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Evaluation of Bacterial Profile and Drug Resistance Patterns of Blood Culture Isolates in Amir Al-Momenin Hospital of Gerash, Iran

Iran, Gerash Amir Al-Momenin Hastanesi'nde Kan Kültürü İzolatlarının Bakteriyel Profili ve İlaç Direnç Modellerinin Değerlendirilmesi

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Abstract

Introduction: Bacterial bloodstream diseases cause important public health problems and are considered as significant issues in morbidity and mortality in patients who are hospitalized. This study aimed to investigate the frequency of bacterial isolates from suspected septicemia and subsequent drug resistance patterns in affiliated patients to the Amir Al-Momenin Hospital of Gerash, Fars, Iran.

Materials and Methods: In this hospital-based cross-sectional study, 2485 blood samples were examined in the Bacteriology Laboratory of Amir Al-Momenin Hospital of Gerash, during 2018–2019. Then, drug susceptibility tests were done for positive blood cultures. All specimens were cultivated in MacConkey agar, Blood Agar, and chocolate agar mediums. A total of 120 positive samples were obtained, and biochemical tests were used to classify bacteria to species levels. After identification, a drug susceptibility test was carried out on the Mueller-Hinton agar via 16 antibiotics based on the Clinical and Laboratory Standards Institute guidelines.

Results: Of the 2485 blood culture results, 120 (4.82%) were determined as positive. The blood culture examination revealed the most common isolated as *Staphylococcus epidermidis* (45%, n=54 cases), *Acinetobacter baumannii* (10.83%, n=13 cases), *Escherichia coli* (10%, n=12 cases), *Klebsiella pneumoniae* (5.83%, n=7 cases), respectively. Additionally, among all the antibiotics tested, the highest percentage of resistance was related to cefoxitin in 48 cases (40%), cephalixin in 47 (39.1%), clindamycin in 47 (39.1%), and erythromycin in 42 (35%).

Conclusions: Results revealed that most of the bacterial isolates had a high rate of resistance to the most commonly used antibiotics. Therefore, continuous antibiotic resistance pattern evaluation in different areas is necessary.

Keywords: Bloodstream infection, antimicrobial susceptibility pattern, drug resistance, bacterial isolates

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Öz

Giriş: Bakteriyel kan dolaşımı hastalıkları önemli halk sağlığı sorunlarına neden olur ve hastanede yatan hastalarda morbidite ve mortalite açısından önemli sorunlar olarak kabul edilir. Bu çalışma, İran, Fars, Gerash'taki Amir Al-Momenin Hastanesi'nden takipli hastalar içerisinde sepsis şüphesi olan hastalardaki bakteriyel izolatların sıklığını ve ardından ilaç direnç modellerini araştırmayı amaçladı.

Gereç ve Yöntem: Bu retrospektif tanımlayıcı çalışmada; 2018-2019 yılları arasında Gerash Amir Al-Momenin Hastanesi Bakterioloji Laboratuvarı'nda 2485 kan örneği incelendi. Ardından pozitif kan kültürleri için ilaç duyarlılık testleri yapıldı. Tüm örnekler MacConkey agar, Blood Agar ve çikolata agar besiyerlerine yetiştirildi. Yüz yirmi pozitif örnek alındı ve bakterileri tür seviyelerine göre sınıflandırmak için biyokimyasal testler kullanıldı. Tanımlamadan sonar, Mueller-Hinton agar üzerinde Klinik ve Laboratuvar Standartları Enstitüsü (CLSI) kılavuzlarına dayalı olarak 17 antibiyotik ile ilaç duyarlılık testi yapıldı.

Bulgular: Toplam 2485 kan kültürü sonucunun 120'si (%4,82) pozitif olarak belirlendi. Kan kültürleri incelendiğinde en sık izole edilen etkenler; *Staphylococcus epidermidis* (%45, n=54), *Acinetobacter baumannii* (%10,83, n=13), *Escherichia coli* (%10, n=12) ve *Klebsiella pneumoniae* (%5,83, n=7) idi. Ayrıca, test edilen tüm antibiyotikler arasında en yüksek direnç 48 (%40) hasta ile sefoksitinde görüldü. Sonra sırasıyla; 47 (%39,1) hastada ile sefalekssin, 47 (%39,1) hastada klindamisin ve 42 (%35) hastada eritromisin direnci saptandı.

