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ORIGINAL RESEARCH

The bacterial profile and antibiotic susceptibility pattern among patients with suspected bloodstream infections, Gondar, north-west Ethiopia

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Background: The bacteria most likely to cause bacteremia include *Staphylococcus*, *Streptococcus*, *Enterococcus*, *Escherichia*, *Klebsiella*, *Pseudomonas*, *Enterobacter*, *Haemophilus*, and *Neisseria* genera. Bloodstream infections remain one of the most important causes of morbidity and mortality throughout the world. Drug-resistant pathogens are becoming the most challenging problem and they have different economic and social impacts around the world.

Objective: To study the bacterial profile and antibiotic susceptibility among bacteremia-suspected patients in the University of Gondar Teaching Hospital from September 2003 to February 2013.

Materials and method: This retrospective cross-sectional study was conducted from March to May 2013 at the University of Gondar. Data were collected and extracted manually from the microbiology registration books of the hospital laboratory using checklists and were checked for its completeness and consistency.

Result: Among a total of 856 blood samples analyzed, 169 (19.7%) cases were bacteremia confirmed. From the confirmed cases, 98 (58%) were male and 71 (42%) female. Culture positivity rate was highest (44%) in the age group of ≤28 days followed by the age group of 29 days–5 years.

Conclusion: In our study, coagulase-negative staphylococci were the most common causative agent for bacteremia among the Gram-positive isolates. The overall antimicrobial susceptibility pattern of the Gram-positive isolates was an intermediate level of resistance (60%–80%), but Gram-negative bacteria showed a high level of resistance (>80%) against ampicillin and amoxicillin.

Keywords: bacteremia, drug susceptibility, sepsis, resistant

Introduction

Bacteremia is the presence of bacteria in the bloodstream and occurs when bacteria enter the bloodstream. Blood by its nature is sterile. So the presence of any bacteria in circulating blood is a threat to every organ in the body.[1] Most episodes of occult bacteremia spontaneously resolve and serious sequelae are increasingly uncommon. However, sometimes bacteremia can have adverse consequences including multiple organ failures, septic shock, disseminated intravascular coagulation, and death. Generally, the factors that contribute to the initiation of bloodstream infection are immune suppressive agents, widespread use of broad-spectrum antibiotics that suppress the normal flora and allow the emergence of resistant strains, invasive procedures and prolonged survival-debilitated and seriously ill patients. [1–3]

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Bacteremia is related to the presence of viable bacteria in the blood confirmed by cultures in which contamination has been effectively ruled out.[4,5] This may or may not have any clinical significance because harmless, transient bacteremia may occur following dental work or other minor medical procedures; however, it is generally clinically benign and self-resolving in people who do not have an underlying illness or immune deficiency or a turbulent cardiac blood flow.

Several types of bacteria live in different parts of the human body as normal flora. But when bacterial niches are disturbed by different factors and the immunity of individuals are compromised by different factors they may enter into the blood from the skin or urinary tract causing fatal disease.[6] Bacteremia may also be related to a failure of the immune system that is not able to control bacterial dissemination from the surgical wound, gastrointestinal tract, or urinary tract.[1,3,6,7]

The most common bacteria that cause bacteremia include members of *Staphylococcus*, *Streptococcus*, *Enterococcus*, *Escherichia*, *Klebsiella*, *Pseudomonas*, *Enterobacter*, *Haemophilus*, and *Neisseria* genera.[1,8,9] Timely and appropriate use of antibiotics is the appropriate way to treat bacteremia.[10] Despite such precautions, the development of antibiotic-resistant strains of bacteria (eg, methicillin-resistant *Staphylococcus aureus* or MRSA) has led to an increase in the incidence of severe bacteremia since the late 1960s.[11]

Materials and methods

A retrospective cross-sectional study was conducted in the University of Gondar Teaching Hospital from March to May 2013. The University of Gondar Teaching Hospital is a tertiary level hospital providing both inpatient and outpatient services to more than 5 million people in the region. All bacteremia-suspected patients who have symptoms of fever or chills, including shaking, confusion, and a rapid and shallow rate of breathing, are eligible for a blood culture diagnosis of bacteremia.

