospitals in the south of Brazil, confirming data from the national literature21 that prove that MRSA have intrinsic resistance to penicillin, so that this antibiotic does not need antibiogram testing.11

Table 4 shows that MRSA strains identified in this study showed different levels of antimicrobial resistance, with percentages above 50% of resistance to erythromycin, clindamycin, gentamicin, ciprofloxacin, and sulfamethoxazole/trimethoprim, which corroborates with the results obtained by other authors.31 Azithromycin, tetracycline and amoxicillin also showed resistance rates greater than 50%. All strains of S. aureus showed sensitivity to vancomycin, which is in line with other studies.20,21 The only strain of MRSA isolated from urine presented resistance to antimicrobials of first choice for urinary tract infection, such as nalidixic acid, nitrofurantoin, ofloxacin, pipemide acid, and norfloxacin.

We observed that of the nine patients with MSSA infection, only 1 (11.11%) was making use of antimicrobials when collection was performed. However, regarding MRSA infections, we noted that of 17 (100%) patients, 10 (58.82%) were already making empirical use of antibiotic therapy during the period of collection. These results confirm that of the total of 26 (100%) patients with HA1 caused by S. aureus, 11 (42.30%) were making use of antimicrobials during the collection.

Figure 1 shows patients that were making use of antimicrobials concomitant with material collection, distributed by quantity, i.e., before the completion of the microbiological examination (culture with antibiogram). Of the 11 patients studied, only two had microorganisms isolated with antimicrobial sensitivity that was being administered empirically. In one of the patients, one MSSA strain, sensitive to cephalotin, was isolated and one MRSA strain in another patient, the latter was making use of a therapeutic scheme composed of amikacin and cefepime. In this case, the bacterium was sensitive to amikacin. As for cefepime, this antimicrobial is not normally tested for gram-positive bacteria and this is why it had not been tested in the laboratory of the hospital. The other antimicrobials used in patients antibiotic therapy were ineffective (resistant strains) or had not been tested due
to intrinsic resistance of the microorganism under study.

CONCLUSION

The presence of MRSA in a hospital is a sign of antimicrobial resistance dissemination; therefore, considering the high prevalence of MRSA in this study, it is necessary to warn the institution about the importance of adopting new programs for controlling hospital-acquired infections in order to guide the actions of health professionals, especially with regard to controlling the use of antimicrobials.

REFERENCES


9. Menegotto FR, Picoli SU. Staphylococcus aureus oxacilina resistente (MRSA): incidência de cepas adquiridas na comunidade (CA-MRSA) e importância da pesquisa e descolonização

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