Sonuç: Bulgular, bakteri izolatlarının çoğunun en sık kullanılan antibiyotiklere karşı yüksek oranda direnç gösterdiğini göstermektedir. Bu nedenle, farklı alanlarda antibiyotik direnç paternlerinin sürekli değerlendirilmesi gereklidir.

Anahtar Kelimeler: Kan dolaşımı enfeksiyonu, antimikrobiyal duyarlılık paterni, ilaç direnci, bakteriyel izolatlar

Introduction

Septicemia or blood infection is one of the most important causes of morbidity and mortality worldwide and is considered as medical urgency, with treatment that should be performed in hospitals even in intensive care units (ICU)^[1,2]. Bloodstream infections are responsible for 10–20% of all nosocomial infections and are classified as leading causes of death in the United States^[3]. Approximately 20,000 cases of bacteremia occur periodically, with mortality rates of 20–50% worldwide^[1]. The United States reported mortality rate related to septicemia as 14–37%^[4].

Moreover, its prevalence in Southeast Asia has increased from 16.7 in 2001 to 38.1 per 100,000 people in 2010^[5]. A broad spectrum of Gram-negative and Gram-positive bacteria can cause blood infections^[6]. Blood sample cultivation is the most common method for blood infection diagnosis. Such patients should be immediately initiated with antibiotic therapy after blood cultures.

Microbial susceptibility pattern information in society, hospitals, and patients is important to pay attention to. Moreover, bacterial infection prevalence awareness and their antibiotic susceptibilities play a vital role in the prescription of appropriate medications^[1]. Early diagnosis and appropriate treatment or delayed recognition of these infections differentiate between life and death^[7]; thus, rapid bacterial pathogen identification and timely appropriate treatment initiation is the only way to treat bacteremia at the moment^[8]. Several bacterial pathogens have displayed antibiotic resistance, which has led to economic and social burdens worldwide and become serious public health concerns^[9]. Blood infections often occur during the hospitalization period and raise health care costs and losses. Many studies have shown that inappropriate treatment of

bacterial infections is associated with adverse effects, including increased drug resistance and mortality rates^[10]. Identifying the bacterial diversity of blood infections and their antibiotic resistance patterns is important. Therefore, this study aimed to investigate the bacterial agents and their drug resistance patterns in blood cultures of affiliated patients to Amir al-Momenin Hospital in Garash, Fars, Iran in 2018–2019.

Materials and Methods

Bacteria Isolation and Blood Culture

This hospital-based cross-sectional study was performed in Amir-al-Momenin Hospital of Garash (Central Hospital in the south of Fars province, Iran) for 12 months from August 2018 to July 2019, wherein a total of 2485 blood samples from patients with clinically suspected septicemia were examined in the Bacteriology Laboratory of the Hospital.

Two blood samples were taken (5 ml from two different sites) under the aseptic conditions from clinically diagnosed septicemia cases for routine blood culture before antibiotic therapy initiation. The venepuncture site was correctly disinfected with 2% tincture of iodine and 70% alcohol before taking 10 ml of blood for cultivation. Approximately 5 ml of venous blood was added into 50 ml of Brain Heart Infusion broth (HiMedia, India) and was aerobically incubated at 37 °C for 10 days. Subculture and identification of isolates were done on chocolate agar, 5% sheep blood agar, and MacConkey agar after 24 h, 48 h, 5 days, and 10 days.

Note the MacConkey agar plate was incubated in aerobic condition, whereas blood and chocolate agar plates were incubated in the microaerophilic atmosphere using a candle jar (5–10% CO₂).

Bacterial isolates were diagnosed by their morphologic appearances (such as Gram staining, colony shape) and biochemical tests to identify bacteria to species levels. Coagulase, catalase, optochin, novobiocin susceptibility tests, Christie, Atkinson, Munch, Peterson test (for *Streptococcus agalactiae*), and Esculin agar (for *Enterococci*) were implemented to determine Gram-positive bacteria, whereas citrate, indole, motility, triple sugar iron, lysine decarboxylase, urea and oxidase (for *Pseudomonaceae*) were performed or *Enterobacteriaceae* members, formerly *Enterobacteriaceae*, and other Gram-negative bacteria^[11].

Antimicrobial Susceptibility Tests

Antimicrobial susceptibility tests for all blood cultures were done via Mueller-Hinton agar (Oxoid, Hampshire, UK) using Kirby-Bauer disc diffusion method as per Clinical and Laboratory Standards Institute (2019) guidelines^[12].

