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Fatores associados à infecção por *Staphylococcus aureus* resistente à meticilina em unidade de terapia intensiva

Factors associated with staphylococcus aureus meticillin resistant infections in intensive care unit

Factores asociados a la infección por staphylococcus aureus resistente a la meticilina en una unidad de terapia intensiva

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RESUMO

Objetivo: Identificar os fatores associados à infecção por *Staphylococcus aureus* resistente à meticilina (MRSA) em pacientes adultos internados em Unidade de Terapia Intensiva (UTI), e compará-los com um grupo controle. **Métodos:** Estudo caso-controle, retrospectivo, realizado em UTI adulto, no período de janeiro/2015 a junho/2017, com 61 pacientes que desenvolveram infecção por *Staphylococcus aureus* resistente à meticilina e o mesmo número de controle. **Resultados:** A maioria dos participantes era do sexo masculino (60,6%), com diagnóstico neurológico (35,2%) e hipertensos (50,0%). Na comparação dos grupos, houve diferença estatisticamente significante em relação à ventilação mecânica (p=0,0107), traqueostomia (p=0,0083), óbito (p=0,0401), cateter urinário (p=0,0420), dias de internação (p<0,0001) e gravidade dos pacientes (p=0,0003). Os principais fatores associados à infecção por *Staphylococcus aureus* resistente à meticilina foram gravidade (OR= 65,69; IC=3,726-4,808; p=0,0018), Antimicrobiano (OR= 0,047;IC=0,028-0,122;p=0,0024), dias de internação (OR=1,19; IC=0,952-1,031; p=0,0285). **Conclusão:** A infecção por *Staphylococcus aureus* resistente à meticilina é multifatorial e se associou ao tempo de internação e à gravidade dos pacientes. Antimicrobiano foi fator protetor.

Descritores: Staphylococcus Aaureus; Unidade de Terapia Intensiva; Enfermagem; Controle de Infecções; Resistência Microbiana a Medicamentos.

ABSTRACT

Objective: To identify factors associated with methicillin-resistant Staphylococcus aureus (MRSA) infection in adult patients admitted to the Intensive Care Unit (ICU), and to compare them with a control group. **Methods:** Retrospective case-control study carried out in an adult ICU, from January 2015 to June 2017, with 61 patients who developed methicillin-resistant Staphylococcus aureus infection and the same number of control patients. **Results:** Most participants were male 65 (60.6%), with a neurological diagnosis 43 (35.2%) and hypertensive 61 (50.0%). In the comparison of the groups, there was a statistically significant difference in relation to mechanical ventilation (p=0.0107), tracheostomy (p=0.0083), death (p=0.0401), urinary catheter (p=0.0420), length of stay (p<0.0001) and severity (p=0.0003). The main factors associated with methicillin-resistant Staphylococcus aureus infection were: severity (OR= 65.69; CI=3.726-4.808; p=0.0018), use of antimicrobials (OR= 0.047;CI=0.028-0.122;p=0.0024), length of stay (OR=1.19; CI=0.952-1.031; p=0.0285). **Conclusion:** methicillin-resistant Staphylococcus aureus infection is multifactorial and has been associated with length of stay and severity. Use of antimicrobials was a protective factor.

Descriptors: Staphylococcus Aureus; Intensive Care Unit; Nursing; Infection Control; Microbial Drug Resistance.

