PUBLICAÇÃO OFICIAL DO NÚCLEO HOSPITALAR DE EPIDEMIOLOGIA DO HOSPITAL SANTA CRUZ E PROGRAMA
DE PÓS GRADUAÇÃO EM PROMOÇÃO DA SAÚDE - DEPARTAMENTO DE BIOLOGIA E FARMÁCIA DA UNISC

Revista de Epidemiologia e Controle de Infecção

Hospital Santa Cruz

ORIGINAL ARTICLE

Sensitivity profile of blood culture isolates in a clinical analysis laboratory, Fortaleza, CE

Perfil de sensibilidade de isolados de hemocultura em um laboratório de análises clínicas, Fortaleza, CE

Perfil de sensibilidad de hemocultivos aislados en un laboratorio de análisis clínicos, Fortaleza, CE

https://doi.org/10.17058/reci.v12i3.16822

Received: *07/21/2021*
Accepted: *01/28/2022*
Available online: *09/26/2022*

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ABSTRACT

Background and objectives: bacteremia is defined from the presence of bacteria in the bloodstream. Its clinical importance is associated with the high morbidity and mortality rate in the world. In severe cases, it can culminate in sepsis, with a constant increase in cases in Brazil. Therefore, this study aims to assess the main bacterial isolates in blood cultures and a possible change in their sensitivity profiles in a clinical analysis laboratory in Fortaleza, Ceará. **Methods:** an epidemiological, descriptive, retrospective study was carried out, with a quantitative approach of positive blood cultures, seeking to assess the main isolated microorganisms and their sensitivity profiles. The data used were obtained from the laboratory system through the EpiCenter→ software, from January 2019 to December 2020. Statistical analysis was performed using the Graphpad 7.0 software. **Results:** 840 microorganisms were identified from blood cultures, and the main ones were *E. coli, K. pneumoniae, P. aeruginosa, S. epidermidis, S. aureus* and *S. haemolyticus*. Some isolates show a change in the sensitivity profile, such as *K. pneumoniae* and *P. aeruginosa*, showing an increase in sensitivity to carbapenems and cephalosporins, while *S. epidermidis* showed a decrease in sensitivity to minocycline in the comparison between years 2019 and 2020.**Conclusion:** clinical isolates from blood cultures showed a change in the sensitivity profile between 2019 and 2020, taking into account that, for *K. pneumoniae*, *P. aeruginosa*, this change resulted in an increase in sensitivity, with an increase in resistance in *S. epidermidis* isolates.

Keywords*: Bacteremia. Blood Culture. Bacterial Resistance. Sensitivity Profile.*

RESUMO

Justificativa e objetivos: bacteremia é definida a partir da presença de bactérias na corrente sanguínea. Sua importância clínica está associada à alta taxa de morbidade e mortalidade no mundo. Nos casos graves, pode culminar em sepse, com constante aumento dos casos no Brasil. Portanto, o presente estudo tem como objetivo avaliar

Please cite this article as: *Alves Filho, A. L., Medeiros, A. A., Calixto Marques, F. W., & Costa, C. L. (2022). Perfil de sensibilidade de isolados de hemocultura em um laboratório de análises clínicas, Fortaleza, CE. Revista De Epidemiologia E Controle De Infecção, 12(3). https://doi.org/10.17058/reci.v12i3.16822*

os principais isolados bacterianos em hemoculturas e uma possível alteração nos seus perfis de sensibilidade em um laboratório de análises clínicas de Fortaleza, Ceará. **Métodos:** foi realizado um estudo epidemiológico, descritivo, retrospectivo, com abordagem quantitativa de hemoculturas positivas, buscando avaliar os principais microrganismos isolados e seus perfis de sensibilidades. Os dados utilizados foram obtidos a partir do sistema laboratorial através do *software* EpiCenter→, referente ao período de janeiro de 2019 a dezembro de 2020. A análise estatística foi realizada pelo *software* Graphpad 7.0. **Resultados:** foram identificados 840 microrganismos a partir das hemoculturas, sendo os principais *E. coli*, *K. pneumoniae*, *P. aeruginosa*, *S. epidermidis*, *S. aureus* e *S. haemolyticus*. Alguns isolados apresentam uma alteração no perfil de sensibilidade, como *K. pneumoniae* e *P. aeruginosa*, apresentando um aumento na sensibilidade frente aos carbapenêmicos e as cefalosporinas, enquanto o *S. epidermidis* apresentou uma diminuição na sensibilidade frente à minociclina na comparação entre os anos de 2019 e 2020. **Conclusão:** os isolados clínicos de hemocultura apresentaram uma alteração no perfil de sensibilidade entre 2019 e 2020, levando em consideração que, para *K. pneumoniae* e *P. aeruginosa*, essa alteração resultou no aumento na sensibilidade, com aumento na resistência nos isolados de *S. epidermidis*.