The antibiotics discs were obtained from MAST company (MAST, Group Ltd., Merseyside, UK) in the following concentrations: ampicillin (AM, 10 µg), amikacin (AN, 30 µg), cefixime (CFE, 30 µg), imipenem (IPM, 10 µg), ciprofloxacin (CP, 5 µg), ceftazidime (CAZ, 30 µg), gentamicin (GM, 10 µg), co-trimoxazole (SXT, 1.25/23.75 µg), erythromycin (E, 15 µg), ceftaxime (CTX, 30 µg), clindamycin (CC, 2 µg), cephalexin (CN, 30 µg), ceftriaxone (CRO, 30 µg), and levofloxacin (LEV, 5 µg).

Staphylococcus aureus (ATCC 25923), *Pseudomonas aeruginosa* (ATCC 27853), and *Escherichia coli* (ATCC 25922) were used as reference strains for culture and drug susceptibility tests.

Ethics Clearance

The Ethics Committee of Gerash University of Medical Sciences, Gerash, Iran, approved this study with reference number IR.GERUMS.REC.1400.021.

Data Analysis

Statistical analyses were done by Statistical Package for the Social Sciences software version 25 (IBM, Chicago, IL, USA). All data were prepared as percentages and frequencies for a basic description. Statistical analyses were performed using the chi-square test, and a p value of ≤ 0.05 was considered statistically significant.

Results

Culture and Isolation

This study revealed 120 (4.82%) patients with positive blood cultures out of 2485 blood culture results. Among total cases, 50% (n=60 cases) and 50% (n=60 cases) were females and males, respectively.

Blood culture examinations revealed that the most common isolated organisms were *Staphylococcus epidermidis* (*S. epidermidis*) (45%, n=54 cases), *Acinetobacter baumannii* (*A. baumannii*) (10.83%, n=13 cases), *Escherichia coli* (*E. coli*) (10%, n = 12 cases), *Klebsiella pneumoniae* (5.83%, n=7 cases), respectively. Other isolated microorganisms are shown in Figure 1.

Figure 1. Bacterial isolates collected from blood culture

Moreover, patients with positive blood cultures were classified based on inpatient wards. The current study revealed the most cases of septicemia in the emergency (ER) ward with 53 cases (44.17%), pediatric ward with 25 (20.83%), neonatal ICU (NICU) with 14 (11.67%), internal medicine with 10 cases (8.33%), ICU with eight cases (6.67%), and outpatient (OPD) and surgical wards with five cases (4.17%), respectively (Figure 2).

S. epidermidis (15%), *A. baumannii* (7.5%), and *E. coli* (5.83%) were the most common causes of blood infections in the ER ward, respectively, whereas *S. epidermidis* (3.33%) and *A. baumannii* (0.83%) in the OPD ward; *S. epidermidis* (n=3, 2.5%) and *Serratia marcescens* (n=2, 1.67%) in the ICU ward; *S. epidermidis* (n=3, 2.5%) and *E. coli* (n=2, 1.67%) in the internal ward; *S. epidermidis* (n=18, 15%) in the pediatrics ward; *S. epidermidis* (n=1, 0.83%), *Klebsiella pneumoniae* (n=1, 0.83%), *E. coli* (n=1, 0.83%), and *Alcaligenes* spp. (n=1, 0.83%) in surgery ward; *S. epidermidis* (n=7, 5.83%), *Pseudomonas aeruginosa* (n=2, 1.67%), and *Staphylococcus saprophyticus* (n=2, 1.67%) in the NICU ward. Generally, *S. epidermidis* was the most prevalent isolated bacteria from different parts of the hospital (Table 1).

Moreover, septicemia in males and females was equal [60 (50%) of males and 60 (50%) of females]. No significant relationship was determined between gender and blood infections ($p>0.05$).

Antibiotic Susceptibility

S. epidermidis isolates were resistant to CN (83.3%), FOX (83.3%), CC (81.5%), and P (75.9%) antibiotics, respectively.

Results of antimicrobial susceptibility testing showed that $\geq 38.5\%$ of *A. baumannii* isolates were non-susceptible to CTX, CFE, AM, and CAZ. *E. coli* isolates were resistant to LEV (41.6%), IPM (33.3%), and CFE (33.3%) antibiotics, respectively. Results of antibiotic susceptibility for other isolates of blood cultures are presented in Tables 2 and 3. Additionally, among all the tested antibiotics, the highest percentage of resistance was related to FOX with 48 cases (40%), CN with 47 cases (39.1%), CC with 47 cases (39.1%), and E with 42 cases (35%).

