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Original Article

Changing Face of Antimicrobial Resistance: A Cross-Sectional Study

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Abstract

Introduction

Infections of sterile body fluids are significant contributors to mortality and morbidity. Accurate species-level identification and understanding of the antimicrobial resistance profiles are crucial for selecting appropriate antimicrobials for empirical and targeted therapy. This study aims to examine the distribution of various bacterial species and their evolved antimicrobial resistance profiles isolated from different body fluids.

Methods

This retrospective study evaluated 301 body fluid samples collected at a tertiary hospital between January 2023 and December 2023. Samples were gram-stained and cultured on an appropriate media. Bacterial identification and susceptibility testing were performed using the BD Phoenix™ system, with disk diffusion method used for antibiotics not available in the system.

Results

Microbial growth was detected in 151 cases (50.2%), with a comparable prevalence among males and females (53.0% vs. 46.7%). The mean age was 49.81± 24.1 years. Growth rates were slightly higher in hospital-acquired infections (55.7%) than in community-acquired infections (49.2%). Cerebrospinal fluid showed the highest growth rate at 34.3%. Among the isolates, *Streptococcus species* were the most common (14.6%), while *Escherichia coli* was the predominant Gram-negative bacterium (13.2%). Sensitivity was highest with tigecycline (100%) and meropenem (92%), whereas resistance was most notable against ampicillin-sulbactam (100%) and azithromycin (95.2%). Multidrug resistance was identified in 106 isolates (70.2%).

Conclusion

High antibiotic resistance and multidrug-resistant strains underscore the need for rigorous antibiotic stewardship and improved infection control to address untreatable infections.

1. Introduction

Sterile body fluids, including ascitic fluid, cerebrospinal fluid, peritoneal fluid, synovial fluid, pleural fluid, and drain fluid, are normally devoid of microorganisms under healthy conditions [1]. However, when these fluids become infected, they can harbor various pathogenic bacteria, leading to serious invasive diseases such as bacteremia, bacterial meningitis, and bacterial peritonitis [2]. These infections are critical conditions that demand prompt medical intervention to prevent the escalation of potentially life-threatening systemic infections [3,4]. The presence of pathogens in these fluids signals a breach in the body's defenses and necessitates prompt treatment to prevent severe complications [5].

Antimicrobial resistance represents a growing global health crisis, contributing to increased morbidity, prolonged hospital stays, higher medical costs, and elevated mortality rates. The European Centre for Disease Prevention and Control reports that multidrug-resistant microorganisms are responsible for approximately 25,000 deaths annually in Europe alone [6]. Similarly, The United States Centers for Disease Control and Prevention conservatively estimate that over two million individuals in the United States are affected by antibiotic-resistant infections annually, with at least 23,000 fatalities directly attributed to these infections [7]. According to a study in 2019, it was estimated that antimicrobial-resistant infections were directly responsible for approximately 1.27 million deaths, with nearly 5 million deaths linked to drug-resistant infections in some capacity. By 2050, this number could rise to 10 million deaths annually, surpassing the mortality rates associated with cancer [8].

The problem of antimicrobial resistance is particularly pronounced in developing countries, where factors such as limited healthcare infrastructure, inadequate resources, poor hygiene and sanitation, irrational antibiotic use, and socioeconomic challenges exacerbate the spread of resistant microbes [1]. Various bacterial agents have been implicated in infections of body fluids, including gram-negative bacteria such as *Escherichia coli*, *Klebsiella spp.*, *Acinetobacter spp.*, and *Pseudomonas spp.*, as well as Gram-positive bacteria like *Streptococcus spp.*, *Neisseria meningitidis*, *Enterobacter spp.*, and *Staphylococcus species* [3]. Understanding the bacterial profiles and their antimicrobial susceptibility patterns is crucial for effectively treating and managing these infections.

Despite the critical nature of these infections, data on the bacteriological profile and antimicrobial resistance patterns of different body fluids in developing countries remains limited. The current study aims to evaluate the bacterial profile and antimicrobial susceptibility patterns among various body fluids. By providing a detailed analysis of prevalent bacterial strains and their resistance patterns, this study seeks to inform better management practices and contribute to developing effective local antimicrobial policies.