Bacteriological investigation

Culture media

Laboratory investigation standard operation procedures based on the Clinical and Laboratory Standards Institute's (CLSI) recommendations were used by the University of Gondar Teaching Hospital laboratory to isolate bacteria from a blood sample. A 5-mL blood sample was collected aseptically and added to 45 mL of Trypanosoma broth (1:9 ratio) and incubated at 37°C. The turbidity (sign of bacterial growth) was checked daily until the 14th day to report no bacterial growth. Turbid broth cultures were subcultured into MacConkey agar, Blood agar plates and Chocolate agar plates (Oxoid™ Ltd, Thermo Fisher Scientific, Waltham, MA, USA) and incubated at 37°C for 24–48 hours. The Chocolate agar-incubated cultures were carried out in a microaerophilic atmosphere by using a candle jar. Identification of bacteria was made using colony characteristics, Gram reaction of the organisms, and biochemical tests following standard procedures.[12]

Antimicrobial susceptibility testing

Antimicrobial susceptibility testing was performed for all blood culture isolates according to the criteria of the CLSI by the disk diffusion method with the exception of *S. aureus* where the susceptibility test for vancomycin was done by dilution method.[12,13] From a pure culture, three to five selected colonies of bacteria were taken and transferred to a tube containing 5-mL sterile normal saline and mixed gently to a homogenous suspension and incubated at 37°C until the turbidity of the suspension become adjusted to a McFarland 0.5. A sterile cotton swab was used, and the excess suspension was removed by gentle rotation of the swab against the surface of the tube. The swab was then used to distribute the bacteria evenly over the entire surface of Mueller Hinton agar. The inoculated plates were left at room temperature to dry for 3–5 minutes, and a set of antibiotic discs were then placed on the surface of a Muller-Hinton plate. The drugs for disc diffusion testing were in the following concentrations: Ampicillin (10 μg), Amoxicillin (25 μg), Gentamicin (10 μg), Erythromycin (15 μg), Pencillin (10 μg), Nalidixin acid (30 μg), Ciprofloxacin (5 μg), Chlorapinicole (30 μg), Co-Trimoxazol (25 μg), Tetracyline (30 μg), Chloramphenicol (30 μg), Norfloxacin (10 μg), Augmentin (30 μg), Ceftriaxone (30 μg), Cefotaxime (30 μg), and Vancomycin (30 μg). All antimicrobial disc used for the study were obtained from Oxoid™ Ltd (Thermo Fisher Scientific). Diameters of a zone of inhibition around the disk were measured with the ruler and the isolates were classified as sensitive, intermediate, and resistant according to the standardized table supplied by the CLSI. Bacteria resisting more than two drugs of the different families are considered as "multi-drug resistant".[13] High, intermediate and low levels of resistance are defined when the percentage of resistance is >80%, 60%–80%, and <60% respectively.

Quality control

The quality of blood culture was maintained by proper antiseptic techniques during collection of the blood samples, with an appropriate sample volume taken, an appropriate time of collection and a patient history taken including current medications. Culture media were tested for sterility by incubating overnight at 37°C and for performance by inoculating known standard strains. Standard strains of *Escherichia coli* American Type Culture Collection (ATCC) 25922 and *S. aureus* ATCC 25923 were used during culture and antimicrobial susceptibility testing.[13]

Data collection and analysis

Raw data were extracted manually from the microbiology registration books of the hospital laboratory by investigators and were analyzed and expressed descriptively.