Discussion

Today, despite significant advances in health, antimicrobial, and supportive therapies, septicemia remains a life-threatening factor. Causative agent isolation in blood culture is essential for proper antibiotic treatment^[13]. Different organisms have different sensitivities to antibiotics and successful treatment relies on appropriate drug administration. Delayed treatment and inappropriate use may lead to antibiotic resistance^[14]. This study was conducted in the Amir-al-Momenin teaching hospital of Garash, Iran, for 12 months. Of the 2485 blood cultures, 120 (4.82%) were detected as positive.

Figure 2. Investigation of the different wards of the hospital in terms of blood infection prevalence

ICU: Intensive care unit

Table 1. Results of blood culture based on a hospital ward

Result culture	Department							
	Total isolate	ER	OPD	ICU	Internal	Pediatric	Surgery	NICU
<i>Acinetobacter baumannii</i>	13 (10.83%)	9 (7.5%)	1 (0.83%)	0 (0.0%)	1 (0.83%)	1 (0.83%)	0 (0.0%)	1 (0.83%)
<i>Alcaligenes</i> spp.	2 (1.67%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.83%)	0 (0.0%)	1 (0.83%)	0 (0.0%)
<i>Citrobacter</i> spp.	1 (0.83%)	1 (0.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
<i>E. coli</i>	12 (10%)	7 (5.83%)	0 (0.0%)	1 (0.83%)	2 (1.67%)	1 (0.83%)	1 (0.83%)	0 (0.0%)
<i>Enterobacter</i> spp.	2 (1.67%)	1 (0.83%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.83%)
<i>Staphylococcus saprophyticus</i>	4 (3.33%)	0 (0.0%)	0 (0.0%)	1 (0.83%)	0 (0.0%)	1 (0.83%)	0 (0.0%)	2 (1.67%)
<i>Staphylococcus epidermidis</i>	54 (45%)	18 (15.0%)	4 (3.33%)	3 (2.5%)	3 (2.5%)	18 (15.0%)	1 (0.83%)	7 (5.83%)
Viridans <i>Streptococci</i>	2 (1.67%)	1 (0.83%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.83%)	0 (0.0%)	0 (0.0%)
<i>Shigella</i> spp.	1 (0.83%)	1 (0.83%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
<i>Salmonella enterica</i> Serovar Paratyphi B	1 (0.83%)	1 (0.83%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
<i>Staphylococcus aureus</i>	4 (3.33%)	3 (2.5%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.83%)	0 (0.0%)	0 (0.0%)
<i>Serratia marcescens</i>	4 (3.33%)	2 (1.67%)	0 (0.0%)	2 (1.67%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
<i>Streptococcus mitis</i>	1 (0.83%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.83%)	0 (0.0%)	0 (0.0%)
<i>Streptococcus pneumoniae</i>	2 (1.67%)	2 (1.67%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
<i>Providencia</i> spp.	1 (0.83%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.83%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
<i>Pseudomonas aeruginosa</i>	3 (2.5%)	1 (0.83%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (1.67%)
<i>Klebsiella pneumoniae</i>	7 (5.83%)	4 (3.33%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.83%)	1 (0.83%)	1 (0.83%)
Gram-positive bacilli	2 (1.67%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.83%)	0 (0.0%)	1 (0.83%)	0 (0.0%)
<i>Micrococcus</i> spp.	1 (0.83%)	1 (0.83%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
<i>Proteus mirabilis</i>	1 (0.83%)	0 (0.0%)	0 (0.0%)	1 (0.83%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
<i>Streptococcus</i> Group D	2 (1.67%)	1 (0.83%)	0 (0.0%)	0 (0.0%)	1 (0.83%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Total	120 (100%)	53 (44.17%)	5 (4.17%)	8 (6.67%)	10 (8.33%)	25 (20.83%)	5 (4.17%)	14 (11.67%)

ER: Emergency ward, NICU: Neonatal intensive care unit, OPD: Outpatient wards, ICU: Intensive care unit

The most common blood infection causes in our study include *S. epidermidis* (n=54, 45%), *A. baumannii* (n=13, 10.83%) and *E. coli* (n=12, 10%), respectively.

These findings are consistent with the study results by Sedigh et al.^[15] that evaluated pediatric bloodstream infections in Nemazee Hospital, Shiraz, Iran.