2. Methods

2.1. Study Design, Area, and Period

This retrospective study was conducted on 301 body fluid samples collected between January 2023 and December 2023 at Smart Health Tower, Iraq. Ethical approval for the study was obtained from the Kscien Organization for Ethical Approval (reference number: 24/No. 24). Before data collection, all participants were fully informed about the nature of the study, and their consent was obtained in accordance with ethical standards.

2.2. Sampling and Study Population

Data were meticulously extracted from the records of patients who had their body fluid samples processed in the microbiology laboratory. The samples included cerebrospinal fluid, pleural fluid, peritoneal fluid, synovial fluid, drain fluid, pericardial fluid, and others that were not specifically categorized as these fluids in the database. Blood culture specimens were specifically excluded from the study due to the distinct processing methods required. The inclusion criteria encompassed data sets that provided complete information, including age, sex, isolated pathogens, and antibiotic resistance profiles of the isolates. Patients with incomplete data were excluded to ensure the accuracy and reliability of the study findings.

2.3. Sample Processing

Upon receipt in the laboratory, each body fluid specimen underwent direct Gram staining as an initial diagnostic step. Following this, specimens were cultured on enriched media, including blood agar and chocolate agar, as well as differential media such as MacConkey agar. The plates were incubated under aerobic conditions for 24 hours. Blood agar and chocolate agar plates were additionally incubated in a capnophilic environment to support the growth of fastidious organisms. If microbial growth was observed, colonies were identified using the BD Phoenix™ system, an automated platform for both identification and susceptibility testing of bacterial isolates, which provides accurate genus and species-level identification [9]. For samples that did not exhibit visible growth after the initial 24 hours, the incubation was extended to 48 hours.

2.4. Determination of the Antibiotic Sensitivity Pattern

Antibiotic susceptibility testing was performed using the BD Phoenix™ system, following the Clinical and Laboratory Standards Institute guidelines. For antibiotics not available in the BD Phoenix™ system, the disk diffusion method (Kirby-Bauer) was employed, utilizing prepared antibiotic discs with standardized concentrations on Mueller-Hinton agar ensuring comprehensive susceptibility testing across all relevant antibiotics. The antibiotics tested included Amikacin, Gentamicin, Gentamicin-Syn, Ampicillin-sulbactam, Ampicillin, Amoxicillin, Amoxicillin-Clavulanate, Piperacillin-Tazobactam, Piperacillin, Penicillin G, Oxacillin, Cefuroxime, Ceftriaxone, Cefepime, Cefoxitin, Ceftaroline, Cefpodoxime, Cefixime, Cefotaxime, Clarithromycin, Azithromycin, Erythromycin, Ciprofloxacin, Levofloxacin, Moxifloxacin, Norfloxacin, Ofloxacin, Trimethoprim-Sulfamethoxazole, Vancomycin, Teicoplanin, Daptomycin, Clindamycin, Tetracycline, Doxycycline, Minocycline, Tigecycline, Imipenem, Meropenem, Nitrofurantoin, Linezolid, Rifampin, Chloramphenicol, Mupirocin High level. This combined

approach ensured consistent and accurate interpretation of susceptibility results, enhancing the reliability of the findings.

2.5. Antibiotic Classification and Multidrug Resistance

The antibiotics were grouped into seven distinct categories: aminoglycosides, beta-lactams, macrolides, tetracyclines, glycopeptides, sulfonamides, and fluoroquinolones. Multidrug-resistant (MDR) isolates were defined as bacterial strains exhibiting resistance to three or more antibiotic classes [10]. This classification allowed for a thorough analysis of resistance patterns and aided in identifying the most challenging cases of antibiotic resistance.

2.5. Data analysis

The collected data were entered into Microsoft Excel 2007 before being transferred to SPSS version 25 for statistical analysis. Laboratory findings were categorized by age, gender, Source of infection, comorbidities, hospital stay duration, and bacterial isolate types. The analysis included calculating prevalence rates, frequencies, susceptibility patterns, and other descriptive statistics. The chi-square test was employed to compare categorical variables with bacterial growth, with statistical significance set at a p-value of less than 0.05.