Ethical considerations

An ethical approval letter was obtained from the School of Biomedical and Laboratory Science, College of Medicine and Health Sciences, University of Gondar. Official permission was obtained from the School of Biomedical and Laboratory Science and Hospital Diagnostic Center prior to the commencement of data collection. The data were retrospective and, therefore, there was no need for consent. The Gondar University ethical committee approved permission to collect the data. Patient data were kept confidentially using codes.

Results

Sociodemographic characteristics

During the period 2003–2013, a total of 856 blood samples were analyzed and bacteremia was confirmed in 169 (19.7%) cases. From the confirmed cases, 98 (58%) were male and 71 (42%) female. Culture positivity rate was highest in the age group of ≤28 days (44%; 55/125) followed by those in the age group of 29 days–5 years (Table 1).

Table 1 Prevalence of bacteremia among sex and age groups of suspected patients in the University of Gondar Teaching Hospital from September 2003 to February 2013

Characteristics		No. tested	Positive results, n (%)
Gender	Male	428	98 (23)
	Female	428	71 (17)
Age	≤28 days	125	55 (44)
	29 days–5 years	90	30 (33.3)
	6–14 years	139	19 (13.7)
	15–23 years	160	20 (12.5)
	24–32 years	180	19 (10.6)
	33–41 years	87	12 (13.8)
	42–50 years	46	9 (19.6)
	51–59 years	6	0 (0.0)
	≥60 years	23	5 (21.7)
Total		856	169 (19.7)

Bacterial isolate

From a total of 856 bacteremia-suspected cases, 169 were positive. Mixed bacterial growths were observed in five specimens so that a total of 174 bacteria were isolated (Table 2). From the isolated bacteria, Gram-positive bacteria were more prevalent than Gram-negative bacteria. The most commonly isolated bacteria were coagulase-negative staphylococci (CoNS) followed by *S. aureus*, *E. coli*, and *Citrobacter* species.

Antibiotic susceptibility pattern

Antibiotic susceptibility pattern of Gram-positive bacteria

The observed drug susceptibility pattern of Gram-positive isolates indicated an intermediate level of resistance (60%–80%). In response to the penicillin, the resistance pattern was 72%, in ampicillin, it was 63.4%, in erythromycin, it was 60.3% with only a low level of resistance (60%) in the rest of the tested drugs (Table 3).

Antibiotic susceptibility pattern of Gram-negative bacteria

The antibiotic susceptibility test for Gram-negative bacteria revealed a high level of resistance (>80%) for ampicillin (90.4%), and for amoxicillin (88.7%), an intermediate level of resistance to tetracycline (74.2%) and cotrimoxazole (62.3%), and a low level of resistance to the remaining drugs (Table 4).

Table 2 The frequency of bacterial isolates from patients with bacteremia at the University of Gondar Teaching Hospital from September 2003 to February 2013

Sr. no	Organism	Frequency (%)
1	CoNS	55 (31.6)
2	*Staphylococcus aureus*	48 (27.6)
3	*Escherichia coli*	15 (8.6)
4	*Citrobacter* spp.	8 (4.6)
5	*Salmonella enterica* subsp. *arizonae*	6 (3.4)
6	*Pseudomonas aeruginosa*	6 (3.4)
7	*Streptococcus pyogenes*	6 (3.4)
8	*Klebsiella pneumoniae*	6 (3.4)
9	*Enterobacter* spp.	6 (3.4)
10	*Klebsiella pneumoniae* subsp. *ozaenae*	4 (2.3)
11	*Salmonella* spp.	4 (2.3)
12	*Providentia* spp.	3 (1.7)
13	*Proteus* spp.	3 (1.7)
14	*Streptococcus viridans*	2 (1.1)
15	*Klebsiella pneumoniae* subsp. *rhinoscleromatis*	1 (0.6)
16	*Enterococcus* spp.	1 (0.6)
	Total	174 (100)

Abbreviation: CoNS, coagulase-negative staphylococci.

