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PROFILE OF BLOODSTREAM INFECTIONS IN AN INTENSIVE CARE UNIT FOR COVID-19

PERFIL DAS INFECÇÕES DE CORRENTE SANGUÍNEA EM UNIDADE DE TERAPIA INTENSIVA PARA COVID-19

PERFIL DE INFECCIONES DEL TORRENTE SANGUÍNEO EN LA UNIDAD DE CUIDADOS INTENSIVOS POR COVID-19

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ABSTRACT

Objective: To identify the profile of Bloodstream Infections (BSI) in patients in the Intensive Care Unit (ICU) of a Reference Hospital for COVID-19, in the metropolitan region of Recife - Pernambuco, from January to December in 2021. **Method:** This is a cross-sectional, retrospective, descriptive study, with a quantitative approach, carried out using a database from a microbiological laboratory. **Results:** 24 isolated types of microorganisms were identified, where the highest prevalence was the species *Staphylococcus haemolyticus, followed by the species Staphylococcus epidermidis, Acinetobacter baumannii, Klebsiella pneumoniae and Staphylococcus hominis*. Levofloxacin and linezolid were the most resistant and sensitive antimicrobials, respectively, among the strains. **Conclusion:** The results on the microbiological profile of bloodstream infections in COVID-19-ICUs are of great importance for designing strategies that improve care, preventing complications and injuries to infected patients.

Descriptors: SARS-CoV-2; Bloodstream infection; Intensive care unit.

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RESUMO

Objetivo: Identificar o perfil das Infecções de Corrente Sanguínea (ICS) em pacientes na Unidade de Terapia Intensiva (UTI) de um Hospital de Referência para a COVID-19, na região metropolitana de Recife - Pernambuco, de janeiro a dezembro no ano de 2021. **Método:** Trata-se de um estudo transversal, retrospectivo, descritivo, com abordagem quantitativa, realizado através de um banco de dados de um laboratório microbiológico. **Resultados:** Foram identificados 24 tipos isolados de microrganismos, onde a maior prevalência foi da espécie *Staphylococcus haemolyticus*, seguida das espécies *Staphylococcus epidermidis,* A*cinetobacter baumannii*, *Klebsiella pneumoniae* e *Staphylococcus hominis*. A levofloxacina e a linezolida foram os antimicrobianos mais resistente e sensível, respectivamente, dentre as cepas. **Conclusão:** Os resultados sobre o perfil microbiológico de infecções de corrente sanguínea em UTI-COVID-19 são de grande importância para traçar estratégias que melhorem a assistência, prevenindo complicações e agravos aos pacientes infectados.

Descritores: SARS-CoV-2; Infecção da corrente sanguínea; Unidade de terapia intensiva.

RESUMEN

Objetivo: Identificar el perfil de Infecciones del torrente sanguíneo (ITS) en pacientes internados en la Unidad de Cuidados Intensivos (UCI) de un Hospital de Referencia para COVID-19, en la región metropolitana de Recife - Pernambuco, de enero a diciembre de 2021. **Método:** Se trata de un Estudio descriptivo, transversal, retrospectivo, con enfoque cuantitativo, realizado a partir de una base de datos de un laboratorio microbiológico. **Resultados:** Se identificaron 24 tipos aislados de microorganismos, donde la mayor prevalencia fue la especie *Staphylococcus haemolyticus, seguida de las especies Staphylococcus epidermidis, Acinetobacter baumannii, Klebsiella pneumoniae y Staphylococcus hominis.* Levofloxacina y linezolid fueron los antimicrobianos más resistentes y sensibles, respectivamente, entre las cepas. **Conclusión:** Los resultados sobre el perfil microbiológico de las infecciones del torrente sanguíneo en las UCI-COVID-19 son de gran importancia para diseñar estrategias que mejoren la atención, previniendo complicaciones y lesiones a los pacientes infectados.

Descriptores: SARS-CoV-2; Infección del torrente sanguíneo; Unidad de terapia intensiva.