RESUMEN

Objetivo: Identificar los factores asociados a la infección por *Staphylococcus aureus* resistente a la meticilina (SARM) en pacientes adultos internados en una Unidad de Cuidados Intensivos (UCI) y compararlos con un grupo control. **Métodos:** Se trata de un estudio de caso-control, retrospectivo, realizado en una UCI de adultos entre enero de 2015 y junio de 2017, con 61 pacientes que desarrollaron la infección por *Staphylococcus aureus* resistente a la meticilina y el mismo número de control. **Resultados:** La mayoría de los participantes tenía 65 años (60,6%) y era del sexo masculino; 43 (35,2%) poseían diagnóstico neurológico y 61 (50,0%) padecían de hipertensión. En la comparación de los grupos se observó una diferencia estadísticamente significativa en relación con la ventilación mecánica (p=0,0107), la traqueotomía (p=0,0083), la muerte (p=0,0401), el catéter urinario (p=0,0420), los días de hospitalización (p<0,0001) y la gravedad de los pacientes (p=0,0003). Los principales factores asociados con la infección por *Staphylococcus aureus* resistente a la meticilina fueron: gravedad (OR= 65,69; CI=3,726-4,808; p=0,0018), antimicrobiano (OR= 0,047; CI=0,028-0,122; p=0,0024), días de internación (OR=1,19; CI=0,952-1,031; p=0,0285). **Conclusión:** La infección por *Staphylococcus aureus* resistente a la meticilina es multifactorial y está asociada al tiempo de internación y a la gravedad de los pacientes. El antimicrobiano fue el factor protector.

Descriptores: Staphylococcus Aureus; Unidad de Cuidados Intensivos; Enfermería; Control de Infecciones; Farmacorresistencia.

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INTRODUCTION

Health Care-Associated Infections (HAIs) are not only a biological event, but a historical and social phenomenon that has a direct impact on safety of health care and is one of the main challenges to quality health care[1-2].

The Center of Diseases Control and Prevention (CDC) estimates that almost 1.7 million HAIs occur annually in patients being treated for other health problems, and that more than 98,000 of these patients (one in 17) die from it[3]. In Brazil, data on HAIs are still poorly documented due to the reduced standard of information in several hospitals, which makes it difficult to know the magnitude of the problem in the country[4]. A study carried out by the Ministry of Health evaluated 99 tertiary hospitals linked to the Unified Health System (SUS) and located in Brazilian capitals and found that the prevalence of HAIs among hospitalized patients was 13%[5].

It is estimated that HAIs in critically ill patients represent 20% of all infections in hospitalized patients[6-7], 15% of primary bloodstream infections[8] and correspond to almost half a million cases per year in intensive care units (ICUs)[9]. Among these infections, contamination by Staphylococcus aureus is among the main causes of morbidity and mortality and is associated with high rates of health care-associated complications, especially in developing countries[10].

Staphylococcus aureus is a gram-positive bacteria present in the human microbiota, mainly on the skin, which can become pathogenic and lead to an infection when there is a breakdown of the skin barrier or decreased immunity. When this important nosocomial pathogen is resistant to methicillin, it is called MRSA (Methicillin-resistant Staphylococcus Aureus)[10-11].

In the hospital environment, one of the most common places for colonization and infection by MRSA is the ICU, where approximately 20% of infected patients are predisposed to death[12]. In Latin America, MRSA is the leading cause of nosocomial infection, which shows the importance of identifying risk factors for colonization and infection by this microorganism[13].

Studies have shown that MRSA colonization is still the main risk factor for active infection[14-15]. In addition, some predisposing factors are comorbidities such as diabetes, chronic lung disease, prolonged hospitalization, use of invasive equipment or invasive procedures, presence of colonized or infected patients in the same environment, previous hospitalization and exposure to antimicrobials[14,16-18].

Longer hospital stays, frequent use of immunosuppressants and/or antimicrobials, nutritional conditions, age, as well as the hands of health professionals are significant factors associated with HAIs[18-19]. These factors lead to increased hospital morbidity and mortality, prolonged hospitalizations and increased costs and favor the selection and dissemination of multidrug-resistant microorganisms[20].

It should be noted that overuse and indiscriminate use of antimicrobials results in the development of multidrug-resistant microorganisms and is related to the dissemination and horizontal transmission of HAIs[10,21]. In addition, 8% of patients staying in the ICU for more than two days have acquired at least one HAI[22].