Table 3 Antibiotic susceptibility pattern of Gram-positive bacteria isolated from blood culture at the University of Gondar Teaching Hospital from September 2003 to February 2013

Isolates		Amp n/total (%)	Amx n/total (%)	Cro n/total (%)	Ery n/total (%)	Cn n/total (%)	Nor n/total (%)	Vanco n/total (%)	Pg n/total (%)	Cip n/total (%)	Caf n/total (%)
CoNS (55)	S	18 (32.7)	26 (47.3)	37 (67.3)	25 (45.5)	26 (47.3)	36 (65.5)	52 (94.5)	13 (23.5)	34 (62)	27 (49)
	I	2 (3.6)	3 (5.4)	0	2 (3.5)	0	0	0	3 (5.5)	2 (3.5)	0
	R	35 (63.7)	26 (47.3)	18 (32.7)	28 (51)	29 (52.7)	19 (34.5)	3 (5.5)	39 (71)	19 (34.5)	28 (51)
Staphylococcus aureus (48)	S	10 (20.8)	10 (20.8)	23 (48)	13 (27)	27 (56.2)	19 (39.5)	39 (81.2)	8 (16.7)	31 (64.6)	29 (60.4)
	I	4 (8.4)	3 (6.2)	0	1 (2.2)	3 (6.2)	2 (4.2)	0	2 (4.2)	3 (6.2)	0
	R	34 (70.8)	35 (73)	25 (52)	34 (70.8)	18 (37.5)	27 (56.3)	9 (18.8)	38 (79.1)	14 (29.2)	19 (39.6)
Streptococcus pyogenes (6)	S	6 (100)	6 (100)	5 (83.3)	3 (50)	2 (33.3)	3 (50)	6 (100)	5 (83.3)	3 (50)	4 (66.7)
	I	0	0	0	0	4 (66.7)	0	0	0	0	0
	R	0	0	1 (16.7)	3 (50)	0	3 (50)	0	1 (16.7)	3 (50)	2 (33.3)
Streptococcus viridans (2)	S	1 (50)	0	–	0	0	0	1 (50)	0	2 (100)	1 (50)
	I	0	0	–	0	0	0	0	0	0	1 (50)
	R	1 (50)	2 (100)	–	2 (100)	2 (100)	2 (100)	1 (50)	2 (100)	0	0
Enterococcus spp. (1)	S	0	0	–	–	1 (100)	1 (100)	–	–	–	
	I	0	0	–	–	0	0	–	–	–	
	R	1 (100)	1 (100)	–	–	0	0	–	–	–	
Total	S	35 (31. 2)	42 (37.5)	65 (59.6)	41 (37)	56 (50)	59 (52.7)	98 (88.3)	26 (23.5)	70 (63)	61 (55)
	I	6 (5.4)	6 (5.4)	0	3 (2.7)	7 (6.3)	2 (1.8)	0	5 (4.5)	5 (4.5)	1 (0.9)
	R	71 (63.4)	64 (57.1)	44 (40.4)	67 (60.3)	49 (43.7)	51 (45.5)	13 (11.7)	80 (72)	36 (32.5)	49 (44.1)
	T	112	112	109	111	112	112	111	111	111	111

Note: (% = n/total), n = number of sensitive isolates.
Abbreviations: Amp, ampicillin; Amx, amoxicillin; Cro, ceftriaxone; Ery, erythromycin; Cn, gentamicin; Nor, norfloxacin; Vanco, vancomycin, Pg, penicillin G; Cip, ciprofloxacin; Caf, chloramphenicol; CoNS, coagulase-negative staphylococci; S, sensitive; I, intermediate; R, resistant; T, total.

Multidrug resistance pattern of bacterial isolates

Multidrug resistance strains were common for both Gram-negative and Gram-positive isolates. Out of 174 isolates, 165 (94.8%) were found to be resistant to at least one antibiotic used in the susceptibility tests and 9 (5.2%) isolates were found to not be resistant to antibiotics used for the susceptibility tests. Resistance to two or more drugs was observed in 94 (84%) of Gram-positive and 57 (92%) of Gram-negative isolates (Table 5).