Descritores*: Bacteremia. Hemocultura. Resistência Bacteriana. Perfil de Sensibilidade.*

RESUMEN

Justificación y objetivos: la bacteriemia se define por la presencia de bacterias en el torrente sanguíneo. Su importancia clínica está asociada con la alta tasa de morbimortalidad en el mundo. En casos severos, puede culminar en sepsis, con un aumento constante de casos en Brasil. Por tanto, este estudio tiene como objetivo evaluar los principales aislados bacterianos en hemocultivos y un posible cambio en sus perfiles de sensibilidad en un laboratorio de análisis clínicos en Fortaleza, Ceará. Métodos: se realizó un estudio epidemiológico, descriptivo, retrospectivo, con abordaje cuantitativo de hemocultivos positivos, buscando evaluar los principales microorganismos aislados y sus perfiles de sensibilidad. Los datos utilizados se obtuvieron del sistema de laboratorio a través del *software* EpiCenter→, para el período de enero de 2019 a diciembre de 2020. El análisis estadístico se realizó mediante el *software* Graphpad 7.0**. Resultados:** se identificaron 840 microorganismos a partir de hemocultivos, siendo los principales *E. coli, K. pneumoniae, P. aeruginosa, S. epidermidis, S. aureus* y *S. haemolyticus*. Algunos aislados muestran un cambio en el perfil de sensibilidad, como *K.pneumoniae* y *P. aeruginosa*, mostrando un aumento en la sensibilidad a los carbapenémicos y cefalosporinas, mientras que *S. epidermidis* mostró una disminución en la sensibilidad a la minociclina, en la comparación entre los años de 2019 y 2020. **Conclusiones:** los aislados clínicos de hemocultivos mostraron un cambio en el perfil de sensibilidad entre 2019 y 2020, teniendo en cuenta que para *K. pneumoniae*, *P. aeruginosa*, este cambio resultó en un aumento de la sensibilidad, con un aumento de la resistencia en los aislados de *S. epidermidis*.

Palabras clave*: Bacteriemia. Cultura de Sangre. Resistencia Bacteriana. Perfil de Sensibilidad.*

INTRODUCTION

Bacteremia is associated with the presence of bacteria in the bloodstream, which may have a primary (direct entry into the bloodstream via needles, contaminated infusions, catheter, etc.) or secondary origin (from a primary focus of infection, with possible hematogenous or lymphatic spread), having great clinical importance due to the high morbidity and mortality when associated with sepsis,[1] considering the increase in sepsis cases in Brazil.[2] According to the Global Sepsis Alliance (GSA), sepsis can be caused by blood infections, urinary tract infections, lung infections, intestinal infections, and skin infections, being characterized by an inflammatory reaction that affects organs and systems from infections caused by viruses, bacteria, fungi and parasites.[3]

Given the increase in cases of bacteremia and sepsis, blood culture has emerged as the main laboratory methodology for identifying microorganisms, enabling the assessment of the sensitivity profile of clinical isolates.[4,5] The main microorganisms present in bacteremia differ in terms of age. In children, the most reported cases are caused by *Streptococcus pneumoniae, Neisseria meningitidis* and *Haemophilus influenzae*[5]. In adult patients, the most frequent isolates are *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Enterococcus* spp., *S.pneumoniae*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Klebsiella* spp.[6] and *Acinetobacter baumannii*.[7]

