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Bacteriological profile and antibiotic susceptibility patterns of bloodstream infection at Tripoli University Hospital

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A B S T R A C T

Bloodstream infections remain one of the most significant causes of morbidity and death in healthcare settings throughout the world and are frequent reasons for getting medical care in the community, particularly in developing countries. This study is aimed at identifying a bacteriological profile and an antibiotic susceptibility pattern in blood cultures isolated from patients attending Tripoli University Hospital (TUH). This retrospective cross-sectional study has been carried out in a microbiology lab on blood cultures of patients suspected of having bloodstream infections from different wards in the Tripoli University Hospital over a period from May to November 2022. Blood samples were examined, isolated bacteria were identified using standard techniques, and then antimicrobial sensitivity testing was performed using CLSI guidelines. Out of 730 blood samples, 24.8% were culture-positive. Out of the 24.8% positive cultures, 15.1% were Gram-positive and 9.7% were Gram-negative. The most predominant organism was Staphylococcus epidermidis (7.1%), followed by Klebsiella species (5.6%). Most of the Gram-positive bacteria were susceptible to Linezolid, Clindamycin, Tetracycline, and Erythromycin. Most of the Gram-negative bacteria showed sensitivity to Imipenem, followed by Amikacin, Levofloxacin, and Trimethoprim/sulfamethoxazole. In conclusion, the present study shows an important prevalence of bacterial isolates in the blood and emphasizes the requirement for continuous monitoring of the susceptibility of the bacterial pathogens to antibiotics to avoid unsuitable use of the antibiotics.

الخصائص البكتريولوجية و أنماط الحساسية للمضادات الحيوية لعدوى مجرى الدم في المستشفي الجامعي طر ابلس

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وحدة الرعاية الصحية، وزارة الصحة، طرابلس، ليبيا

الكلمات المفتاحية:
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عدوي
الملف البكتيري
قابلية
مضادات الميكروبات

الملخص

تظل عدوى مجرى الدم أحد أهم أسباب المراضة والوفاة في أماكن الرعاية الصحية في جميع أنحاء العالم، وهي أسباب متكررة للحصول على الرعاية الطبية في المجتمع، وخاصة في البلدان النامية. تهدف هذه الدراسة إلى تحديد المظهر البكتريولوجي ونمط قابلية المضادات الحيوية في مزارع الدم المعزولة لدى المرضى الذين يحضرون الى المستشفي الجامعي طرابلس. تم إجراء هذه الدراسة المقطعية بأثر رجعي في مختبر الأحياء الدقيقة على مزارع الدم للمرضى المشتبه في إصابتهم بعدوى مجرى الدم من مختلف الأجنحة في مستشفى طرابلس الجامعي على مدى فترة من مايو الى نوفمبر 2022. تم فحص عينات الدم ، وتم تحديد البكتيريا المعزولة باستخدام تقنيات قياسية ، ثم تم إجراء اختبار الحساسية لمضادات الميكروبات باستخدام إرشادات CLSI. من بين 730 عينة دم ، كانت 24.8% إيجابية الزرع. من بين 24.8% مزرعة إيجابية ، كانت 15.1% موجبة الجرام و 9.7% سلبية الغرام. كان الكائن الحي الأكثر انتشارًا هي البكتيريا الكرويّة العنقودية الجلديّة 52 (7.1%) ، يليها انواع الكلابسيلا 41 (6.7%) كانت معظم البكتيريا موجبة الجرام حساسية للينزوليد ، الكليندامايسين ، التراسيكلين ، والإريثروميسين. أظهرت معظم البكتيريا سالبة الجرام حساسية تجاه الإيميبينيم ، يليها أميكاسين ، وليفوفلوكساسين ، وتريميثوبريم / سلفاميثوكسازول. في الخلاصة ، تُظهر الدراسة

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الحالية انتشارًا مهمًا للبكتيرية المعزولة في الدم وتؤكد على الحاجة إلى المراقبة المستمرة لقابلية البكتيرية الممرضة للمضادات الحيوية لتجنب الاستخدام غير المناسب للمضادات الحيوية.