Discussion

The prevalence rate of bacteremia in Gondar University Teaching Hospital is comparable to reports in Tikur Anbessa Hospital, Addis Ababa, Ethiopia (21.4%,[14,15] and in India (20.5%).[15] However, our finding is slightly higher than the research done in Kasturba Hospital, India (17.8%)[16] and Uganda (17.1%),[17] but lower than research done in Gondar University Hospital (24.2%).[18] The research was done in Teheran Hospital, Iran, Imam Khomeini Teaching Hospital, Iran and in Jimma and shows that the prevalence of bacteremia was 10.23%, 5.6%, and 8.8% respectively,[10,19,20] which are all lower values than in our study. The difference could be due to a variation in the blood culture system, the study design, the geographical location, and/or epidemiological differences in the etiological agents.

Our study shows that males are more likely to suffer from bacteremia than females. This is similar to the study conducted in Iran.[24] The highest isolation rate was observed in the age group of ≤28 days followed by the age group of 29 days–5 years and the age group of 60 years and above. This is comparable with the previous study conducted at the University of Gondar Teaching Hospital.[21] This could be explained by the fact that extreme ages are susceptible to infection because of lower immunity. And also the age group of ≤5 years are exposed to microorganisms because they are fed contaminated food, soil, and other materials due to lack of knowledge about infectious diseases and their transmission, and lack of personal hygiene.

The observation in this study showed that Gram-positive bacteria were predominant compared with Gram-negative bacteria which is in line with other studies conducted in Ethiopia[10,18] and elsewhere in the world.[22] The most isolated organism in our study was CoNS followed by *S. aureus*. This finding is in line with previous studies conducted in Ethiopia[10,18] and other countries.[23] But this finding is contradictory to other reports, such as a study conducted in Kasturba Hospital, India,

Table 4 Antibiotic susceptibility pattern of Gram-negative bacteria isolated from blood culture at the University of Gondar Teaching Hospital from September 2003 to February 2013