The main blood culture isolates show considerable resistance to antibiotics of clinical importance[7]. Thus, it is possible to observe that antimicrobial resistance patterns have been altered and multidrug-resistant bacteria have increased alarmingly, resulting in serious infections with complicated treatments.[8] Antimicrobial resistance is a characteristic that can be intrinsic or acquired horizontally, through the acquisition of resistance genes, or through spontaneous mutations.[9] This resistance is an inevitable evolutionary process,[10] whose species with the highest frequency of antimicrobial resistance are *S. aureus*, *Enterococcus faecium*, *E. faecalis*, *S. pneumoniae*, *E. coli*, *K. pneumoniae*, *P. aeruginosa* and *A. baumannii*.[11] Duval et al (2019) highlight the main multidrug-resistant microorganisms of global importance, such as carbapenem-resistant *A. baumannii*, carbapenem-resistant *P. aeruginosa*, and 3rd generation carbapenem- cephalosporin-resistant *Enterobacterales* (*K. pneumoniae*, *E. coli*,

Enterobacter spp., *Serratia spp.* and *Proteus spp.*).[12]

Identifying the pattern of antimicrobial resistance makes it possible to support empirical treatments,[4] since the release of blood cultures is a slow process, often unable to provide support and rapid therapeutic interventions. As a result, empirical treatment ends up being the only immediate solution, but empirical treatments end up being performed with broad-spectrum antibiotics, harming the patient due to drug toxicity and aiding in the selection of multidrug-resistant microorganisms.[6]

In Brazil, the main bacteria of clinical importance are non-fermenting bacteria, Extended Spectrum Beta-lactamase (ESBL) producing enterobacteria and methicillin-resistant *S. aureus*. Those related to cases of bacteremia are *S. aureus*, coagulase-negative *Staphylococcus*, *Enterococcus spp*, *E. coli* and *Klebsiella spp.*[7] Therefore, the present study aims to assess the main bacterial isolates in blood cultures and a possible change in their sensitivity profiles in a clinical analysis laboratory in Fortaleza, Ceará.

METHODS

This is an epidemiological, descriptive, retrospective study with a quantitative approach of outsourced blood cultures from patients admitted to a tertiary hospital, a reference in Fortaleza, featuring 23 specialties, with 296 beds and eight operating rooms equipped with laminar flow.

This research was carried out taking into account the guarantee of the ethical and legal principles that govern research on human beings, recommended in Resolution 466/2012 of the Brazilian National Health Council (CNS), approved by the Research Ethics Committee, with CAAE (*Certificado de Apresentação para Apreciação Ética* - Certificate of Presentation for Ethical Consideration) 42401920.0.0000.5049.

Samples were collected from January 2019 to December 2020, and analyzed in a clinical analysis laboratory in Fortaleza, Ceará. Patients of both sexes without age restriction who were admitted to the hospital were included.

Patient data was collected in EpiCenter→ system from the laboratory's database, along with software linked to BD Phoenix™, MicroScan and AutoSCAN-4. The results were based on plotting performed in EpiCenter→ software, dividing Gram-positive cocci (GPC) and Gram-negative bacilli (GNB) into groups, selecting the seven main microorganisms isolated from each group and performing the comparison through the elaboration of tables and graphs, demonstrating the total number of microorganisms isolated and analyzing the sensitivity profiles of the three main microorganisms of each group by drug tested. In addition to the aforementioned analyses, the analysis of the amounts of positive blood cultures and contaminants from 2019 and 2020 was carried out. The drugs used to compare the sensitivity profile of GNB and GPC were pre-established according to BrCast, version 9.0 of 2019, valid from 02/04/2019, assessing the minimum inhibitory concentration (MIC) of each drug to the respective identified microorganism.[13]

In the study, all samples of positive blood cultures and confirmed by the responsible laboratory were included. Through microbiological analysis, antimicrobial susceptibility tests were performed, following the standardization institution BrCast, classifying sensitive only the values referring to the usual doses.

The analysis of the sensitivity profile of the classes of antibiotics was performed through the arithmetic mean of the individual percentages of each drug against the species analyzed using Graphpad 7.0. The assessment of the change in antibiotic sensitivity profiles in 2019 and 2020 was compared using the chi-square test with Yates' correction (α= 5%), using Graphpad 7.0, considering an increase or decrease in sensitivity if p-value is above 0.05.

RESULTS

During the research period, 840 microorganisms isolated from blood cultures of patients admitted to a tertiary hospital from January 2019 to December 2020 were identified.