3. Results

In this study, prevalence of microbial growth was comparable, with 88 cases (53.0%) males, compared to 63 cases (46.7%) in females. The overall mean age of participants was 49.81 ± 24.1 years. Notably, the mean age of individuals with microbial growth was slightly higher at 50.23 ± 26.1 years, compared to 49.4 ± 21.9 years in those without growth. The highest prevalence of microbial growth occurred in individuals aged 21-40, with 44 cases (59.5%). Hospital-acquired infections exhibited a slightly higher growth rate, with 54 cases (55.7%), compared to community-acquired infections, with 61 cases (49.2%). Additionally, patients with diabetes and obesity demonstrated higher rates, with 29 cases (63%) and 22 cases (56.4%), respectively (Table 1).

Microbial growth was observed in 151 cases (50.2%), with notable variability across fluid types; cerebrospinal fluid exhibited the highest rate at 12(34.3%) cases, followed by a pleural fluid at 9(25.7%), and synovial fluid at 3(20%). Among gram-positive bacteria, *Streptococcus species* were the most commonly isolated, accounting for 22(14.6%) cases, followed by *Staphylococcus aureus* and *Staphylococcus epidermidis*, each at 15(9.9%). For Gram-negative bacteria, *Escherichia coli* was the most prevalent at 20(13.2%) cases, followed by *Pseudomonas aeruginosa* at 11(7.2%) and *Klebsiella pneumoniae* 9(6.0%). *Candida species* were detected in 4(2.6%) of cases (Table 2).

Regarding the resistance pattern, a diverse range of resistance profiles was observed (Figure 1). Among the tested gram-positive isolates, the sensitivity rate was highest to tigecycline at 23(100%), followed by meropenem at23(92%), daptomycin at 28(90.3%), imipenem at 25(89.3%), and vancomycin 57(89%). Conversely, high antibiotic resistance rates were observed, with

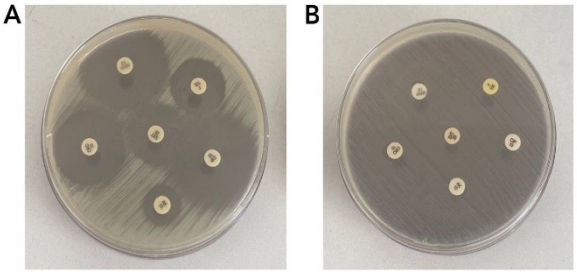

Figure 1. Antibiotic sensitivity assessment of the isolated bacterial strains, (A) All tested antibiotics (SXT: Trimethoprim/sulphamethoxazole, CRO: Ceftriaxone, CIP: Ciprofloxacin, F: Nitrofurantoin, AK: Amikacin, MRP: Meropenem) exhibited full sensitivity against the isolates (B) isolates were resistant to all antibiotic's tested.

7 (100%) isolates resistant to ampicillin-sulbactam, 20(95.2%) to azithromycin, 11(78.6%) to ofloxacin, and 14(77.8%) to cefixime. Among the Gram-positive bacterial isolates examined, Corynebacterium striatum exhibited the highest antibiotic resistance rate at 30(73.2%), followed by *Arcanobacterium haemolyticum* with 23(63.9%), Enterococcus faecalis with 93(48.7%), and *Staphylococcus species* at 110(45.8%). Overall, the total resistance rate for the Gram-positive isolates was 637(41.5%) (Table 3).

Among the Gram-negative isolates, relative sensitivities were observed as follows: 44(83%) to meropenem, 42(76.4%) to imipenem, 39(75%) to piperacillin-tazobactam, 29(70.7%) to nitrofurantoin, and 37(68.5%) to amikacin. Conversely, high resistance rates were noted, with 20(100%) of isolates showing resistance to clindamycin, 14(100%) to rifampin, 35(94.6%) to ampicillin, and 13(92.9) to erythromycin. Within the Gram-negative bacterial isolates, *Burkholderia cepacia* demonstrated highest resistance rate with 21 isolates (72.4%), followed by *Achromobacter species* at 56(67.5%) isolates, *Moraxella species* at 33(62.3%), and *Acinetobacter baumannii* at 19(61.3%). The overall resistance rate among the Gram-negative isolates was 448(49.5%) (Table 4).