INTRODUCTION

The outbreak of the new coronavirus, declared as SARS-CoV-2 (Severe Acute Respiratory Syndrome 2) by the International Committee on Taxonomy of Viruses, was quickly spread from China, in Wuhan, to the whole world, being officially declared by the World Health Organization as a pandemic on March 11, 2020.[1] The emergency health impacts arising from the COVID-19 pandemic were so serious that, in June of the same year, the number of cases exceeded 12 million worldwide, with an outcome of death for approximately 6 .7% of patients.[2]

As it is a disease that affects the respiratory system, and can therefore progress seriously to acute respiratory distress syndrome (ARDS), many affected individuals needed to be admitted to the Intensive Care Unit (ICU). This fact

increased the occurrence of infections secondary to COVID-19, such as Bloodstream Infection (BSI).[3] A retrospective cohort study found that half (50%) of the COVID-19 deaths investigated had secondary bacterial infections, such as pneumonia and bloodstream infection.[4,5]

The occurrence of secondary infections alerts us to the need to adopt stricter measures to reduce, control and prevent one of the most serious healthcare-related infections (HAIs), since caring for these patients is more complex given the environment in which they find themselves.[5,6]

Data from an observational study carried out in Turkey from July 2020 to January 2021 demonstrate that, among patients who presented infections secondary to COVID-19 in an ICU, bloodstream infection was the most prevalent (13.2%).[7] The hospital environment, especially the ICU, is very favorable for co-infections and bacterial resistance to antibiotics. This fact may be associated with a greater need for handling invasive devices and maintaining catheters.[8]

Another contributing factor to bacterial resistance are biofilms present in the lumens of central venous catheters (CVC). These colonizing microorganisms, which are structured in an extracellular polymeric substance (EPS), adhere to the surface of the lumens and act as deposits for other pathogenic microorganisms, which are much more resistant due to the larger layer of EPS present. Furthermore, the high doses of antibiotics used to treat these infections can further contribute to bacterial resistance as biofilms can protect pathogens from the effects of medications.[9,10]

In view of the above, this work aimed to identify the profile of bloodstream infections in patients admitted to the intensive care unit of a reference hospital for COVID-19. Its purpose is to support the construction of hospital infection control protocols, where the indicators generated will contribute to decision making, safe and effective action plans for risk management and patient safety, in addition to scientifically elucidating the rational use of antimicrobials as a result of high bacterial resistance.

METHODS

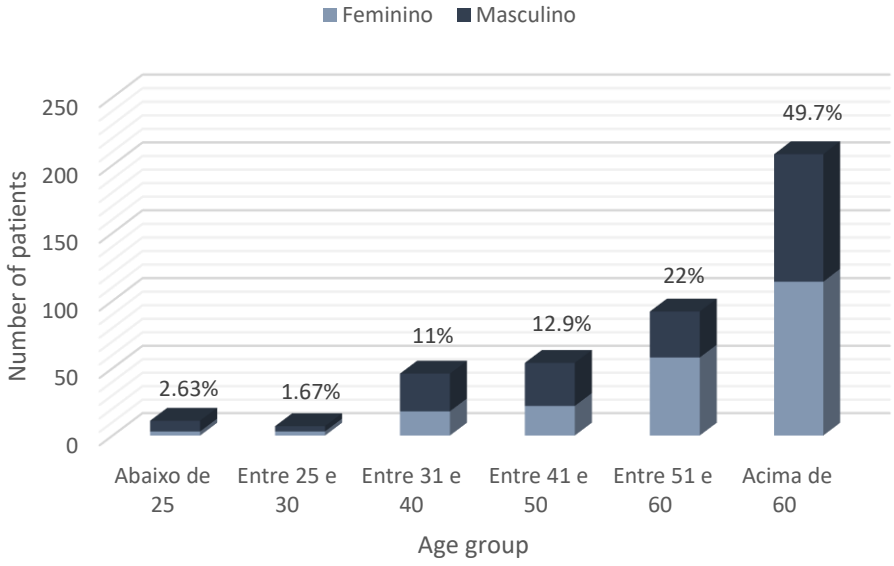
This is a retrospective, descriptive, cross-sectional study with a quantitative approach. The data were obtained from a database from a microbiological analysis laboratory in an Intensive Care Unit for patients with COVID-19 and Bloodstream Infection admitted to a reference hospital in the metropolitan region of Recife-PE.