In 2019, 64% (254/397) GNB and 36% (143/397) GPC were isolated from blood cultures. In 2020, 43.3% (192/443) GNB and 56.6% (251/443) GPC were isolated. The main isolates from the GNB group in 2019 were *E. coli*, 34.6% (88/254) *K. pneumoniae*, 29.1% (74/254), and *P. aeruginosa*, 18.5% (47/254). The main GPC isolates in 2019 were *S. epidermidis*, 39.8% (57/143), *S. aureus*, 24.4% (35/143), and *S. haemolyticus*, 12.6% (18/143).

In 2020, the main GNB isolates were *E. coli*, 31.2% (60/192), *K. pneumoniae*, 26.5% (51/192) and *P. aeruginosa*, 23% (44/192), while those of GPC were *S. epidermidis*, 51.4% (129/251), *S. haemolyticus*, 19.5% (49/251), and *S. hominis*, 13.5% (34/251), showing a change in prevalence between 2019 and 2020.

In 2019, the main GNB isolates showed the following sensitivity profiles: *E. coli* showed lower sensitivity to sulfonamides (53.85%), monobactams (58.82%) and penicillin (62.01%); *K. pneumoniae* showed lower sensitivity to phosphomycin (0%), to monobactams (58.82%) and to penicillin (34.09%); *P. aeruginosa* was less sensitive to phosphomycin (0%), glycylcycline (0%) and sulfonamides (0%). While GPC isolates showed the following sensitivity profile: *S. epidermidis* showed lower sensitivity to cephalosporins (7.78%), penicillin (15.05%) and quinolones (39.09%); *S. aureus* showed lower sensitivity to penicillin (41.03%), cephalosporins (72.92%) and quinolones (92.68%); and *S. haemolyticus* showed lower sensitivity to penicillin (16.67%), cephalosporins (33.33%) and aminoglycosides (37.50%) (Table 1).

In 2020, the main GNB isolates showed the following sensitivity profiles: *E. coli* showed lower sensitivity to monobactams (57.14%), penicillin (57.97%) and sulfonamides (59.38%); *K. pneumoniae* showed lower sensitivity to penicillin (46.43%), to monobactams (62.50%) and to sulfonamides (62.96%); *P. aeruginosa* showed lower sensitivity to phosphomycin (0%), sulfonamides (0%) and glycylcycline (6.25%). In GPC isolates, *S. epidermidis* showed a lower sensitivity to penicillin (17.70%), quinolones

(38.07%) and sulfonamides (38.61%); *S. aureus* showed a lower sensitivity to penicillin (75.76%); and *S. haemolyticus* showed lower sensitivity to penicillin (8.14%), quinolones (25.74%) and aminoglycosides (32.43%). (Table1).

Comparative assessment of the change in sensitivity profile was observed for the main GNB and GPC isolates from blood cultures, from January 2019 to December 2020. As for GNB, *E. coli* isolates showed a decrease in their percentage of sensitivity to amikacin, amoxicillin-clavulanate, aztreonam, cefuroxime, ciprofloxacin, phosphomycin with G6P, gentamicin levofloxacin and tigecycline. However, no statistical difference was observed in susceptibility in the other antibiotics tested. *K. pneumoniae* isolates showed a percentage increase in the susceptibility of their isolates, comparing the two years, as 2019 isolates are less susceptible to the antibiotics tested. A change was observed in the susceptibility of *K. pneumoniae* to cefazolin (p=1.14), cefepime (p=0.39), ceftazidime (p=0.20), ceftriaxone (p=0.56), ertapenem (p=0.10), gentamicin (p=3.36), imipenem (p=2.34), meropenem (p=1.91), tigecycline (p=0.09), all representing an increase in sensitivity when compared to the years 2019 and 2020. *P. aeruginosa* isolates showed a decrease in the percentage of their sensitivity to amikacin and aztreonam (Table 2). A change in the susceptibility of *P. aeruginosa* to imipenem (P=3.54) was observed, representing an increase in sensitivity when compared to the years 2019 and 2020.