Among the bacterial isolates tested, 106 (70.2%) were identified as MDR. Specifically, 51 out of 65 (78.5%) gram-negative isolates exhibited MDR. Within this category, 10 out of 11 (90.9%) *Pseudomonas aeruginosa* isolates and 17 out of 20 (85%) *Escherichia coli* were classified as MDR. In contrast, the prevalence of MDR among gram-positive isolates was lower, with 55 out of 82 (67.1%) demonstrating resistance. Notably, 14 out of 15 (93.3%) *Staphylococcus aureus* isolates were MDR (Table 5).

4. Discussion

Microbial invasion of body fluids and normally sterile body areas can lead to systemic illness and represents a life-threatening emergency. Delays in treatment can be fatal. The effectiveness of available antibiotics has recently diminished globally due to the rise of resistant strains. Consequently,

Table 1. Comparative Evaluation of Bacterial Growth with Demographic and clinical Characteristics among samples isolated from different body fluids.

Variables	Bacterial Growth		Total	P-Value
	No Growth	Growth		
Gender (N, %)				
Female	72(53.3)	63(46.7)	135 (100)	0.274
Male	78(47.0)	88(53.0)	166 (100)	
Age (Mean± SD)	49.4± 21.9	50.23± 26.1	49.81± 24.1	0.764
Age group (N, %)				
≤ 20	24(61.5)	15 (38.5)	39(100)	
21-40	30(40.5)	44(59.5)	74(100)	
41-60	34(48.6)	36(51.4)	70(100)	0.166
≥ 61	62(52.5)	56(47.5)	118(100)	
Source of infection (N, %)				
Community	63(50.8)	61(49.2)	124(100)	
Hospital	43(44.3)	54(55.7)	97(100)	0.354
Not mentioned	44(55.0)	36(45.0)	80(100)	
Length of hospital stay (Day, Mean± SD)	15.40±34.9	16.03±35.2	15.69±34.9	0.917
Asthma (N, %)				
Yes	7(53.8)	6(46.2)	13(100)	
No	99(47.6)	109(52.4)	208(100)	0.508
Not mentioned	44(55.0)	36(45.0)	80(100)	
Heart Failure (N, %)				
Yes	25(62.5)	15(37.5)	40(100)	
No	81(44.8)	100(55.2)	181(100)	0.105
Not mentioned	44(55.0)	36(45.0)	80(100)	
Renal insufficiency				
Yes	13(50)	13(50)	26(100)	
No	93(47.7)	102(52.3)	195(100)	0.546
Not mentioned	44(55.0)	36(45.0)	80(100)	
Hypertension				
Yes	27(45.8)	32(54.2)	59(100)	
No	79(48.8)	83(51.2)	162(100)	0.623
Not mentioned	44(55.0)	36(45.0)	80(100)	
Obesity				
Yes	17(43.6)	22(56.4)	39(100)	
No	89(48.9)	93(51.1)	182(100)	0.466
Not mentioned	44(55.0)	36(45.0)	80(100)	
Malignant				
Yes	12(52.2)	11(47.8)	23(100)	
No	94(47.5)	104(52.5)	198(100)	0.510
Not mentioned	44(55.0)	36(45.0)	80(100)	
Diabetes				
Yes	17(37)	29(63)	46(100)	
No	89(50.9)	86(49.1)	175(100)	0.137
Not mentioned	44(55.0)	36(45.0)	80(100)	

infections caused by these resistant agents are increasingly difficult to treat and sometimes become untreatable [11].

A study by Shume et al. at Hiwot Fana Specialized University Hospital in Eastern Ethiopia reported a higher prevalence of microbial growth among males [1]. In contrast, a separate study conducted at Debre Markos Comprehensive Specialized Hospital in the Amhara regional state of Ethiopia found a greater incidence of microbial growth among females than males [12]. In the present study, microbial growth was more prevalent among males, with 88 out of 166 (53%) exhibiting growth. Additionally, the highest prevalence of microbial growth occurred in individuals aged 21-40, with 44 cases (59.5%). This finding contrasts with two other studies, which reported the highest prevalence in patients aged over 40 years [1,12].

