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ORIGINAL ARTICLE

Bacterial microorganisms isolated in blood cultures of patients in a tertiary care hospital

Microorganismos bacterianos aislados en hemocultivos de pacientes en un hospital de tercer nivel de atención

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Abstract

Background: *Bacteremia is defined as the presence of bacteria in the blood and is a main risk factor for the development of sepsis and septic shock.* **Objective**: *Describe the isolated microorganisms, sensitivity, and resistance in patients from a tertiary hospital of the Mexican Social Security Institute in Puebla, Mexico.* **Materials and methods**: *A descriptive, cross-sectional, retrospective study was carried out in patients with blood culture records from July 2020 to June 2023. Records from the "R.E.A.L." computer laboratory management system were consulted. The following were evaluated: number of blood culture samples, isolated microorganisms, resistance, and medical area. For the resistance analysis, blood cultures from the ESKAPE group and coagulase-negative Staphylococcus spp were considered; subsequently, analysis was performed using the WHONET platform. Descriptive statistics were used for the rest of the analysis.* **Results**: *A total of 974 blood culture studies with isolates were identified; 512 (52.56%) corresponded to male patients and 462 (47.44%) to female patients. There were 704 (72.27%) blood cultures, whose isolated germs correspond to the ESKAPE group, and those with isolates > 15 microorganisms.* **Conclusions:** *The most frequently identified microorganism was Escherichia coli, followed by Staphylococcus epidermidis and Staphylococcus hominis. The hospital area with the highest number of blood culture isolates was the medical area.*

Keywords: *Bacteremia. Microorganisms. Bacterial resistance. Blood cultures.*

Resumen

Antecedentes: *La bacteriemia se define como la presencia de bacterias en sangre, y es un factor de riesgo principal para desarrollo de sepsis y choque séptico.* **Objetivo**: *Describir los microorganismos aislados, sensibilidad y resistencia en pacientes de un hospital de tercer nivel del Instituto Mexicano del Seguro Social en Puebla, México.* **Material y métodos**: *Se realizó un estudio descriptivo, transversal, retrospectivo, en pacientes con registros de hemocultivos de julio de 2020 a junio de 2023. Se consultaron registros del sistema informático de gestión de laboratorio "R.E.A.L.". Se evaluó: número de muestras de hemocultivo, microorganismos aislados, resistencia y área médica. Para el análisis de resistencia se consideraron hemo-*

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cultivos del grupo ESKAPE y Staphylococcus spp coagulasa negativos, posteriormente se realizó análisis mediante la plataforma WHONET. Para el resto del análisis se utilizó estadística descriptiva. **Resultados***: Se identificaron 974 estudios de hemocultivo con aislamientos; 512 (52.56%) correspondieron a pacientes del sexo masculino y 462 (47.44%) al sexo femenino. Se registraron 704 (72.27%) hemocultivos, cuyos gérmenes aislados corresponden al grupo ESKAPE y aquellos con aislamientos mayores de 15 microrganismos.* **Conclusiones***: El microrganismo más frecuentemente identificado fue Escherichia coli, seguido de Staphylococcus epidermidis y Staphylococcus hominis. El área hospitalaria con mayor número de aislamientos en sus hemocultivos fue el área médica.*

Palabras clave: *Bacteremia. Microorganismos. Resistencia bacteriana. Hemocultivos.*

Introduction

Bacteremia or bloodstream infection is defined as the presence of bacteria in the blood and is a major risk factor for the development of sepsis and septic shock (associated in up to 95%) and contributes to substantial morbidity and mortality[1,2].

In these cases, the key to initial treatment is rapid restoration of blood perfusion and adequate antibiotic administration. The empirical choice of antibiotic is based on local prevalence and resistance patterns, and its administration is preferable within the 1st hour once the diagnosis is established[3].

Sepsis is an infection associated with organ injury distant from the site of infection. Septic shock is established when a patient with sepsis presents with hypotension refractory to fluid resuscitation and requires vasopressors, and the risk of death increases substantially[4,5].

In high-income countries, up to 31.5 million cases of sepsis are reported, of which 19.4 million are severe sepsis, causing approximately 5.3 million deaths annually. Information on the incidence and mortality of sepsis in middle- and low-income countries is scarce and varies across regions depending on factors such as population, etiological agents, and socioeconomic level[4].

The case series differs greatly depending on the primary site of infection, specific populations, pathogens, antibiotic resistance, and geographic region. *Escherichia coli* is the most frequent causative microorganism of sepsis worldwide, while in South Korea, S*taphylococcus aureus* and *Klebsiella pneumoniae* are more common. This highlights the importance of having local epidemiological studies[6].

Blood culture is the study of choice for diagnosing bacteremia and septicemia, as it allows the identification of the etiology, which is vital for optimizing therapy[7,8].