Of the 491 blood cultures, 74 (15.1%) samples were identified as positive. *Acinetobacter* isolates (8.1%) were found to be the most common Gram-negative isolates. Additionally, among the obtained Gram-positive cocci, *S. epidermidis* strains (48.6%) were the predominant bacterial pathogens. Therefore, the most Gram-positive cocci were sensitive to vancomycin (98%) and chloramphenicol (72.5%). Further, the most effective antibiotics against Gram-negative isolates were chloramphenicol (30.4%) and CP (47.8%).

Moreover, several researchers have evaluated the bacterial profile and antimicrobial susceptibility pattern in patients with suspected septicemia in other parts of the world. A study

conducted by Vaez et al.^[16] at Tehran Be'esat Hospital revealed that coagulase-negative staphylococci were the most frequent bacterium and *Proteus* was the least frequent among the 129 positive blood cultures.

Another study carried out by Dagnew et al.^[1] at Gondar University Hospital (Ethiopia) revealed that the dominant bacteria isolated from blood cultures were coagulase-negative staphylococci (42.3%), *S. aureus* (23.9%), *Klebsiella* spp. (9.12%), *E. coli* (7%), *Pseudomonas aeruginosa* (5.6%), and *Salmonella* spp. (4.2%), respectively.

The present study has an equal rate of septicemia in both genders, 60 (50%) in males and 60 (50%) in females. No significant relationship was observed between gender and bloodstream infections ($p>0.05$). Similarly, the study by Mahmoudi et al.^[17] revealed no significant relationship between gender and bloodstream infections.

The investigation performed by Dogru et al.^[18] in Turkey revealed the most frequently isolated microorganisms as *Pseudomonas*

Table 2. Results of antibiotic susceptibility testing of Gram-negative bacterial agents isolated from blood samples of patients with a blood infection

Result culture	AM	AN	CFE	IPM	CP	CAZ	GM	SXT	E	FOX	P	CTX	CC	CN	CRO	LEV	Total
<i>Acinetobacter baumannii</i>	38.5%	30.7%	46.2%	24.0%	23.1%	38.5%	30.7%	15.4%	0.0%	0.0%	0.0%	46.2%	0.0%	0.0%	0.0%	0.0%	13
<i>Alcaligenes</i> spp.	0.0%	50%	0.0%	50%	50%	0.0%	50%	0.0%	0.0%	0.0%	0.0%	50%	0.0%	0.0%	0.0%	50%	2
<i>Citrobacter</i> spp.	0.0%	100%	0.0%	0.0%	100%	0.0%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1
<i>E. coli</i>	0.0%	25.0%	33.3%	33.3%	25.0%	16.7%	25.0%	8.4%	0.0%	8.3%	0.0%	25.0%	0.0%	0.0%	0.0%	41.6%	12
<i>Enterobacter</i> spp.	50.0%	0.0%	0.0%	50.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	100.0%	0.0%	2
<i>Shigella</i> spp.	0.0%	100.0%	0.0%	0.0%	100.0%	100.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	1
<i>Salmonella enterica</i> Serovar Paratyphi B	10.0%	100.0%	100.0%	100.0%	0.0%	100.0%	100.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1
<i>Serratia marcescens</i>	25.0%	25.0%	0.0%	25.0%	25.0%	75.0%	25.0%	25.0%	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	4
<i>Providencia</i> spp.	0.0%	100.0%	0.0%	100.0%	100.0%	100.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1
<i>Pseudomonas aeruginosa</i>	0.0%	0.0%	0.0%	0.0%	66.6%	33.3%	33.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3
<i>Klebsiella pneumonia</i>	14.2%	14.2%	14.2%	14.2%	57.14%	14.2%	14.2%	14.2%	0.0%	0.0%	0.0%	42.8%	0.0%	0.0%	28.6%	0.0%	7
<i>Proteus mirabilis</i>	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%	100.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1

AM: ampicillin, AN: amikacin, CFE: cefixime, IPM: imipenem, CP: ciprofloxacin, CAZ: ceftazidime, GM: gentamicin, SXT: sulfamethoxazole, E: erythromycin, FOX: cefoxitin, P: penicillin, CTX: cefotaxime, CC: clindamycin, CN: cephalixin, CRO: ceftriaxone, LEV: levofloxacin, OX: oxacillin

aeruginosa and *Acinetobacter* spp., and 43% of infections were in females and 57% in males. This study was similar to ours and no significant relationship was determined between the prevalence of infection and gender ($p>0.05$). A common finding in these studies is the prevalence of *Staphylococci* in bloodstream infections, which is similar to our results.