GPC isolates such as *S. epidermidis* demonstrated a percentage decrease in sensitivity to ciprofloxacin, clindamycin, erythromycin, levofloxacin, minocycline, oxacillin, rifampicin and trimethopim-sulfamethoxazole. A change in the susceptibility of *S. epidermidis* to minocycline was observed (p=0.01), representing a decrease in sensitivity when compared to the years 2019 and 2020. *S. aureus* isolates showed a decrease in sensitivity to clindamycin and erythromycin. An alteration was observed in the susceptibility of *S. aureus* to penicillin G (p=3.41), representing an increase in sensitivity when compared to the years 2019 and 2020. *S. haemolyticus* isolates showed a decrease in the percentage sensitivity to amoxicillin-clavulanate, ampicillin-sulbactam, ceftriaxone, ciprofloxacin, clindamycin, chloramphenicol, levofloxacin, rifampicin and trimethoprim-sulfamethoxazole. However, no statistical difference was observed in susceptibility in other antibiotics tested (Table 3).

The rate of positivity and contaminants in blood cultures is variable when comparing 2019 and 2020. In 2019, 4% (10/233) of the isolates were contaminants and 95% (223/233) were blood cultures confirmed as positive. In 2020, 16% (49/309) of the isolates were contaminants and 84% (260/309) were blood cultures confirmed as positive.

Table 1. Sensitivity rate to the classes of antibiotics used for Gram-negative and Gram-positive bacilli, compared to the main isolates from blood cultures in 2019 and 2020.

				Antimicrobial sensitivity rate (%) (2019)						
Microorganisms	**Penicillin**	**Cephalosporins**	**Carbapenems**	**Aminoglycosides**	**Quinolones**	**Sulphonamides**	**Glycycycline**	**Monobactam**	**Phosphomycin**	**Glycopeptide**
Gram-negative	39.13%	44.47%	65.38%	67.69%	62.84%	32.11%	53.31%	52.54%	33.33%	-
E. coli	62.01%	72.3%	98.29%	82.35%	69.23%	53.85%	100%	58.82%	100%	-
K. pneumoniae	34.09%	34.74%	62.39%	52.28%	52.06%	42.47%	56.94%	23.81%	0%	-
P. aeruginosa	21.28%	26.38%	35.46%	68.44%	67.22%	0%	0%	75.00%	0%	-
Gram-positive	24.25%	38.01%	100%	67.55%	59.13%	67.02%	-	-	-	98.17%
S. epidermidis	15.05%	7.78%	100%	68.00%	39.09%	44.00%	-	-	-	95.94%
S. aureus	41.03%	72.92%	100%	97.14%	92.68%	97.06%	-	-	-	98.57%
S. haemolyticus	16.67%	33.33%	100%	37.50%	45.63%	60.00%	-	-	-	100%
				Antimicrobial sensitivity rate (%) (2020)						
Microorganisms	**Penicillin**	**Cephalosporins**	**Carbapenems**	**Aminoglycosides**	**Quinolones**	**Sulphonamides**	**Glycycycline**	**Monobactam**	**Phosphomycin**	**Glycopeptide**
Gram-negative	44.12%	56.85%	79.94%	81.17%	71.82%	40.78%	65.44%	61.31%	55.30%	-
E. coli	57.97%	73.25%	100%	87.12%	62.13%	59.38%	96.00%	57.14%	90.91%	-
K. pneumoniae	46.43%	67.15%	89.29%	69.64%	67.86%	62.96%	93.75%	62.50%	75.00%	-
P. aeruginosa	27.96%%	30.15%	50.54%	86.76%	85.49%	0%	6.25%	64.29%	0%	-
Gram-positive	33.87%	72.18%	100%	68.42%	54.60%	61.44%	-	-	-	99.38%
S. epidermidis	17.70%	62.00%	100%	72.82%	38.07%	38.61%	-	-	-	99.48%
S. aureus	75.76%%	100%	100%	100%	100%	100%	-	-	-	100%
S. haemolyticus	8.14%	54.55%	100%	32.43%	25.74%	45.71%	-	-	-	98.65%

Please cite this article as: *Alves Filho, A. L., Medeiros, A. A., Calixto Marques, F. W., & Costa, C. L. (2022). Perfil de sensibilidade de isolados de hemocultura em um laboratório de análises clínicas, Fortaleza, CE. Revista De Epidemiologia E Controle De Infecção, 12(3). https://doi.org/10.17058/reci.v12i3.16822*

Table 2. Comparison of antimicrobial susceptibility profiles of the main Gram-negative bacilli (GNB) isolated from blood cultures, between 2019 and 2020.