The relevance of active, systematic and continuous surveillance for hospital infections has the objective of decreasing the number of infections, mainly those caused by MRSA and, consequently, reducing the use of vancomycin for treatment or antibiotic prophylaxis. In addition, it aims to reduce antimicrobial resistance, treatment costs and length of hospital stay[21-23].

Nasopharyngeal colonization usually precedes MRSA infections[15]. In this sense, early detection of colonized patients minimizes the risk of direct and/or cross-transmission. This has become a growing challenge and therapeutic options have been increasingly restricted due to the resistance of microorganisms to antimicrobials[21].

The role of the nursing team should be emphasized, as these professionals are the largest providers of specialized health care. The nurse has a fundamental role in the prevention of HAIs in the ICU; with systematized procedures and supported by the best scientific evidence available, these professionals can minimize the risk of unnecessary harm associated with health care. In addition, this study may contribute to the multifaceted management of the prophylactic care that health professionals will have as guidelines to prevent MRSA.

However, despite of the complexity and severity of the issue, the literature review showed that it is not fully addressed in the nursing literature and most of the studies conducted in the ICU do not stratify the sample with its controls to justify the results. Therefore, a study on risk factors contributes to the planning and establishment of strategies for the prevention, control and surveillance of this infection. In this sense, we ask: What are the associated factors for MRSA in adult patients admitted to the ICU in a university hospital?

OBJECTIVE

To identify factors associated with infection caused by methicillin-resistant Staphylococcus aureus in adult patients admitted to the Intensive care Unit and to compare them with a control group.

METHODS

Ethical aspects

The research started after approval by the Research Ethics Committee of the Medical School of Botucatu and in accordance with Resolution 466/12[24].

Study design, setting and period

This is a retrospective, descriptive, case-control study with a quantitative approach. In this study, the qualification strategy for observational studies in epidemiology (STROBE) was followed[25].

The study was carried out in a general adult intensive care unit with 25 beds in a public hospital in the State of São Paulo, in the period between January 2015 and June 2017.

Study sample; inclusion and exclusion criteria

Non-probabilistic convenience sample, consisting of adult patients who developed MRSA infection during ICU stay. Participants were 18 years old or over, of both genders and duly documented in the electronic medical record by the team of the Comission

for the Control of Health Care-Associated Infections (CCIRAS) of the institution. Patients who had an infection acquired in the community or had a previously known infection at the time of admission to the ICU or readmissions were excluded.

An infection acquired in the community is one whose incubation or development period was already in course at hospital admission and that cannot be related to a previous hospitalization period, health interventions or procedures performed[26].

For the selection of patients for the control group, the defined matching criteria were applied: adult patients, of both genders, who were admitted to the ICU during the study period and did not develop a MRSA infection. The mean age of the cases was also considered when pairing this group.

The control sample was defined according to the number of cases identified in the study period.

Study protocol

Data were collected by the researcher from July to October 2017, through the electronic medical record of the patients provided by the Medical Informatics Center of the hospital. By applying some research filters in these records, a list of hospitalizations containing the name, medical record number and ICU record was obtained.

Then, the electronic medical record called SOUL MV was accessed. This medical record gathers clinical and care information of all patients who developed an infection during the study period. Subsequently, inclusion and exclusion criteria were checked.

For both groups, a form with two parts was used to collect the data. The first part addressed patient identification data (gender, age, length of stay), hospitalization variables (use of mechanical ventilation, tracheostomy, severity, diagnosis at admission, outcomes of hospitalization), use of drains and catheters, procedures performed. The second part addressed the drug/antimicrobial ratio and their respective classes.

The medications considered were vasoactive drugs, sedatives/hypnotics, diuretics, antiepileptics, corticosteroids, antiarrhythmics.