Isolates		Amp	Amx	Cro	Cip	Cn	Na	Nor	Sxt	Te	Cxt
Escherichia coli (15)	S	1 (6.6)	2 (13.3)	11 (73.3)	10 (66.7)	7 (46.7)	9 (60)	10 (66.7)	4 (26.7)	3 (20)	8 (53.3)
	I	0	0	2 (13.3)	0	0	0	0	0	2 (13.3)	0
	R	14 (92.3)	13 (86.7)	2 (12.3)	5 (33.3)	8 (53.3)	6 (40)	5 (33.3)	11 (73.3)	10 (66.7)	7 (46.7)
Citrobacter spp. (8)	S	0	0	5 (62.5)	5 (62.5)	2 (25)	5 (62.5)	7 (87.5)	7 (87.5)	1 (12.5)	5 (62.5)
	I	0	0	0	0	0	2 (25)	0	0	0	0
	R	8 (100)	8 (100)	3 (37.5)	3 (37.5)	6 (75)	1 (12.5)	1 (12.5)	1 (12.5)	7 (87.5)	3 (37.5)
Pseudomonas aeruginosa (6)	S	0	0	4 (66.7)	3 (50)	3 (50)	–	5 (83.3)	2 (33.3)	2 (33.3)	4 (66.7)
	I	0	0	2 (33.3)	0	0	–	0	0	0	2 (33.3)
	R	6 (100)	6 (100)	0	3 (50)	3 (50)	–	1 (16.7)	4 (66.7)	4 (66.7)	0
Salmonella enterica subsp. *Arizonae* (6)	S	0	0	0	5 (83.3)	0	3 (50)	5 (83.3)	2 (33.3)	1 (16.7)	5 (83.3)
	I	0	0	0	0	0	3 (50)	0	0	0	0
	R	6 (100)	6 (100)	6 (100)	1 (16.7)	6 (100)	0	1 (16.7)	4 (66.7)	5 (83.3)	1 (16.7)
Klebsiella pneumoniae (6)	S	0	0	2 (33.3)	2 (33.3)	2 (33.3)	–	6 (100)	2 (33.3)	2 (33.3)	–
	I	0	0	0	0	1 (16.7)	–	0	0	0	–
	R	6 (100)	6 (100)	4 (66.7)	4 (66.7)	3 (50)	–	0	4 (66.7)	4 (66.7)	–
Enterobacter spp. (6)	S	1 (16.7)	1 (16.7)	0	6 (100)	1 (16.7)	3 (50)	5 (83.3)	0	2 (33.3)	2 (33.3)
	I	0	0	3 (50)	0	0	0	0	0	0	0
	R	5 (83.3)	5 (83.3)	3 (50)	0	5 (83.3)	3 (50)	1 (16.7)	6 (100)	4 (66.7)	4 (66.7)
Salmonella spp. (4)	S	0	0	4 (100)	2 (50)	4 (100)	3 (75)	–	1 (25)	0	4 (100)
	I	0	0	0	0	0	0	–	0	0	0
	R	4 (100)	4 (100)	0	2 (50)	0	1 (25)	–	3 (75)	4 (100)	0
Klebsiella pneumoniae subsp. Ozaenae (4)	S	0	0	4 (100)	4 (100)	2 (50)	4 (100)	3 (75)	1 (25)	0	1
	I	3 (75)	3 (75)	0	0	0	0	0	0	0	0
	R	1 (25)	1 (25)	0	0	2 (50)	0	1 (25)	3 (75)	4 (100)	3 (75)
Providential spp. (3)	S	0	0	3 (100)	3 (100)	–	3 (100)	3 (100)	2 (66.7)	1 (33.3)	–
	I	0	0	0	0	–	0	0	0	0	–
	R	3 (100)	3 (100)	0	0	–	0	0	1 (33.3)	2 (66.7)	–
Proteus spp. (3)	S	1 (33.3)	1 (33.3)	2 (66.7)	–	3 (100)	2 (66.7)	3 (100)	2 (66.7)	1 (33.3)	2 (66.7)
	I	0	0	0	–	0	0	0	0	0	1 (33.3)
	R	2 (66.7)	2 (66.7)	1 (33.3)	–	0	1 (33.3)	0	1 (33.3)	2 (66.7)	0
Klebsiella pneumoniae subsp. *rhinoscleromatis* (1)	S	0	0	–	–	–	1 (100)	1 (100)	–	1 (100)	1 (100)
	I	0	0	–	–	–	0	0	–	0	0
	R	1 (100)	1 (100)	–	–	–	0	0	–	0	0
Total	S	3 (4.8)	4 (6.5)	35 (57.4)	40 (69)	24 (41.4)	33 (66)	48 (82.7)	23 (37.7)	14 (22.5)	32 (60.4)
	I	3 (4.8)	3 (4.8)	7 (11.5)	0	1 (1.7)	5 (10)	0	0	2 (3.3)	3 (5.6)
	R	56 (90.4)	55 (88.7)	19 (31.1)	18 (31)	33 (56.9)	12 (24)	10 (17.2)	38 (62.3)	46 (74.2)	18 (34)
	T	62	62	61	58	58	50	58	61	62	53

Abbreviations: Amp, ampicillin; Amx, amoxicillin; Cro, ceftriaxone; Cip, ciprofloxacin; Cn, gentamicin; Na, nalidixic acid; Nor, norfloxacin; Sxt, trimethoprim-sulfamethoxazole; Te, tetracycline; Cxt, cefoxitin; S, sensitive; I, intermediate; R, resistant; T, total.