Introduction

Bloodstream infection (BSIs) refers to the presence of microbial organisms that are living and active within the bloodstream. These microorganisms are responsible for triggering or have triggered an inflammatory response, which can be identified through observable modifications in hemodynamic, laboratory, and clinical parameters. One or more positive blood cultures provide further evidence of this occurrence [1]. BSIs are causes of significant morbidity and mortality in populations of all age groups across the world [2]. Bacteremia is the term used to describe the existence of living bacteria in the bloodstream, while Septicemia is a systemic illness caused by the multiplicity of microorganisms and their toxins in the blood [3]. Sepsis is an organ dysfunction with a high risk of death brought on by an imbalanced host protection mechanism against infection. It is regarded as an important factor in the loss of health. In developing countries, septicemia is a significant contributor to illness and death among hospitalized patients [4]. Conditions related to BSI range from self-limiting infections to life-threatening sepsis in critically ill patients; these infections require quick and aggressive antimicrobial therapy [5]. There are around 200,000 cases of bacteremia each year, with fatality rates ranging from 20 to 50 percent globally. BSI, which makes up 10–20% of all nosocomial infections and is the eighth largest cause of mortality in the United States, where 17% of cases result in death [6]. The incidence of nosocomial bloodstream infections has been shown to increase with central venous catheter use, patient conditions (e.g., cancer, trauma, and high-risk nursery settings), and other hazard variables such as intensive care unit admission and hand washing habits of healthcare workers [7]. Respiratory, genitourinary, and intra-abdominal foci are common and recognizable sources of BSIs [8]. However, according to a meta-analysis study, the prevalence of community-onset BSI was reported in Africa (14.6%), Asia (7.3%), Europe (2.9%), and the Americas (7.3%) [9]. Recent studies conducted globally found that the most common pathogens isolated from BSIs are *Staphylococcus aureus* (20.7%), followed by *Escherichia coli* (20.5%), *Klebsiella* species (7.7%), *Pseudomonas aeruginosa* (5.3%), and *Enterococcus faecalis* (5.2%) [10]. The gold standard for identifying BSIs is through blood culture [11]. When it comes to bloodstream infections, the decision of which antimicrobial treatment to use and when to use it can have a significant effect on the ultimate outcome, and empiric therapy is selected based on patterns of antimicrobial susceptibility. Therefore, epidemiological information from diverse patient populations in many countries is becoming increasingly important. Septic shock and death from BSI can occur as a consequence of delayed diagnosis and treatment [12]. Studies pooling blood culture tests at regular intervals are important to provide physicians with the information they need to start treating critically ill patients awaiting blood culture results [13]. The present study was conducted to identify the bacteriological profile and antibiotic susceptibility pattern of blood cultures isolated from patients attending Tripoli University Hospital (TUH).

Materials and Methods:

Study design: This retrospective cross-sectional study was carried out in the laboratory of microbiology at Tripoli University Hospital (TUH) from May to November 2022 to study the bacteriological profile and antibiotic susceptibility pattern of blood culture isolates. Patients with suspected bloodstream infections from various departments in the hospital.

Sample collection and laboratory procedures: Blood samples were collected from the patients (about 5 ml of venous blood for adults and 2 ml for children) and transported into a bottle containing 45 ml of tryptic soy broth sterile culture medium. The microbiology lab at Tripoli University Hospital received the blood culture broths and incubated them at 37°C for the following 30 minutes.

Bacterial identification: Blood culture broths were examined every day for up to 7 days for evidence of bacterial growth (turbidity, hemolysis). Gram staining was performed on all positive blood samples, and subcultures were made on Blood agar, Chocolate agar, and MacConkey agar. The media were similarly incubated at 37°C for 24 h. Standard microbiological methods were used for the organism's isolation and identification based on colony morphology, colony Gram stain, and biochemical test.

Antimicrobial susceptibility test: The antibiotic sensitivity testing for isolated organisms was performed on Mueller-Hinton agar using disk diffusion (Kirby Bauer's) method according to the Clinical and Laboratory Standards Institute (CLSI) guidelines. The antimicrobials for disc diffusion testing were: Amikacin, Penicillin, Moxifloxacin, Ciprofloxacin, Tetracycline, Gentamycin, Erythromycin, Trimethoprim/sulfamethoxxazole, Linezolid, Levofloxacin, Tobramycin, Aztreonam, Clindamycin, Doxycycline, Cefepime, Chloramphenicol, Moxifloxacin, Meropenem, Cefoxitin, and Imepenem.

Data Statistical Analysis: The data were entered and analyzed using SPSS version 22.0 software. Descriptive statistics, including frequency, were done. Variables were expressed as frequencies and percentages.