In this study, microbial growth was detected in 50% of cases. Among the categorized body fluids, cerebrospinal fluid, peritoneal fluid, synovial fluid, and pleural fluid—the prevalence rate was 25/68 (36.8%). This rate is higher than that reported in several other studies. For instance, Çetin et al. in Turkey observed a prevalence rate of 25% [13]. Similarly, a study from a tertiary care hospital in South India reported a prevalence rate of approximately 29.9% [3]. A four-year retrospective study conducted at a tertiary hospital in Northern Ethiopia found a prevalence rate of 20.2% among 218 patients [4]. Additionally, a study at a University Hospital in Eastern Ethiopia reported a prevalence rate of 16.7% [1]. The considerable variation in positivity rates for these fluids may be attributed to differences in antibiotic usage, the frequency of effusions resulting from infectious processes, variations in infection control practices, sample size, study duration, and the diversity of study populations.

Table 2. Distribution of pathogenic microorganisms isolated from different body fluids.

Variables	Total (N, %)	Type of fluid				
		CSF	Pleural	Pericardial	Synovial	Others
Growth status (N, %)						
Growth	151(50.2)	12(34.3)	9(25.7)	1(12.5)	3(20)	126(60.6)
No growth	150(49.8)	23(65.7)	26(74.3)	7(87.5)	12(80)	82(39.4)
Gram-positive bacteria (N, %)	82(54.3)					
Streptococcus species	22(14.6)	0(0)	1(11.1)	0(0)	0(0)	21(16.7)
Staphylococcus aureus	15(9.9)	0(0)	0(0)	0(0)	1(33.3)	14(11.1)
Staphylococcus epidermidis	15(9.9)	4(33.3)	0(0)	0(0)	0(0)	11(8.7)
Staphylococcus species	11(7.3)	3(25)	3(33.3)	0(0)	0(0)	5(4.0)
Enterococcus faecalis	11(7.3)	1(8.3)	1(11.1)	0(0)	0(0)	9(7.1)
Arcanobacterium haemolyticum	2(1.3)	0(0	0(0)	0(0)	0(0)	2(1.6)
Corynebacterium striatum	2(1.3)	0(0)	0(0)	0(0)	1(33.3)	1(0.8)
Pediococcus pentosaceus	2(1.3)	0(0)	0(0)	0(0)	0(0)	2(1.6)
Kocuria Kristinae	1(0.7)	0(0)	0(0)	0(0)	0(0)	1(0.8)
Kytococcus sedentarius	1(0.7)	0(0)	0(0)	0(0)	0(0)	1(0.8)
Gram negative bacteria (N, %)	65(43%)					
Escherichia coli	20(13.2)	1(8.3)	0(0)	0(0)	0(0)	19(15.1)
Pseudomonas aeruginosa	11(7.2)	2(16.7)	0(0)	0(0)	0(0)	9(7.1)
Klebsiella pneumonia	9(6.0)	0(0)	0(0)	0(0)	0(0)	9(7.1)
Achromobacter species	5(3.3)	0(0)	0(0)	0(0)	1(33.3)	4(3.2)
Moraxella species	4(2.6)	0(0)	0(0)	0(0)	0(0)	4(3.2)
Acinetobacter baumannii/calcoaceticus	2(1.3)	0(0)	0(0)	1(100)	0(0)	1(0.8)
Burkholderia cepacia	2(1.3)	0(0)	1(11.1)	0(0)	0(0)	1(0.8)
Klebsiella species	2(1.3)	0(0)	0(0)	0(0)	0(0)	2(1.6)
Proteus species	2(1.3)	0(0)	0(0)	0(0)	0(0)	2(1.6)
Aeromonas hydrophila	1(0.7)	0(0)	1(11.1)	0(0)	0(0)	0(0)
Alcaligenes faecalis	1(0.7)	0(0)	0(0)	0(0)	0(0)	1(0.8)
Alloiococcus otitidis	1(0.7)	0(0)	0(0)	0(0)	0(0)	1(0.8)
Escherichia hermannii	1(0.7)	0(0)	0(0)	0(0)	0(0)	1(0.4)
Pseudomonas oryzihabitans	1(0.7)	0(0)	0(0)	0(0)	0(0)	1(0.8)
Rhizobium radiobacter	1(0.7)	1(8.3)	0(0)	0(0)	0(0)	0(0)
Serratia odorifera	1(0.7)	0(0)	1(11.1)	0(0)	0(0)	0(0)
Stenotrophomonas maltophilia	1(0.7)	0(0)	1(11.1)	0(0)	0(0)	0(0)
Yeast	4(2.7)					
Candida species	4(2.7)	0(0)	0(0)	0(0)	0(0)	4(3.2)