According to the Anatomical-Therapeutic-Chemical Classification of the World Health Organization, the antibacterial agents studied in this work correspond to nine therapeutic groups: Tetracyclines, Penicillins, Cephalosporins/Carbapenems, Sulfonamides/Trimethoprim, Macrolides/ Lincosamides, Aminoglycosides, Quinolones, Glycopeptides/Polymyxins/Imidazoles/ Others and Antimycotics for systemic use[27].

To classify the patient's severity, the following standard was used: 1. Stable - requires prophylactic observation of ventilatory and hemodynamic status; 2. Severe stable - changes in vital signs, requires the use of low level of support for maintaining ventilatory, hemodynamic and/or metabolic status, good response to therapy; 3. Severe unstable - changes in vital signs, requires the use of a high level of support for maintaining ventilatory, hemodynamic and/or metabolic status (dialysis) to present the desired response to therapy; 4. Very severe - changes in vital data, requires the use of high level of support for maintaining ventilatory and/ or hemodynamic status; 5. Discharge - patient is in the ICU, but has already been discharged and is waiting for a transfer[28].

Analysis of results and statistics

In this study, quantitative variables such as age and length of stay were analyzed in terms of means and standard deviations. The other classification variables were presented in tables containing absolute (n) and relative (%) frequencies.

The statistical analysis was conducted in two stages, using the Statistical Package for the Social Sciences (SPSS) 21. In the first stage, the variables that showed statistical significance in the univariate analysis ($p<0,20$) and were reported in the literature as potential risk factors for ARF were used to adjust the multiple logistic regression model. Values of $p < 0.05$ (95% CI Confidence Interval) were considered statistically significant.

In the second stage, the double interactions test between exposures included in the multiple model was carried out and the final model was composed only of the main effects of each exposure. In addition, this stage included the association value for predicting the increase in the odds in relation to the dependent variable, based on the knowledge of the relationship with a group of independent variables considered statistically significant.

RESULTS

Based on the inclusion criteria, 122 subjects were selected for the study sample, 61 in each group. Table 1 shows the sociodemographic characteristics of the study participants.

Most participants were male 65 (53.3%), hypertensive 61 (50%) and their diagnosis was classified as other 49 (40.2%), which included: vascular, urinary, hematological systems and trauma, followed by neurological system 43 (35.2%).

The use of mechanical ventilation was predominant in the case group 57 (93.4%), with a statistically significant difference (p=0.0107). It is observed that, in this group, the number of tracheostomies was also higher (13; 10.6%) (p=0.0083).

Regarding the use of invasive devices, the only one that was statistically significant (p=0,0420) was the indwelling bladder catheter, present in all patients in the case group. The participants in this group were also the most severe (p=0.0003), had a higher incidence of death (p=0.0401) and length of hospitals stay almost tripled in relation to the control group, with a statistically significant difference ($p< 0.0001$).

Tables 2 describes the intravenous drugs used by the study participants. Hypnotics/Sedatives and antimicrobials were the most used drugs in both groups, 93 (76.23%) and 88 (72.1), respectively. However, the greater use of antibiotics before the diagnosis of MRSA occurred in the case group (p=0.0435).

It was also observed that 39 (63.9%) patients who developed MRSA used up to two antimicrobials, but this showed no statistically significant difference between the groups (p=4549). The class Glycopeptides/ Polymyxins/Imidazoles/Others was the most used by participants who developed a MRSA infection (p=0.0014).

Table 3 shows the data related to the logistic regression analysis of the variables that were statistically associated with the development of MRSA infection. It is observed that the Very severe state (OR=65.697; CI=3.726–4.808; p=0.0018) and length of stay (OR=1.190;CI=0.952 -1.031; p=0.0285) stood out as risk factors for MRSA infection. The use of antimicrobials was a protective factor (OR= 0.047; CI=0.028-0.122; p=0.0024).