Results and Discussion

A total of 730 patients suspected of having bloodstream infections from different hospital departments were enrolled in this study. The sex ratio was 39.2% males and 60.8% females. Seven hundred and thirty blood culture samples were taken up for study, of which 24.8% were identified as culture-positive. Out of the 24.8% positive cultures, 10% were male and 14.8% were female. Out of the 24.8% positive cultures, 15.1% were Gram-positive and 9.7% were Gram-negative. Among the 24.8% isolates, the most predominant organism was *Staphylococcus epidermidis* 7.1%, followed by *Klebsiella* species 5.6%, and the least prevalent were *Enterobacter cloacae* 0.1%, *Burkholderia* 0.1%, and *Salmonella* species 0.1% Table (1).

Table 1: Types of bacteria isolated in blood culture

Gram-reaction	Isolated species	Frequency	Percentage
	Staphylococcus epidermidis	52	7.1
	Staphylococcus aureus	29	4.0
	Staphylococcus hominis	14	1.9
Gram-positive bacteria	*Micrococcus species*	4	0.5
	Enterococcus species	3	0.4
	Staphylococcus haemolyticus	2	0.3
	Staphylococcus warneri	2	0.3
	Streptococcus pneumoniae	2	0.3
	Non-hemolytic streptococcus	2	0.3
	Klebsiella species	41	5.6
	Acinetobacter species	14	1.9
Gram-negative bacteria	*Escherichia Coli*	12	1.6
	Pseudomonas aeruginosa	2	0.3
	Salmonella species	1	0.1
	Enterobacter cloacae	1	0.1
	Burkholderia	1	0.1

Among the gram-positive isolates, *S. epidermidis* was seen in 29 females and 23 male patients, and *S. aureus* was seen in 18 females and 11 male patients. The gender-wise distribution of Gram-positive isolates is shown in Figure (1). In the current study, between the Gram-negative isolates, *Klebsiella* species were observed in 23 females and 18 male patients, and *Acinetobacter* species were seen in 12 females and 2 male patients. The distribution of Gram-negative isolates from blood cultures in males and females is shown in Figure (2).

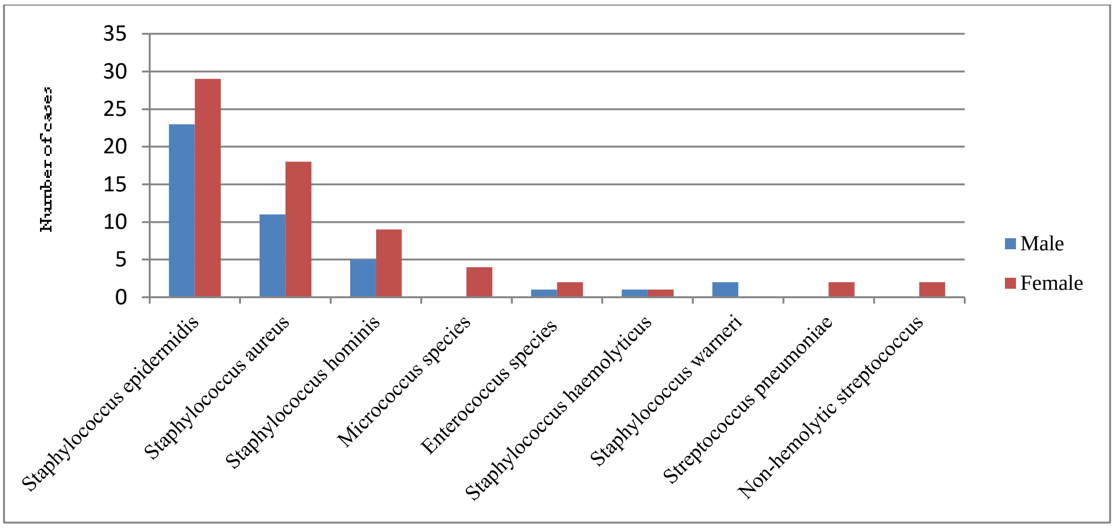

Figure 1: Distribution of Gram-positive isolates (n=110).