CSF: Cerebrospinal fluid.

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Table 3. Antimicrobial Susceptibility Profile of Gram-Positive Bacteria Isolated from different body fluids.

Antibiotic class	Antibiotics	*Streptococcus species*	*Staphylococcus aureus*	*Staphylococcus epidermidis*	*Staphylococcus species*	*Enterococcus faecalis*	*Arcanobacterium haemolyticum*	*Corynebacterium striatum*	*Pediococcus pentosaceus*	Total (N, %)
Aminoglycosides	Amikacin (N, %)	14	0	3	3	1	2	2	0	25
	I	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	R	13(92.9)	0(0)	2(66.7)	1(33.3)	1(100)	1(50)	1(50)	0(0)	19(76)
	S	1(7.1)	0(0)	1(33.3)	2(66.7)	0(0)	1(50)	1(50)	0(0)	6(24)
	Gentamicin (N, %)	16	15	14	11	10	2	1	1	70
	I	0(0)	0(0)	0(0)	0(0)	1(10)	0(0)	0(0)	0(0)	1(1.4)
	R	16(100)	2(13.3)	5(35.7)	4(36.4)	6(60)	2(100)	1(100)	1(100)	37(52.9)
	S	0(0)	13(86.7)	9(64.3)	7(63.6)	3(30)	0(0)	0(0)	0(0)	32(45.7)
	Gentamicin-Syn (N, %)	1	11	9	6	7	0	0	0	34
	I	0(0)	0(0)	1(11.1)	0(0)	2(28.6)	0(0)	0(0)	0(0)	3(8.8)
	R	0(0)	1(9.1)	2(22.2)	1(16.7)	2(28.6)	0(0)	0(0)	0(0)	6(17.7)
	S	1(100)	10(90.9)	6(66.7)	5(83.3)	3(42.8)	0(0)	0(0)	0(0)	25(73.5)
Penicillin's	Ampicillin-sulbactam (N, %)	0	2	3	2	0	0	0	0	7
	I	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	R	0(0)	2(100)	3(100)	2(100)	0(0)	0(0)	0(0)	0(0)	7(100)
	S	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	Ampicillin (N, %)	4	10	5	5	8	0	0	1	33
	I	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	R	3(75)	9(90)	5(100)	4(80)	2(25)	0(0)	0(0)	0(0)	23(69.7)
	S	1(25)	1(10)	0(0)	1(20)	6(75)	0(0)	0(0)	1(100)	10(30.3)
	Amoxicillin (N, %)	5	0	0	0	2	0	0	0	7
	I	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	R	1(20)	0(0)	0(0)	0(0)	2(100)	0(0)	0(0)	0(0)	3(42.9)
	S	4(80)	0(0)	0(0)	0(0	0(0)	0(0	0(0	0(0	4(57.1)
	Amoxicillin-Clavulanate (N, %)	18	3	1	4	5	1	2	3	37
	I	1(5.6)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(2.7)
	R	8(44.4)	3(100)	1(100)	4(100)	3(60)	1(100)	2(100)	1(33.3)	23(62.2)
	S	9(50)	0(0)	0(0)	0(0)	2(40)	0(0)	0(0)	2(66.7)	13(35.1)
	Piperacillin-Tazobactam (N, %)	8	2	2	3	0	1	2	0	18
	I	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	R	2(25)	0(0)	1(50)	2(66.7)	0(0)	0(0)	1(50)	0(0)	6(33.3)
	S	6(75)	2(100)	1(50)	1(33.3)	0(0)	1(100)	1(50)	0(0)	12(66.7)
	Piperacillin (N, %)	5	0	1	2	1	0	0	1	10
	I	0(0)	0(0)	0(0)	0(0)	1(100)	0(0)	0(0)	0(0)	1(10)
	R	0(0)	0(0)	1(100)	2(100)	0(0)	0(0)	0(0)	0(0)	3(30)
	S	5(100)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(100)	6(60)
	Penicillin G (N, %)	6	11	8	8	8	0	0	0	41
	I	2(33.3)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	2(4.9)
	R	2(33.3)	8(72.7)	8(100)	3(37.5)	4(50)	0(0)	0(0)	0(0)	25(61)
	S	2(33.3)	3(27.3)	0(0)	5(62.5)	4(50)	0(0)	0(0)	0(0)	14(34.1)
	Oxacillin (N, %)	0	15	14	9	5	0	0	0	43
	I	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	R	0(0)	5(33.3)	5(35.7)	6(66.7)	3(60)	0(0)	0(0)	0(0)	19(44.2)
	S	0(0)	10(66.7)	9(64.3)	3(33.3)	2(40)	0(0)	0(0)	0(0)	24(55.8)