A good collection technique that yields excellent sample quality is vital for obtaining reliable results. Inappropriate antibiotic therapy is associated with higher mortality. When implemented appropriately and early, it reduces mortality, days of hospitalization, and hospital costs, and avoids the inappropriate use of antibiotics even in severe bacterial infections. Therefore, emergency broad-spectrum empirical antibiotic therapy should be confirmed or rectified when microbiological data are available[1,9-11].

The objective of this study was to describe the isolated microorganisms and their sensitivity and resistance patterns in patients from a tertiary care hospital of Instituto Mexicano del Seguro Social in Puebla, Mexico.

Material and methods

We conducted a descriptive, cross-sectional, retrospective study of patients with blood culture records from July 2020 through June 2023 in a tertiary care center of Instituto Mexicano del Seguro Social in Puebla, Mexico.

At the study hospital, the personnel who obtain blood culture samples are trained previously and periodically on the collection technique including the use of protective equipment (gloves and masks), aseptic and antiseptic technique of the collection area and the blood culture bottle cap, collection of the required blood volume, and incubation of the sample.

The records of the microbiology laboratory management computer system "R.E.A.L." were consulted. The following were evaluated: number of blood culture samples per patient, isolated microorganisms, bacterial susceptibility or resistance, and the medical area in which the patients were hospitalized. For the antimicrobial resistance analysis, blood cultures belonging to the ESKAPE group and coagulase-negative *Staphylococcus* spp. (CNS) were considered. Once the data segmentation was performed, an analysis was carried out using the WHONET platform considering one isolate per patient; and generating a report of the percentage of antibiotic resistance with the division of relevant

antibiotics for Gram-positive and Gram-negative microorganisms. Descriptive statistics were used for the rest of the analysis.

Results

A total of 974 blood culture studies with microorganism isolation were identified during the study period; 512 (52.56%) from male patients and 462 (47.44%) from female patients.

Regarding the hospital areas where the samples were taken, 4 areas were recorded: 582 (59.75%) studies from the medical area (internal medicine, pediatrics, hematology, etc.), 177 (18.17%) from the surgical area (general surgery, oncological surgery, neurosurgery, etc.), 166 (17.04%) patients from the critical care area (ICU, ED, COVID area), and 49 (5.04%) from other or unspecified services. A total of 704 (72.27%) blood cultures whose isolated germs corresponded to the ESKAPE group and with isolations of more than 15 microorganisms were recorded; these microorganisms were considered of epidemiological importance for the unit (importance group). The details of the results are shown in Table 1.

The percentage of resistance by isolated microorganism of the Gram group is shown in Tables 2 and 3. In the case of the Gram-positive group, a higher percentage of resistance to erythromycin is observed; in the Gram-negative group, a higher percentage of resistance to ciprofloxacin is observed. The most frequently isolated microorganisms by the hospital area are presented in Table 4.

Table 1. Frequency of isolated microorganisms, Gram stain, and group

Microorganism	Isolates	Gram stain	Group
Escherichia coli	193	Gram -	ESKAPE
Staphylococcus epidermidis	184	Gram +	Importance for the unit
Staphylococcus hominis	98	Gram +	Importance for the unit
Klebsiella pneumoniae	67	Gram -	ESKAPE
Staphylococcus haemolyticus	54	Gram +	Importance for the unit
Staphylococcus aureus	39	Gram +	ESKAPE
Pseudomonas aeruginosa	37	Gram -	ESKAPE
Acinetobacter baumannii	17	Gram -	ESKAPE
Enterococcus faecium	15	Gram +	ESKAPE
Total	704		

Gram -: Gram-negative; Gram +: Gram-positive.

Discussion

The diagnosis of bacteremia can be crucial when deciding the treatment of at-risk patients, and correct and timely management makes a difference in the patient's outcome. Therefore, in patients who present with syndromes associated with a moderate probability of bacteremia, blood cultures are justified if there is no option for culture from the primary site of infection[12].

The blood culture sample must be obtained correctly and before the start of any antibiotic in the patient. On the other hand, errors in the sample are usually: single sample (2-3 samples are recommended), insufficient volume, inadequate collection and processing method[13,14]. Greater contamination has been demonstrated if the collection site comes from catheters versus samples taken by peripheral venipuncture, with the exception of a sample from a newly inserted catheter[15]. At the hospital where this work was carried out, care is taken with the sample collection technique, with frequent and periodic training of those who take it (laboratory technicians, nurses, residents, etc.).