Banaras Hindu University Hospital, India, Teheran Hospital, Iran, Imam Khomeini Teaching Hospital, Iran and Uganda, showing that Gram-negative bacteria were the most causative agents of bacteremia.[16,17,19,20,22] This might be due to the organisms responsible for bacteremia varying across geographical boundaries. Though, generally, the kind of bacteria isolated from blood in our study is similar to previous findings from Ethiopia[10,18] and elsewhere in the world.[17,23,24]

In our study, CoNS is the most common causative agent for bacteremia among Gram-positive isolates, which is similar to the studies conducted in Jimma, Addis Ababa, and Gondar.[10,18] This may be due to the fact that most CoNS are the normal flora of the skin. So, during blood collection, they may contaminate the blood. And also it may be the expanding use of intravascular catheters and indwelling prosthetic devices causing the increase of nosocomial bacteremia caused by CoNS because they infect a wide variety of prosthetic medical devices. Among Gram-negative bacteria, *E. coli* was the predominant species which is comparable to the previous study conducted in Jimma.[10] This may be due to its association with high-risk surgical procedures, particularly in the digestive or urinary tract that releases bacteria from sequestered sites into the blood, which may carry infection to remote parts of the body.

Table 5 Multi-drug resistance pattern of bacterial isolates from blood culture at the University of Gondar Teaching Hospital from September 2003 to February 2013

Isolates	Frequency	R0 (%)	R1 (%)	R2 (%)	R3 (%)	R4 (%)	R5 (%)	R6 (%)	>R7 (%)
Gram positive	112	7 (6.2)	11 (9.8)	23 (20.5)	13 (11.6)	8 (7.1)	12 (10.8)	13 (11.6)	25 (22.3)
CoNS	55	4 (7.3)	7 (12.7)	11 (20)	11 (20)	2 (3.6)	7 (12.7)	3 (5.4)	10 (18.2)
Staphylococcus aureus	48	1 (2.1)	4 (8.3)	9 (18.7)	1 (2.1)	6 (12.5)	4 (8.3)	9 (18.7)	14 (29.2)
Streptococcus pyogen	6	2 (33.3)	0 (0.00)	3 (50)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (16.7)
Streptococcus viridans	2	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (50)	1 (50)	0 (0.00)
Enterococcus spp.	1	0 (0.00)	0 (0.00)	0 (0.00)	1 (100)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
Gram negative	62	2 (3.2)	3 (4.8)	10 (16.1)	15 (24.2)	11 (17.7)	13 (20.9)	6 (9.7)	2 (3.2)
Escherichia coli	15	1 (6.7)	0 (0.00)	4 (26.7)	2 (13.3)	2 (13.3)	1 (6.7)	3 (20)	2 (13.3)
Citrobacter spp.	8	0 (0.00)	1 (12.5)	1 (12.5)	1 (12.5)	3 (37.5)	1 (12.5)	1 (12.5)	0 (0.00)
Salmonella enterica subsp. *arizonae*	6	0 (0.00)	0 (0.00)	0 (0.00)	1 (16.7)	1 (16.7)	3 (50)	1 (16.7)	0 (0.00)
Pseudomonas aeruginosa	6	0 (0.00)	0 (0.00)	2 (33.3)	2 (33.3)	1 (16.7)	1 (16.7)	0 (0.00)	0 (0.00)
Klebsiella pneumonia	6	0 (0.00)	1 (16.7)	0 (0.00)	1 (16.7)	1 (16.7)	2 (33.3)	1 (16.7)	0 (0.00)
Enterobacter spp.	6	0 (0.00)	0 (0.00)	1 (16.7)	1 (16.7)	0 (0.00)	4 (66.7)	0 (0.00)	0 (0.00)
Salmonella spp.	4	0 (0.00)	1 (25)	0 (0.00)	1 (25)	1 (25)	1 (25)	0 (0.00)	0 (0.00)
Klebsiella pneumoniae subsp. *ozaenae*	4	1 (25)	0 (0.00)	1 (25)	1 (25)	1 (25)	0 (0.00)	0 (0.00)	0 (0.00)
Providential spp.	3	0 (0.00)	0 (0.00)	0 (0.00)	3 (100)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
Proteus spp.	3	0 (0.00)	0 (0.00)	1 (33.3)	1 (33.3)	1 (33.3)	0 (0.00)	0 (0.00)	0 (0.00)
Klebsiella pneumoniae subsp. *rhinoscleromatis*	1	0 (0.00)	0 (0.00)	0 (0.00)	1 (100)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)