	% S E. Coli		*%S K. Pneumoniae*		*%S P. Aeruginosa*	
Antibiotics	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**
Amicacin	98.72%(77/78)	96.97%(32/33)	76.71%(56/73)	89.29%(25/28)	85.11%(40/47)	83.87%(26/31)
Amoxicillin-clavulanate	64.71%(11/17)	42.86%(3/7)	35.00%(7/20)	50.00%(4/8)	0.00%(0/1)	
Ampicillin	35.90%(28/78)	37.50%(12/32)	0.00%(0/72)	0.00%(0/27)	0.00%(0/35)	0.00%(0/16)
Ampicillin-sulbactam	48.72%(38/78)	54.55%(18/33)	24.66%(18/73)	46.43%(13/28)	0.00%(0/35)	0.00%(0/16)
Aztreonam	58.82%(10/17)	57.14%(4/7)	23.81%(5/21)	62.50%(5/8)	75.00%(9/12)	64.29%(9/14)
Cefazolin	72.13%(44/61)	76.92%(20/26)	31.91%(15/47)	73.33%(11/15)	0.00%(0/35)	0.00%(0/15)
Cefepime	75.32%(58/77)	72.73%(24/33)	36.99%(27/73)	71.43%(20/28)	61.70%(29/47)	77.42%(24/31)
Cefotaxime	68.75%(11/16)	71.43%(5/7)	31.82%(7/22)	50.00%(4/8)		
Cefoxitin	79.22%(61/77)	81.82%(9/11)	45.83%(33/72)	70.00%(7/10)	0.00%(0/35)	0.00%(0/16)
Ceftazidime	71.43%(55/77)	75.76%(25/33)	33.33%(24/72)	70.37%(19/27)	70.21%(33/47)	73.33%(22/30)
Ceftriaxone	70.49%(43/61)	76.92%(20/26)	36.00%(18/50)	77.78%(14/18)	0.00%(0/35)	0.00%(0/15)
Cefuroxime	68.75%(11/16)	57.14%(4/7)	27.27%(6/22)	57.14%(4/7)		
Ciprofloxacin	69.23%(54/78)	57.58%(19/33)	47.95%(35/73)	67.86%(19/28)	72.74%(34/47)	87.10%(27/31)
Ertapenem	97.44%(76/78)	100.00%(33/33)	60.27%(44/73)	89.29%(25/28)	0.00%(0/35)	0.00%(0/16)
Phosphomycin with G6P	100.00%(2/2)	90.91%(20/22)	0.00%(0/3)	75.00%(15/20)	0.00%(0/7)	
Gentamicin	91.03%(71/78)	90.91%(30/33)	56.94%(41/72)	82.14%(23/28)	70.21%(33/47)	80.65%(25/31)
Imipenem	98.72%(77/78)	100.00%(3333)	63.89%(46/72)	89.29%(25/28)	51.06%(24/47)	77.42%(24/31)
Levofloxacin	69.23%(54/78)	66.67%(22/33)	56.16%(41/73)	67.86%(19/28)	61.70%(29/47)	83.87%(26/31)
Meropenem	98.70%(76/77)	100.00%(33/33)	63.01%(46/73)	89.29%(25/28)	55.32%(26/47)	74.19%(23/31)
Piperacillin-tazobactam	96.15%(75/78)	100.00%(33/33)	52.05%(38/73)	71.43%(20/28)	68.09%(32/47)	80.00%(24/30)
Tigecycline	100.00%(78/78)	96.00%(24/25)	56.94%(41/72)	93.75%(15/16)	0.00%(0/35)	6.25%(1/16)
Tobramycin	82.35%(14/17)	83.33%(5/6)	47.62%(10/21)	57.14%(4/7)	66.67%(8/12)	92.86%(13/14)
Trimethoprim-sulfamethazole	53.85%(42/78)	59.38%(19/32)	42.47%(31/73)	62.96%(17/27)	0.00%(0/35)	0.00%(0/2)

Note: The main results of the minimum inhibitory concentration were cefazolin (≤ 4), cefepime (≤ 0.125), ceftazidime (≤ 0.5), gentamicin (≤ 2), imipenem (≤ 1), meropenem (≤ 0.125) and tigecycline (≤ 2), for K. pneumoniae, and imipenem (≤ 4), for P. aeruginosa.