The database presented information on the age and gender of patients positive for both COVID-19 and ICS; the microorganism detected in blood culture, the antimicrobials tested for treatment, as well as their sensitivity and resistance. The sample was census, with only those patients duplicated in the database being excluded, resulting in 418 patients included in the study. Such data were tabulated in Microsoft Office's Excel 2021 software, analyzed and presented in the form of tables and graphs containing relative and absolute frequencies. The research began only after acquiring the letter of consent and approval from the Research Ethics Committee, with opinion number 5.447.009 and CAAE 58609622.2.0000.5200, respecting the guidelines and standards that regulate research involving human beings in accordance with Resolution CNS 466/2012.

RESULTS

From the analysis of blood culture results, 418 cases of bloodstream infection were identified. Of the patients investigated, 52.15% were female and 47.85% were male. When analyzing the profile of individuals in terms of age group, there was a prevalence of older patients over 60 years old (49.76%), followed by adults between 41 and 60 years old (34.92%). There were no patients under 20 years of age (figure 1).

Figure 1: Profile of patients with Bloodstream Infection admitted to a COVID-19 ICU of a reference hospital in the metropolitan region of Recife-PE, in 2021.



Source: Authors, 2023.

Regarding the material used for collection and blood culture by the microbiological laboratory, there was a division into two main groups (table 1). The first group covers all collections performed through percutaneous puncture and the second group encompasses all collections performed through a central venous catheter (CVC), which also includes those performed through a catheter tip. Only one patient had his material collected through mean arterial pressure (MAP).

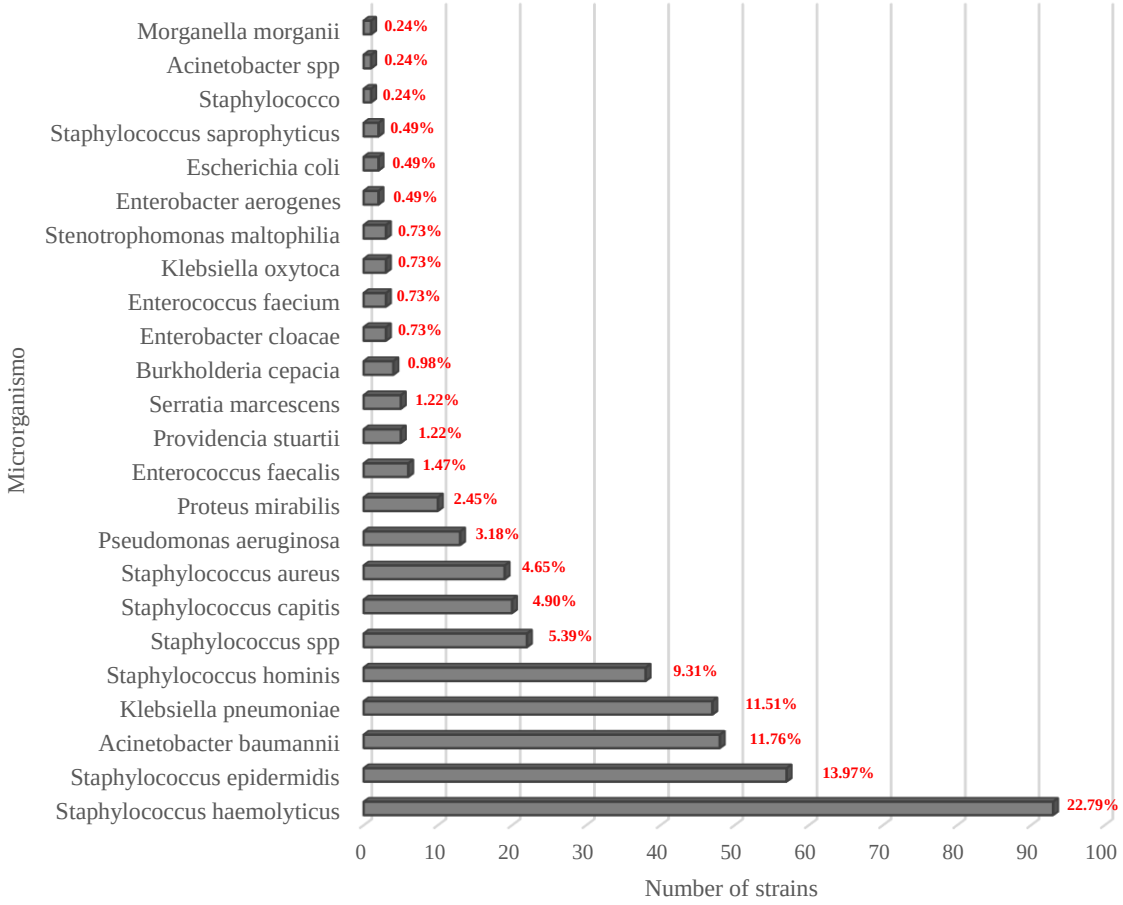
Table 1: Count and percentage of the type of material collected for microbiological analysis of patients with BSI admitted to the ICU-COVID-19, in the year 2021, in a reference hospital in Recife-PE.