Abbreviation: CoNS, coagulase-negative staphylococci.

This study also provides insight into the drugs susceptibility profile of bacteria isolated from blood. The overall antimicrobial susceptibility pattern of Gram-positive bacteria in our study shows an intermediate level of resistance (60%–80%) was observed in response to penicillin, ampicillin, and erythromycin, whereas antibiotics like vancomycin, ciprofloxacin, and ceftriaxone show a high sensitivity pattern relative to other tested drugs (Table 4), which is slightly different from the study conducted in Jimma[10] and elsewhere in the world.[16,17,23,24]

The overall antimicrobial susceptibility pattern of Gram-negative bacteria shows that they have a high level of resistance (>80%) against ampicillin and amoxicillin and an intermediate level of resistance to tetracycline and co-trimoxazole. However, high sensitivity was observed to norfloxacin and ciprofloxacin relative to other tested drugs, which is in agreement with the previous studies conducted in Jimma[16] and elsewhere in the world.[16,20] In our study, ciprofloxacin, vancomycin, ceftriaxone, and norfloxacin were the most effective drug when compared to other drugs tested against both Gram-negative and Gram-positive isolates. This finding is comparable to the studies conducted in Ethiopia[10,18] and elsewhere in the world.[17,20] The effectiveness of these drugs against the tested organisms in our study may be a reflection of the infrequency of prescription of these drugs by physicians and the drugs may be higher cost relative to others, so people do not take these drugs for self-medication.

In this study, multiple drug resistance isolates were observed in both Gram-positive and Gram-negative isolates. This finding is inconsistent with the previous studies conducted in Ethiopia.[10,18] The reason for multidrug resistance in Ethiopia might be the unregulated over-the-counter sale of antimicrobials, mainly for self-treatment of suspected infection in humans without prescription, which would inevitably lead to the emergence and rapid dissemination of resistant strains. In addition, the availability of cheaper generic drugs (like amoxicillin) of variable quality in the market for treatment of bacterial infections may also contribute to the increased level of resistance. A study on the practice of self-medication in Jimma town showed that out of the 152 ill people, 27.6% were self-medicated.[21] Generally, it is well known that microbial drug resistance is growing.

Conclusion

Overall prevalence of bacteremia in our study was 19.7%. The Gram-positive isolates were predominant compared to the Gram-negative ones. Among all isolates, CoNS were predominant. Ciprofloxacin, vancomycin, ceftriaxone, and norfloxacin were the most effective drugs when compared to other drugs tested against both Gram-negative and Gram-positive isolates. Our study results showed the presence of high rates of resistance to the most commonly used antibiotics used to treat bacterial infections. Multiple drug resistance was observed in 94 (84%) of the Gram-positive and 57 (92%) of the Gram-negative isolates.

Recommendations

Empirical antibiotic treatment for Gram-negative and Gram-positive bacteria must be taken into consideration because, nowadays, most of the isolated bacteria show high rates of resistance to the most commonly used drugs like ampicillin, amoxicillin, and tetracycline, etc. Therefore, treatment of bacteremia should be based on culture and sensitivity rather than on universal guidelines.

Routine bacterial surveillance and the study of their resistance pattern must be essential components in providing alternative drugs for resistant bacteria.

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Disclosure

The authors report no conflicts of interest in this work.

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