Table 1 – Socio-demographic and clinical characteristics of patients in the case and control groups, Botucatu, São Paulo, Brazil, 2019

Variables	Case n (%)	Control n (%)	Total n (%)	*p* value
Gender				
Female	24 (39.3)	33 (54.1)	57 (46.7)	0.1024
Male	37 (60.7)	28 (45.9)	65 (53.3)	
Diagnosis at admission*				
Neurological	20 (32.7)	23 (37.7)	43 (35.2)	0.7497
Respiratory	19 (31.1)	17 (27.8)	36 (29.5)	0.6914
Cardiological	11 (18.0)	12 (19.7)	23 (18.8)	0.8169
Abdominal	13 (21.3)	11 (18.0)	24 (19.7)	0.6487
Shock	13 (21.3)	9 (14.7)	22 (18.0)	0.3462
Comorbidities**				
Arterial hypertension	34 (55.7)	27 (44.2)	61 (50.0)	0.2250
Diabetes	20 (32.9)	15 (24.6)	35 (28.7)	0.3316
Smoking/ex-smoking	16 (26.2)	21 (34.4)	37 (30.3)	0.3247
Dyslipidemia	8 (13.1)	7 (11.5)	15 (12.3)	0.7828
Hypothyroidism	9 (15)	2 (3.3)	11 (9.0)	0.3992
Heart disease	10 (16.4)	6 (10)	16 (13.2)	0.2299
Gastrointestinal disease	8 (13.1)	3 (4.9)	11 (10.0)	0.1140
Mechanical Ventilation				
Yes	57 (93.4)	47 (77.0)	104 (85.2)	0.0107
No	4 (6.56)	14 (22.9)	18 (14.7)	
Tracheostomy				
Yes	11 (18.0)	2 (3.3)	13 (10.6)	0.0083
No	50 (81.8)	59 (96.7)	60 (89.3)	
Invasive devices				
Central Venous Catheter	53 (86.9)	46 (75.4)	99 (81.1)	0.1052
Peripheral Venous Catheter	48 (78.7)	45 (73.7)	93 (76.2)	0.5234
Invasive Blood Pressure	21 (34.4)	22 (36.1)	43 (35.2)	0.8497
Shiley Catheter	7 (11.4)	6 (11.4)	13 (10.6)	0.7692
Indwelling Urinary Catheter	61 (100.0)	57 (93.4)	118 (96.7)	0.0420
Hemodialysis				
Yes	8 (13.1)	3 (4.9)	11 (7.1)	0.1140
No	53 (86.9)	58 (52.2)	111 (93.9)	
Surgeries				
Yes	41 (67.2)	35 (57.4)	67 (54.9)	0.2312
No	20 (32.8)	26 (42.6)	55 (48.1)	
Severity				
Stable	4 (6.5)	19 (31.1)	23 (18.8)	0.0012
Severe stable	10(16.4)	26 (42.6)	36 (29.5)	0.0029
Severe unstable	12 (19.7)	5 (8.1)	17 (13.9)	0.1167
Very severe	31 (50.8)	11 (18)	42 (34.4)	0.0003
Discharge	4 (6.5)	0 (0)	4 (6.5)	0.0127
Outcome				
Death	45(73.8)	33 (54.1)	78 (63.4)	0.0401
Transfer	14 (23.0)	22 (36.1)	36 (29.5)	0.0567
Discharge	2(3.28)	6 (9.84)	8 (6.5)	1.0000
Mean Age (years) (±SD)	62.8 (±17.6)	64.6 (±19.1)		0.1473
Length of stay (±SD)	21.3 (±16)	8.6 (±8.3)		<0.0001

*Note: * Diagnosis at admission: others: case 18 (36.7%). control 31(63.3%). total 49 (40.2%). p=0.016; **Diagnosis at admission: others: case 37 (58.7%). control 26 (41.3%). total 63 (51.6%). p=0.4066.*

Table 2 – Intravenous drugs used by study participants, Botucatu, São Paulo, Brazil, 2019