Collected material	Number of patients	Percentage
Blood (percutaneous puncture)	272	65.07%
Central venous catheter (CVC)	145	34.69%
PAM	1	0.24%
Grand total	418	100.00%

Source: Authors, 2023.

Of the 418 cases of BSI, the database only found the species of microorganism in 408. During the laboratory analysis, 24 isolated types of microorganisms were identified (graph 1). The highest prevalence was of the species Staphylococcus haemolyticus (22.79%) with a total of 93 strains, followed by the species Staphylococcus epidermidis with 57 strains (13.97%), Acinetobacter baumannii with 48 strains (11.76%), Klebsiella pneumoniae with 47 strains (11.51%) and Staphylococcus hominis with 38 strains (9.31%). In addition to these, one species was found only once in relation to the total number of cases, Morganella morganii (0.24%).

Graph 1: Microbiological profile of the ICU-COVID-19 of a reference hospital in Recife-PE, in 2021.



Source: Authors, 2023.

Regarding treatment, 34 types of antimicrobials were tested to identify the bacterial resistance and sensitivities of the strains. Therefore, it is noted that levofloxacin proved to be more resistant among the strains (78.19%), followed by ciprofloxacin (68.38%), tripetoprim/sulfamethoxazole (68.38%), gentamicin (66.17%) and penicillin (61.27%). In terms of sensitivity, the strains proved to be most sensitive to linezolid (62.25%), followed by vancomycin (61.02%), daptomycin (56.61%) and tetracycline (54.65%), where the first and third were found to be sensitive by all the strains tested (table 2).

Table 2: Profile of bacterial resistance and sensitivities in relation to antimicrobials used in patients with BSI admitted to the COVID-19 ICU, in 2021, in a reference hospital in Recife-PE.

Antimicrobials	Number of strains (%)			
	Sensitive	**Intermediary**	**Resistant**	**Not tested**
Amikacin	11.02%	2.45%	23.03%	0%
Amoxicillin + clavulanic acid	1.22%	0%	6.86%	0%
Ampicillin	1.22%	0%	4.90%	0%
Ampicillin/Sulbactam	0%	0%	1.47%	0%
Aztreonam	1.47%	0.98%	15.68%	0%
Cefepime	3.67%	0.49%	20.83%	0%
Cefotaxime	0.49%	0.24%	16.91%	0%
Ceftazidime	5.14%	0.49%	19.60%	0%
Ceftazidime/Avibactam	0.24%	0%	0%	0%
Ceftolozane/Tazobactam	0.24%	0%	0%	0%
Cefuroxime	0.49%	0%	14.21%	0%
Ciprofloxacin	10.04%	0.49%	68.38%	0%
Clindamycin	7.35%	0%	52.696%	0%
Chloramphenicol	2.20%	0%	11.27%	0%
Colistin	11.27%	0%	0.49%	0.24%
Daptomycin	56.61%	0%	0%	0%
Erythromycin	5.88%	0.49%	53.43%	0.24%
Ertapenem	4.16%	0%	14.70%	0%
High level streptomycin	1.96%	0%	0.24%	0%
Gentamicin	26.96%	3.18%	66.17%	0%
Imipenem	6.37%	0.98%	27.20%	0%
Levofloxacin	12.99%	0.24%	78.18%	0%
Linezolid	62.25%	0%	0%	0%
Meropenem	9.55%	0.24%	27.45%	0%
Norfloxacin	0%	0%	0.24%	0%
Oxacillin	4.16%	0%	55.39%	0%
Penicillin	0.98%	0%	61.27%	0%
Piperacillin + Tazobactam	7.10%	0%	17.15%	0%
Teicoplanin	44.36%	0%	17.89%	0%
Tetracycline	54.65%	0.98%	4.16%	0%
Tigecycline	2.94%	0.98%	0%	0%
Tobramycin	2.45%	0.24%	16.17%	0%
Trimethoprim/Sulfamethoxazole	24.26%	0.49%	68.38%	0%
Vancomycin	61.02%	0%	1.22%	0%