Table 3. Comparison of antimicrobial susceptibility profiles of the main Gram-positive cocci (GPC) isolated from blood cultures, between 2019 and 2020.

	%S S. Epidermidis		*%S S. Aureus*		*%S S. Haemolyticus*	
Antibiotics	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**
Amoxicillin-clavulanate	22.58% (7/31)	24.00% (12/50)	61.54% (8/13)	100.00% (7/7)	25.00% (1/4)	9.09% (2/22)
Ampicillin	0.00% (0/44)	5.10% (5/98)	0.00% (0/26)	27.27% (3/11)	0.00% (0/14)	6.25% (2/32)
Ampicillin-sulbactam	22.58% (7/31)	24.00% (12/50)	61.54% (8/13)	100.00% (7/7)	25.00% (1/4)	9.09% (2/22)
Ceftaroline	23.33% (7/30)	100.00% (9/9)	87.50% (14/16)	100.00% (4/4)		100.00% (5/5)
Ceftriaxone		24.00% (12/50)	58.33% (7/12)	100.00% (7/7)	33.33% (1/3)	9.09% (2/22)
Ciprofloxacin	42.00% (21/50)	34.95% (36/103)	90.91% (30/33)	100.00% (11/11)	31.25% (5/16)	29.73% (11/37)
Clindamycin	38.64% (17/44)	33.33% (32/96)	50.00% (16/32)	27.27% (3/11)	31.25% (5/15)	30.56% (11/36)
Chloramphenicol	88.89% (16/18)	95.83% (46/48)	100.00% (16/16)	100.00% (4/4)	90.91% (10/11)	84.62% (11/13)
Daptomycin	100.00% (48/48)	100.00% (101/101)	100.00% (33/33)	100.00% (11/11)	100.00% (16/16)	100.00% (36/36)
Erythromycin	30.00% (15/50)	17.48% (18/103)	33.33% (11/33)	27.27% (3/11)	0.00% (0/16)	21.62% (8/37)
Gentamicin	68.00% (34/50)	72.82% (75/103)	97.14% (34/35)	100.00% (11/11)	37.50% (6/16)	32.43% (12/37)
Levofloxacin	41.94% (13/31)	41.18% (21/51)	94.44% (17/18)	100.00% (7/7)	60.00% (3/5)	21.74% (5/23)
Linezolid	98.00% (49/50	100.00% (102/102)	97.06% (33/34)	100.00% (11/11)	100.00% (16/16)	100.00% (37/37)
Minocycline	100.00% (19/19)	45.83% (22/48)	100.00% (16/16)	100.00% (3/3)	100.00% (11/11)	100.00% (9/9)
Oxacillin	24.00% (12/50)	20.39% (21/103)	77.14% (27/35)	81.82% (9/11)	18.75% (3/16)	21.62% (8/37)
Penicillin G	2.22% (1/45)	3.06% (3/98)	0.00% (0/26)	27.27% (3/11)	0.00% (0/14)	3.13% (1/32)
Rifampicin	98.00% (49/50)	93.75% (90/96)	91.43% (32/35)	100.00% (11/11)	62.25% (10/16)	51.52% (17/33)
Teicoplanin	93.88% (46/49)	98.96% (95/96	100.00% (33/33)	100.00% (11/11)	100.00% (16/16)	97.30% (37/37)
Tetracycline	93.55% (29/31)	96.08% (49/51)	82.35% (14/17)	100.00% (7/7)	40.00% (2/5)	95.65% (22/23)
Tigecycline	44.00% (22/50)	100.00% (52/52)	100.00% (16/16)	100.00% (4/4)		100.00% (13/13)
Trimethoprim-sulfamethoxazole		38.61% (39/101)	97.06% (33/34)	100.00% (11/11)	60.00% (9/15)	45.71% (16/35)
Vancomycin	98.00% (49/50)	100.00% (103/103)	97.14% (34/35)	100.00% (11/11)	100.00% (16/16)	100.00% (37/37)

Note: the main results of the minimum inhibitory concentration were minocycline (≤ 0.25), for S. epidermidis, and penicillin G (≤ 0.125), for S.aureus.