Variables	Case n(%)	Control n(%)	Total n(%)	*p* value
Drug Classes				
Vasoactive Drugs	36 (59.0)	38 (62.2)	74 (60.6)	0.7109
Sedatives/Hypnotics	48 (78.6)	45 (73.7)	93 (76.2)	0.5234
Antimicrobials	49 (80.3)	39 (63.9)	88 (72.1)	0.0435
Diuretics	18 (29.5)	13 (21.3)	31 (25.4)	0.2984
Antiepileptics	6 (9.8)	4 (6.5)	10 (8.1)	0.5092
Corticosteroids	11(18.0)	7 (11.4)	18 (14.7)	0.3072
Antiarrhythmics	11(18.0)	12 (19.6)	23 (18.8)	0.8169

To be continued

Table 2 (concluded)

Variables	Case n(%)	Control n(%)	Total n(%)	*p* value
Number of ATM				
Up to 2	39(63.9)	21 (34.4)	60 (49.1)	0.4549
3 to 5	22 (36.7)	18 (29.5)	40(32.7)	0.3317
Class of antimicrobials				
Glycopeptide/Polymyxin/ Imidazole/Derivatives/others	57 (93.4)	23 (37.7)	80(65.5)	0.0014
Penicillin	7(11.4)	14(22.9)	21 (17.2)	0.1013
Quinolones	7(11.4)	5 (8.1)	12 (9.8)	0.5232
Sulfonamide and Trimethropine	1(1.6)	3 (4.9)	4(3.2)	0.3092
Aminoglycosides	1(1.6)	0 (0.0)	1(0.81)	0.3153
Macrolides and Lincosamides	13(21.3)	3(4.9)	16(13.1)	0.6971
Beta-lactams	29 (47.5)	14 (22.9)	43 (35.2)	0.0045

*Note: *ATM – antimicrobials.*

Table 3 – Logistic regression of risk factors associated with the development of Methicillin-resistant Staphylococcus Aureus infection, Botucatu, São Paulo, Brazil, 2019

Variables	OddsRatio	95%CI*		*p* value
Severity (very severe)	65.697	3.726	4.808	0.0018
Antimicrobials	0.047	0.028	0.122	0.0024
Hospitalization days	1.190	0.952	1.031	0.0285

Note: CI= Confidence Interval.

DISCUSSION

In this study, the logistic regression showed that the use of antimicrobials was a protective factor. It should be noted that most patients in the control group received some type of antimicrobial and did not develop a MRSA, corroborating this evidence.

This data must be analyzed in detail case by case, since it is known that the indiscriminate use of antibiotics can increase the patient's resistance to pathogens and decrease the desired therapeutic response later. Once again, the importance of studies addressing specific antimicrobials should be emphasized, as they allow the development of treatment protocols that are more efficient and lead to a better prognosis[9].

Methicillin-resistant Staphylococcus aureus is an important cause of infections worldwide, and an increasingly pressing problem in Latin America[29]. In the clinic, the diagnosis is based on epidemiological information, clinical symptoms and the characterization of the MRSA lineage[30].

In this context, strengthening the surveillance can provide more reliable data, which can contribute to the establishment of protocols that include hospital sectors other than the ICU, reducing the number of patients infected and, consequently, reducing mortality. Therefore, systematic surveillance can be the best way to detect the infection and provide an early treatment, which can avoid worsening of the underlying disease and, consequently, prevent the patient's death.

In this context, it is worth emphasizing the importance of the isolation measures for infected patients, which include hand washing with antiseptics, isolation, use of own materials and subsequent disinfection or disposal, personal protective equipment for professionals, and decolonization measures such as: bathing using chlorhexidine on the body and hair, use of 2% mupirocin where MRSA was isolated, exchange of invasive catheters and monitoring of colonization by the pathogen[31].

However, there are studies showing that the discontinuation of contact precautions for patients with MRSA, along with the daily chlorhexidine bath, is associated with increased MRSA infection[32]. A randomized clinical trial carried out with 45 patients undergoing hip arthroplasty showed that chlorhexidine bathing should be recommended with caution as a strategy to reduce surgical site infection[33].