Source: Authors, 2023.

Table 3 shows the resistance and sensitivity profile to some antimicrobials tested in microorganisms with the highest incidence in patients with bloodstream infections in ICU-COVID-19 in the year 2023: *Staphylococcus haemolyticus,*

Staphylococcus epidermidis, Acinetobacter baumannii, Klebsiella pneumoniae and Staphylococcus hominis.

Table 3: Profile of bacterial resistance and sensitivity to some tested antimicrobials.

Staphylococcus haemolyticus		
Antimicrobial	**Sensitive**	**Resistant**
Ciprofloxacin	5%	95%
Clindamycin	4%	96%
Gentamicin	6%	89%
Levofloxacin	4%	96%
Trimethopim + sulfamethoxazole	14%	86%
Staphylococcus epidermidis		
Ciprofloxacin	14%	86%
Clindamycin	11%	89%
Gentamicin	51%	44%
Levofloxacin	14%	86%
Trimethopim + sulfamethoxazole	25%	75%
Acinetobacter baumannii		
Amikacin	8%	90%
Gentamicin	35%	65%
Levofloxacin	2%	96%
Meropenem	2%	98%
Trimethopim + sulfamethoxazole	6%	94%
Klebsiella pneumoniae		
Amikacin	23%	72%
Ciprofloxacin	0%	98%
Gentamicin	4%	96%
Levofloxacin	2%	98%
Meropenem	6%	94%
Staphylococcus hominis		
Ciprofloxacin	34%	63%
Clindamycin	34%	66%
Gentamicin	47%	45%
Levofloxacin	34%	66%
Tetracycline	79%	13%

Source: Authors, 2023.

Regarding the samples investigated, the species Staphylococcus haemolyticus was 96% resistant to clindamycin and levofloxacin and 14% sensitive to

trimethopim + sulfamethoxazole. Staphylococcus epidermidis had 89% of the strains resistant to clindamycin and 51% of them were sensitive to gentamicin. Acinetobacter baumannii reached 98% resistance to meropenem and 35% sensitivity to gentamicin as well. Klebsiella pneumoniae also reached 98% antimicrobial resistance, but unlike the previous one, this resistance occurred to ciprofloxacin and levofloxacin. The greatest sensitivity of this species to the antimicrobials presented in table 3 was 23% to amikacin. And the last species with the highest incidence, Staphylococcus hominis, was also more resistant to ciprofloxacin and levofloxacin, with 66% and more sensitive to tetracycline, with 79%.