Another study by Japoni et al.^[19] in Shiraz, Iran, revealed that the highest activity against Gram-negative bacteria was observed for IPM (96.1%), CP (83%), and AN (77.9%), whereas for Gram-positive isolates, vancomycin (98.4%), chloramphenicol (86.4%), and CP (77.4%) were effective antibiotics. These findings indicated that the causative agents of bloodstream infections and their antibiotic susceptibility vary in different regions and periods. Thus, monitoring and detecting the bacterial pathogens from blood cultures are very important to manage the infection and therapeutic decisions. This finding can be helpful for clinicians to consider appropriate treatment.

The present study revealed that the highest cases of septicemia are in the ER ward (44.17%), pediatric ward (20.83%), NICU (11.67%), internal medicine (8.33%), ICU (6.67%), and OPD and surgical wards (4.17%), respectively. The study conducted by Mahmoudi et al.^[17] revealed that the prevalence rate of septicemia in the pediatric ward with 40 (20.51%), surgery with 12 (6.15%), and ICU with 25 (12.82%) cases had the top incidence, respectively.

Our study had some limitations, including, first, patients who had fungi septicemia, like *Candida* species, were excluded; second, the genotypic analyses were not performed to understand the clonality and epidemiology of isolates through time; and third, inadequate demographic information of patients and their underlying diseases.

Conclusion

Our study results highlight the etiological agent of septicemia and their antibiotic susceptibility pattern in this area and indicated that the most common cause of bacterial septicemia in the south of Fars province is *S. epidermidis*, *A. baumannii*, and *E. coli*. Most of the isolates were resistant to CN, FOX, and LEV, respectively. High levels of resistance to common antibiotics in bacterial infection treatment were observed among the pathogens isolated from blood culture. Therefore, considering various agents that cause sepsis, different antibiotic resistance patterns, and widespread resistant organisms, periodically determining the most prevalent agents of septicemia and their antibiotic resistance pattern seems necessary. This study is helpful for clinicians to prescribe appropriate medications in the management of sepsis. Moreover, the treatment strategy via antibiotics is suggested to be reviewed due to the increasing rate of antibiotic resistance in different regions.

Table 3. Results of antibiotic susceptibility testing of Gram-positive bacterial agents isolated from blood samples of patients with blood infections

Result culture	AM	AN	CFE	IPM	CP	CAZ	GM	SXT	E	FOX	P	CTX	CC	CN	CRO	LEV	Total
Viridans Streptococci	50%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50%	0.0%	50.0%	0.0%	0.0%	0.0%	100%	0.0%	2
Staphylococcus epidermidis	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	55.5%	66.6%	83.3%	75.9%	0.0%	81.5%	83.3%	16.7%	40.7%	54
Staphylococcus aureus	0.0%	25.0%	0.0%	0.0%	0.0%	0.0%	0.0%	25%	50%	25%	0.0%	0.0%	25%	25%	0.0%	0.0%	4
Staphylococcus saprophyticus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	25%	25%	25.0%	25%	0.0%	50%	25%	0.0%	0.0%	4
Streptococcus mitis	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%	100.0%	100.0%	0.0%	1
Streptococcus pneumoniae	0.0%	0.0%	50.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2
Gram-positive bacilli	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	50.0%	0.0%	0.0%	0.0%	0.0%	2
Micrococcus spp.	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	100.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	1
Streptococcus Group D	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2

AM: ampicillin, AN: amikacin, CFE: cefixime, IPM: imipenem, CP: ciprofloxacin, CAZ: ceftazidime, GM: gentamicin, SXT: sulfamethoxazole, E: erythromycin, FOX: cefoxitin, P: penicillin, CTX: cefotaxime, CC: clindamycin, CN: cephalixin, CRO: ceftriaxone, LEV: levofloxacin, OX: oxacillin

Ethics

Ethics Committee Approval: The Ethics Committee of Gerash University of Medical Sciences, Gerash, Iran, approved this study with reference number IR.GERUMS. REC.1398.005.

Informed Consent: Retrospective descriptive study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: A.F., A.V.L., H.H., Concept: A.F., A.V.L., H.F., J.S., I.A., P.M., Design: A.F., A.V.L., H.F., J.S., K.Z., F.F., Data Collection or Processing: A.F., A.V.L., J.S., H.H., I.A., P.M., F.F., Analysis or Interpretation: A.F., A.V.L., H.F., H.H., K.Z., Z.F., F.F., Literature Search: A.F., A.V.L., H.F., J.S., H.H., I.A., K.Z., P.M., Writing: A.F., A.V.L., H.F., J.S., H.H., I.A., K.Z., Z.F.

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