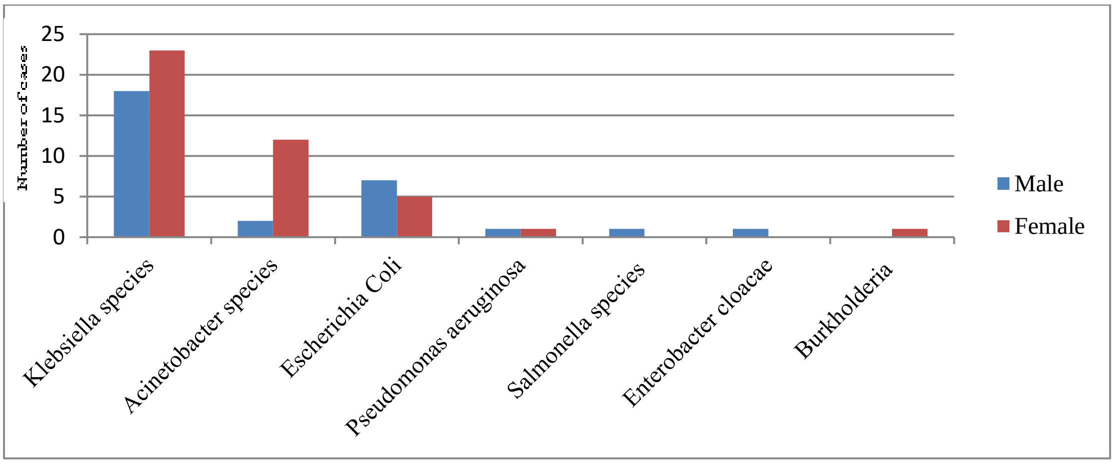

Figure 2: Distribution of Gram-negative isolates (n=71).

S. epidermidis isolates showed (52%) susceptibility to Clindamycin. The isolates of *S. aureus* were sensitive (61%) to Clindamycin and (52%) to Trimethoprim or Sulfamethoxazole. *S. hominis* isolates were (98%) responsive to Moxifloxacin and (87%) to Linezolid. whereas *Micrococcus* species revealed (100%) sensitivity to levofloxacin. On the other hand, *Enterococcus* species and *Staphylococcus warneri* show (100%) sensitivity to Tetracycline. Linezolid, Clindamycin, Tetracycline, and Erythromycin remained the most active drugs in Gram-positive bacteria that cause infections Table (2). whereas *Klebsiella* species reveal 34% sensitivity to imipenem, followed by Amikacin (34%). Imipenem demonstrated 50% effectiveness against *Pseudomonas aeruginosa*. Levofloxacin revealed highest (100%) activity among Gram-negative bacteria Table (3).

Table 2: Antibiotic sensitively pattern of Gram positive organism

Organism	AK %	P %	MOX %	CIP %	TET %	GEN %	E %	SXT %	LINZ %	LEV %	TOB %	AZT %	CLIN %	DOX %
S. epidermidis (n=52)	29	8	32	21	35	29	27	23	27	33	0	2	52	4
S.aureus (n=29)	14	10	27	24	24	14	24	52	34	38	7	27	61	21
S. hominis (n=14)	0	14	98	0	64	43	14	78	87	57	57	0	71	0
Micrococcus species (n=4)	25	50	0	50	75	50	50	25	50	100	0	25	50	25
Enterococcus species (n=3)	0	0	0	0	100	0	0	0	33	0	0	0	0	0
S. haemolyticus (n=2)	50	50	50	0	50	0	0	50	100	0	0	0	50	50
S. warneri (n=2)	0	0	50	0	100	100	50	50	100	100	100	0	100	0
Streptococcus pneumonia (n=2)	0	0	0	0	0	50	50	0	50	0	0	0	50	0
Non-hemolytic streptococcus (n=2)	0	0	0	0	0	0	50	0	0	50	0	0	50	0

AK:Amikacin, P: Penicillin, MOX: Moxifloxacin, CIP: Ciprofloxacin, TET: Tetracycline, GEN: Gentamycin, E: Erythromycin, SXT: Trimethoprim/sulfamethoxxazole, LINZ: Linezolid, LEV: Levofloxacin, TOB: Tobramycin, AZT: Aztreonam, CLIN: Clindamycin, DOX: Doxycycline.

Table 3: Antibiotic sensitive pattern of Gram negative organism

Organism	CEF %	CH %	MOX %	MEM %	CIP %	TET %	GEN %	SXT %	CX %	LEV %	TOB %	AK %	AZT %	IPM %	CLIN %	DOX %
Klebsiella species (n=41)	2	14	2	22	14	2	27	2	10	19	7	34	5	34	0	0
Acinetobacter species (n=14)	0	7	0	21	7	0	7	21	7	14	0	21	7	7	7	7
Escherichia Coli (n=12)	8	8	25	25	0	8	16	16	25	16	0	8	0	25	0	0
Pseudomonas Aeruginosa (n=2)	0	0	0	50	50	0	0	0	0	50	0	0	0	50	0	0
Salmonella species (n=1)	100	100	0	50	0	0	0	50	0	100	0	0	0	0	0	0
Enterobacter cloacae (n=1)	100	100	0	0	0	0	100	100	0	100	0	100	0	0	0	0
Burkholderia (n=1)	0	0	0	50	0	0	0	100	0	100	0	0	0	0	0	0