Health care-associated infections are a serious public health problem because adverse events associated with health care are frequent, lead to high morbidity and mortality, and have a direct impact on patient safety[34].

A recent systematic review that analyzed 21 articles showed that the risk of MRSA infections among burn patients admitted to the ICU is high (55%) and suggest that, in addition to appropriate hand hygiene and adequate wound care while handling these patients, further research should be carried out to identify the risk factors associated with this infection[35].

In this study, most patients who acquired a MRSA infection were male (60.6%) and the mean age was 62.8 years. These data were corroborated in a study conducted in Bogotá with 204 patients who acquired this infection in the ICU[36].

The groups studied showed significant differences in relation to clinical data, such as severity, length of stay and outcome. The rate of MRSA infection among patients considered very severe was 50.8%, which was corroborated in a study carried out in Bogotá, where mortality rate among patients with the infection was 53%, length of stay increased and there was a 70% increase in costs associated with MRSA[36].

MRSA was significantly associated with mortality in patients who developed bacteremia caused by Staphylococcus aureus, as evidenced by a study conducted with 255 episodes *S. aureus* bacteremia[37]. This data was corroborated in a study carried out in a Brazilian university hospital[38], comparing risk factors among patients with MRSA and patients with methicillin-sensitive Staphylococcus aureus infection.

In the present study, the use of MV, tracheostomy and urinary catheter was higher in the group of patients who acquired a MRSA infection. However, this was not a risk factor associated with infection, as evidenced in another study on the theme[38].

A recent study showed that MRSA colonization significantly increases the risk of subsequent MRSA infection. In addition, a significant proportion of infections by this microorganism can occur after hospital discharge[39].

Regarding the antimicrobials used to treat patients with MRSA, there was a high prevalence of the use of Glycopeptide/Polymyxin/Imidazole/Derivatives/others and Beta-lactams in both groups.

The combination of imipenem and vancomycin is widely indicated for the treatment of MRSA. The combination of two antimicrobials was the most prevalent in the present investigation. This finding can be attributed to the limited therapeutic effect of vancomycin used alone in MRSA infections in conjunction with gram-negative bacteria. On the other hand, the association with imipenem broadens the spectrum of antimicrobial action and allows lower doses of vancomycin to be used, which leads to less toxicity and shorter treatment time[40].

Thus, believing that nurses have a primary role in decision-making and promote continuous surveillance, prevention and health promotion actions at all levels of health care, this study can contribute to minimize some risk factors and suggest new approaches that can be implemented to reduce the number of cases of MRSA infection.

However, a study carried out in Nigeria with 80 health professionals showed that, even though knowledge and awareness of infection control among ICU health professionals are good, practice is unsatisfactory. One of the measures was to optimize simple practices, such as hand washing, which has a major impact in the prevention of nosocomial infection[41].

Study limitations

The results of this study reflect the reality of a single intensive care unit of a public hospital, which limits the generalization of the results, despite of the sample size. Lack of records in electronic medical records and absence of patient's severity information were observed. In addition, deaths certificates were not evaluated.

Contributions to the nursing, health or public policy areas

It is believed that the results presented here can support health care practice in the institution where the research was conducted, through the establishment of care protocols for the early detection and prevention of MRSA infections and the development of further multicenter studies.

Furthermore, it can contribute to teaching and research in nursing, as it provides new knowledge and theoretical basis for the multifaceted management of the care required for the prevention of HAIs among critically ill patients in intensive care units.

CONCLUSION

MRSA infection in the ICU is complex and multifactorial. It affects older adults, with urinary catheter, mechanical ventilation and tracheostomy and predisposes to death. It was associated with length of stay and severity of patients.

The use of antimicrobials was a protective factor. In this context, the importance of nurses in continuing education actions, supervision of direct patient care and adequate working conditions are actions to prevent and control this type of infection.

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