The lack of bacterial growth in blood culture studies is associated with problems in the sample collection technique (contamination, insufficient blood volume, etc.), and the fact that the patient has previously received some antimicrobial treatment[12,16]. In this work, the 35 blood cultures that did not show microorganism growth suggest one of these problems. The World Health Organization considers a list of antibiotic-resistant bacteria as a priority for the research of new drugs. This list is called "ESKAPE" for the acronym of the critically prioritized bacteria included (*Acinetobacter baumannii, Pseudomonas aeruginosa, K. pneumoniae,* and *Enterobacter* spp.) and highly prioritized bacteria (*Enterococcus faecium* and *S. aureus*)[17]. These microorganisms are responsible for approximately 40% of infections in hospital centers due to their mechanisms of evasion of treatments, and whose infections lead to high levels of mortality and costs in the health sector[18]. In this study, these bacteria were responsible

Table 2. Isolated Gram-positive microorganisms and percentage of antimicrobial resistance

Microorganisms	Isolates	AMP %R	CLI %R	OXA %R	GEN %R	SXT %R	CIP %R	ERY %R	LVX %R	MFX %R	VAN %R	LNZ %R
Staphylococcus epidermidis	184		64	75	16	35	46	74	51	28	0	0
Staphylococcus hominis	98	-	69	76	4	42	59	82	62	57	1	0
Staphylococcus haemolyticus	54	-	79	87	65	74	85	87	85	79	0	0
Staphylococcus aureus	39	-	40	33	4	6	16	34	17	17	6	0
Enterococcus faecium	15	100	-	-	-	-	91	100	91	-	82	0
Total	390	100	64	70	21	40	56	74	59	45	9	0

%R: percentage of resistance; AMP: ampicillin; CLI: clindamycin; OXA: oxacillin; GEN: gentamicin; SXT: trimethoprim/sulfamethoxazole; CIP: ciprofloxacin; ERY: erythromycin; LVX: levofloxacin; MFX: moxifloxacin; VAN: vancomycin; LNZ: linezolid.

Table 3. Isolated Gram-negative microorganisms and percentage of antimicrobial resistance

Microorganism	Isolates	AMK %R	AMP %R	CAZ %R	FEP %R	CRO %R	IPM %R	MEM %R	CIP %R	SXT %R	TZP %R
Escherichia coli	193	16	92	74	74	74	8	7	72	81	25
Klebsiella pneumoniae	67	0	100	52	52	52	9	9	60	57	18
Pseudomonas aeruginosa	37	31	-	52	31	100	54	56	38	-	3
Acinetobacter baumannii	17	-	64	60	67	75	56	72	60	94	-
Total	325	14	94	63	58	70	25	24	63	73	28

%R: percentage of resistance; AMK: amikacin; AMP: ampicillin; CAZ: ceftazidime; FEP: cefepime; CRO: ceftriaxone; IPM: imipenem; MEM: meropenem; CIP: ciprofloxacin; SXT: trimethoprim/sulfamethoxazole; TZP: piperacillin/tazobactam.

Table 4. Medical areas and total isolates per microorganism

Microorganism	Critical area	Medical area	Surgical area	Other	Overall total
Escherichia coli	14	153	14	12	193
Staphylococcus epidermidis	46	101	31	6	184
Staphylococcus hominis	23	56	18	1	98
Klebsiella pneumoniae	7	40	15	5	67
Staphylococcus haemolyticus	17	25	8	4	54
Staphylococcus aureus	3	27	6	3	39
Pseudomonas aeruginosa	5	25	6	1	37
Acinetobacter baumannii	3	11	2	1	17
Enterococcus faecium	5	5	5	-	15
Total	123	443	105	33	704

for 52% of positive results in blood cultures, while the microorganisms considered important for the unit were responsible for 47%.

This epidemiological basis guides the initiation of empirical antibiotic therapy, such as in cases where it is not possible to wait for the blood culture result.

The percentage of unreported data in the clinical laboratory records in this work represents an opportunity for improvement in that process in the unit. Furthermore, the increase in the supervision of an adequate technique in sample collection involves clinical and paraclinical personnel. A limitation of this study was the lack of clinical correlation.

Conclusions

The most frequently identified microorganism in blood cultures with bacterial growth in this tertiary hospital in Puebla, Mexico was *E. coli*, followed by *Staphylococcus epidermidis* and *Staphylococcus hominis*. The hospital area with the highest number of isolates in its blood cultures was the medical area with 153 isolates out of 193 for *Escherichia coli*. It is necessary to maximize the optimization of the blood culture sampling technique to achieve a record that adequately guides the initiation of empirical antibiotic therapy.

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Conflicts of interest

The authors declare no conflicts of interest.

Ethical considerations

Protection of humans and animals. The authors declare that no experiments involving humans or animals were conducted for this research.

Confidentiality, informed consent, and ethical approval. The authors have obtained approval from the Ethics Committee for the analysis of routinely obtained and anonymized clinical data, so informed consent was not necessary. Relevant guidelines were followed.

Declaration on the use of artificial intelligence. The authors declare that no generative artificial intelligence was used in the writing of this manuscript.

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