CEF: Cefepime, CH: Chloramphenicol, MOX: Moxifloxacin, MEM: Meropenem, CIP: Ciprofloxacin, TET: Tetracycline, GEN: Gentamycin, SXT: Trimethoprim/sulfamethoxxazole, CX: Cefoxitin, LEV: Levofloxacin, TOB: Tobramycin, AK: Amikacin, AZT: Aztreonam, IPM: Imepenem, CLIN: Clindamycin, DOX: Doxycycline

Bloodstream infections are of great concern worldwide and are among the most common infections in healthcare settings, causing high morbidity and mortality among patients [14]. Consequently, one of the most crucial tasks of a diagnostic microbiology laboratory is the quick detection, identification, and antibiotic susceptibility testing of bloodstream infections [15]. The findings of the present study demonstrated that 181 (24.8%) out of 730 blood samples screened were positive for the presence of bacteria, which is similar to studies conducted by Nazir et al. (25.3%) in North India [15], by Khan et al. (21.75%) in Rawalpindi, Pakistan [16], and by Uwe et al. (25.2%) in Lagos, Nigeria [17].

In contrast to the present finding, the study done by Thakur et al. reported a high prevalence of positive blood cultures, accounting for 42% [18], whereas numerous studies in India and Iran reported a lower prevalence of positive blood cultures, accounting for 9.8% and 5.6%, respectively [19,20]. Current study showed that females are more likely to be infected with bacteremia than males. This is similar to the study conducted in Bangladesh [21].

The frequency of isolation of Gram-positive and Gram-negative bacteria from blood cultures in this present study was 60.7% and 39.2%, respectively. This finding is similar to several other studies in Addis Ababa (77.4% vs. 22.6%) [22], North Kerala, India (53.5% vs. 46.4%) [23], and Hyderabad, India (55.2% vs. 44.8%) [24]. In contrast to this result, high levels of Gram-negative bacteria were reported in other studies done in Nepal (78.6% versus 21.3%) [25], Rwanda (68.3% vs. 31.7%) [26], and Amhara, Ethiopia (55.6% vs. 44.4%) [27]. The variation might be related to geographical differences. The frequently isolated organisms from this study include *Staphylococcus epidermidis*, *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella* species, *Pseudomonas aeruginosa*, and members of the *Enterobacteriaceae*. This result is in accordance with the findings obtained by Majada et al. [28]. And by Zerin et al. [21].

The definition of coagulase-negative *staphylococci* (CoNS) continues to be based on diagnostic techniques that meet the clinical requirement of separating *Staphylococcus aureus* from other staphylococci that have previously been categorized as being less or nonpathogenic. CoNS are currently one of the main nosocomial infections due to patient- and procedure-related alterations, whereas *S. epidermidis* and *S. hemolyticus* are the most important species [29]. In the present study, CoNS is frequently the bacteremia-causing agent among Gram-positive isolates, which is similar to the studies conducted in Jimma and Gondar [30, 31]. This could be a result of the majority of CoNS being the skin's typical flora. They could contaminate the blood during the blood collection process. Due to CoNS's ability to infect a wide range of prosthetic medical equipment, it's also possible that the rising usage of intravascular catheters and indwelling prosthetic devices is to blame for the rise in nosocomial bacteremia [30]. Moreover, the most predominant Gram-negative bacteria identified in this study were *Klebsiella* species (7.1%). Similar observations were reported in a previous studies [32,33] Moreover, the present study showed that among the Gram-negative isolates, their antibiotic sensitivity to Levofloxacin, Imipenem, Meropenem, and Amikacin was high or moderate, which is similar to the study conducted by Duan et al. [34].

Conclusion

This study reveals that the prevalence of BSI among patients attending Tripoli University Hospital was high, and the bacterial pathogens in bloodstream infections were caused by both Gram-positive and Gram-negative bacteria. Among all isolates, CoNS and *Klebsiella* species were predominant. Based on the outcomes of testing for sensitivity to antibiotics, the majority of the Gram-positive bacteria were susceptible to Linezolid, Clindamycin, Tetracycline, and Erythromycin. Most of the Gram-negative bacteria showed sensitivity to Imipenem, followed by Amikacin, Levofloxacin, and Trimethoprim/sulfamethoxazole. It is essential to regularly examine and revise the BSI epidemiology. Additional research indicates that it could be beneficial for the rapid treatment of individuals with BSIs.

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