DISCUSSION

Hospital Infections (HI) are one of the most significant causes of morbidity and mortality, and are considered a huge global public health problem. Furthermore, they cause social and economic damage, especially in the ICU due to their high degree of complexity.[4] The new coronavirus pandemic further contributed to the increase in the incidence of BSI in patients admitted to the ICU. According to a retrospective study in the United States, central venous catheter BSI rates increased by 51% during the pandemic when compared to the previous year.[6]

This study showed that the largest number of cases of bloodstream infections secondary to COVID-19 mainly affected the elderly population (over 60 years of age), with 208 cases. One of the possible causes would be due to the natural aging process of humans. Thus, physiological functions change proportionally to this process and directly compromise the immune system of individuals, which, combined with the existence of multiple chronic diseases, predisposes this population to different types of infections.[11,12]

Catheter BSIs are the result of intraluminal and extraluminal contamination by microorganisms favored by longer indwelling time and by greater manipulation of the lumens. This fact favors the increase in the incidence of hospital infections, just as a relatively high number of catheter contamination was shown in table 1, due to the imminent risks that patients are subject to in the ICU.[13] Therefore, it is essential to standardize collections of blood culture and adoption of good biosafety practices so that there are no failures in the isolation of pathogens or exposure of both the patient and the healthcare professional to other infectious microorganisms.[14]

Considering the microorganisms responsible for these infections, gram-positive bacteria were more present in this study than gram-negative ones, highlighting the species *Staphylococcus haemolyticus*as as being the most common because since it presents 93 strains, as it is commonly found in the microbiota of human skin and can be easily transmitted during the care provided, confirming the literature found.[15] This microorganism was also the most found in an analysis of 102 blood cultures from an ICU in a Teaching Hospital in Ceará, with a prevalence of 16.7% according to a documentary and epidemiological study. In second place, the species *Staphylococcus epidermidis* stands out with 15.7%, as in the present study.[16]

A retrospective analysis, carried out from April to December 2020 in a COVID-19 ICU at a University Hospital in Greece, showed that the incidence of bloodstream infections was 57%. Of these, the prevalence of gram-negative bacteria (46) was higher when compared to that of gram-positive bacteria (14) and the species *Acinetobacter baumannii, Klebsiella pneumonia* were the most found.[3] Although these species were not the most prevalent in this study, they still present a very significant percentage of bloodstream infections, ranking third and fourth, respectively.

Since the appearance of SARS-CoV-2 indicating a state of emergency in global public health, studies have been carried out in search of a specific pharmacological treatment against COVID-19. Due to the lack of these treatments, a wide range of antimicrobials began to be used in attempts to control and reduce virus contamination. This fact may have been crucial for the increase in antimicrobial resistance, impacting the morbidity and mortality of patients in intensive care units.[17,18]

The increase in the circulation of bacterial strains resistant to various antimicrobials is directly associated with COVID-19, where the percentage of multidrug resistance of bacteria was 45% higher during the pandemic period, from 2020 to 2021.[19] A survey carried out from September to November 2018 in a public hospital in the east of Minas Gerais evaluated the resistance of isolated strains of the species *Staphylococcus haemolyticus* and *Staphylococcus epidermidis*, which presented, respectively, 52.17% and 58.33% resistance to clindamycin. In the present study, the percentage of resistance of these species to this antimicrobial was 96% and 89%. Furthermore, the number of strains resistant to the antibiotics used was almost twice as high as the number of strains that showed some sensitivity, which refers to the increase in multiresistant

pathogens in the face of the SARS-CoV-2 pandemic and the urgent need for measures that lead to the appropriate use of antimicrobials as a result of this problem for global health.

CONCLUSION

The process of identifying the microbiological profile of bloodstream infections in ICU-COVID-19 is extremely important for improving assistance strategies in preventing and reducing complications and injuries to infected patients. It was possible to highlight that most patients, in addition to COVID-19, had Staphylococcus haemolyticus infections that were almost completely resistant to levofloxacin and clindamycin. Furthermore, it was found that the high percentage of BSI due to CVC is still a recurring and worrying problem with regard to hospital infections.

Therefore, it can be said that the COVID-19 pandemic affected the increase in the incidence of bloodstream infections in this Intensive Care Unit. Therefore, this study encourages new research in favor of healthcare and pharmacological improvements, given the high bacterial resistance to the new coronavirus. It is essential to recognize the challenges faced with the emergence of COVID-19 in order to continually seek solutions that reduce this impact on health. Therefore, the information presented should help in the creation of protocols for ICS, as well as indicators for patient safety risk management.

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