DISCUSSION

In a study carried out with six hospitals in Cascavel, Paraná, it was observed that the main microorganisms isolated in blood cultures were *S. aureus* (17.94%), *S. epidermidis* (16.26%), *K. pneumoniae* (14.52%), *E. coli* (8.97%), *A. baumannii* (8.81%) and *P. aeruginosa* (8.32%).[14]

In another study carried out at the *Hospital das Clínicas* of the *Universidade Federal de Pernambuco* (UFPE), Recife, it was identified that 57.64% of the blood culture isolates were Gram-positive bacteria, while 42.36% were Gram--negative bacteria. The main isolates were *S. aureus* (21.62%), coagulase negative Staphylococcus (20.54%), *K. pneumoniae* (9.72%), *E. coli* (7.56%) and *A.baumannii* (6.48%).[15]

In a study carried out in a tertiary hospital in Minas Gerais, it was shown that 40.6% of those isolated were *S. epidermidis*, 17.2%, *S. aureus*, 7.8%, *Enterobacter spp.* and 6.3% of *Pseudomonas spp.*[16] These studies are similar to what was found in the present study, in 2020, in which the main isolates were *S. epidermidis* (29.12%), *E. coli* (13.54%), *K. pneumoniae* (11, 51%), *S. haemolyticus* (11.06%), *P. aeruginosa* (9.93%) and *S. hominis* (7.67%).

It is possible to observe, considering the analyzed studies, that Gram-negative isolates showed resistance against ampicillin-sulbactam, ceftazidime, ciprofloxacin and levofloxacin. *K. pneumoniae* isolates are less sensitive to aztreonam, cefepime, ceftriaxone, ceftazidime, ciprofloxacin; *E. coli* showed a lower percentage of sensitivity to cefazolin and cefepime; and *P. aeruginosa* had a lower percentage of sensitivity to polymyxin b, ceftazidime and aztreonam.[15] Another study shows that the isolates belonging to the GPC group showed the following sensitivity pattern: 15.4% of *S. epidermidis* are sensitive to oxacillin; 92.3% are sensitive to vancomycin; 92.3 and 27.3% of *S. aureus* are sensitive to oxacillin; and 100% are sensitive to vancomycin.[16]

There is a divergence of data when we compare the assessment of this sensitivity profile of the main isolates, with only the data observed for the GPC group and, individually, for *S. epidermidis* and *S. aureus* agreeing. This divergence regarding the sensitivity profile may occur due to the difference in date between the works and due to the state of study of each work.

Some of the data cited may represent an analytical error in the laboratory or an error in sending the results to the software, as in the case of vancomycin-resistant *S. aureus*, isolated in 2019, and tigecycline-sensitive *P. aeruginosa*.

Clinical isolates from blood cultures showed a change in the sensitivity profile between 2019 and 2020. The sensitivity percentage assessment is changed according to the microorganism in question.

In GNB, when analyzing *E. coli*, it is possible to infer an increase in resistance against penicillin, monobactams, quinolones and phosphomycin, while *P. aeruginosa* shows an increase in resistance against monobactams, and *K. pneumoniae* showed a decrease in the resistance of their isolates, considering that all 2019 isolates are more resistant than those of 2020. While in GPC, *S. epidermidis* isolates show a considerable increase in their resistance against quinolones, macrolides, lincosamines and against a tetracycline (minocycline). *S. aureus* isolates showed an increase in sensitivity, given that the 2019 isolates were more resistant. In contrast, *S. haemolyticus* isolates showed increased resistance against penicillin, quinolones, lincosamines, amphenicols and macrolides.

The change in the sensitivity profile of the main clinical isolates from blood cultures is broad, taking into account that, for some species, this change resulted in an increase in the sensitivity of these isolates. In contrast, the species, with an increase in resistance observed, were against antibiotics of extreme clinical importance, resulting in the use of more potent broad-spectrum antibiotics.

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AUTHORS' CONTRIBUTIONS

André Luis Almeida Alves Filho contributed to article conception, design, analysis and writing; **Alexandre Amaral Medeiros** contributed to data statistical analysis through the GraphPad Software. **Francisco Wallyson Calixto Marques** contributed to the analysis of blood cultures assessed at the Clinical Analysis Laboratory in Fortaleza, Ceará. **Cecília Leite Costa** contributed to article planning, design, review and final approval.

All authors have approved the final version to be published and are responsible for all aspects of the work, including ensuring its accuracy and integrity.