Cephalosporins	Cefuroxime (N, %)	7	3	5	3	0	0	2	0	20
	I	0(0)	0(0)	1(20)	1(33.3)	0(0)	0(0)	0(0)	0(0)	2(10)
	R	1(14.3)	0(0)	0(0)	0(0)	0(0)	0(0)	2(100)	0(0)	3(15)
	S	6(85.7)	3(100)	4(80)	2(66.7)	0(0)	0(0)	0(0)	0(0)	15(75)
	Ceftriaxone (N, %)	17	1	2	2	0	2	2	2	28
	I	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	R	3(17.6)	1(100)	1(50)	2(100)	0(0)	1(50)	1(50)	0(0)	9(32.1)
	S	14(82.4)	0(0)	1(50)	0(0)	0(0)	1(50)	1(50)	2(100)	19(67.9)
	Cefepime (N, %)	15	2	1	2	0	2	1	2	25
	I	1(6.7)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(4)
	R	3(20)	1(50)	0(0)	2(100)	0(0)	1(50)	1(100)	1(50)	9(36)
	S	11(73.3)	1(50)	1(100)	0(0)	0(0)	1(50)	0(0)	1(50)	15(60)
	Cefoxitin (N, %)	0	13	11	8	5	0	0	1	38
	I	0(0)	2(15.4)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	2(5.3)
	R	0(0)	3(23.1)	6(54.5)	6(75)	4(80)	0(0)	0(0)	0(0)	19(50)
	S	0(0)	8(61.5)	5(45.5)	2(25)	1(20)	0(0)	0(0)	1(100)	17(44.7)
	Ceftaroline (N, %)	0	11	4	6	5	0	0	0	26
	I	0(0)	0(0)	0(0)	1(16.7)	0(0)	0(0)	0(0)	0(0)	1(3.8)
	R	0(0)	2(18.2)	0(0)	4(66.6)	4(80)	0(0)	0(0)	0(0)	10(38.5)
	S	0(0)	9(81.8)	4(100)	1(16.7)	1(20)	0(0)	0(0)	0(0)	15(57.7)
	Cefpodoxime (N, %)	8	2	1	1	1	1	2	0	16
	I	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	R	2(25)	1(50)	1(100)	1(100)	0(0)	0(0)	2(100)	0(0)	7(43.8)
	S	6(75)	1(50)	0(0)	0(0)	1(100)	1(100)	0(0)	0(0)	9(56.2)
	Cefixime (N, %)	9	1	1	2	1	2	1	1	18
	I	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	R	7(77.8)	1(100)	1(100)	1(50)	1(100)	1(50)	1(100)	1(100)	14(77.8)
	S	2(22.2)	0(0)	0(0)	1(50)	0(0)	1(50)	0(0)	0(0)	4(22.2)
	Cefotaxime (N, %)	17	13	8	8	4	2	2	2	56
	I	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	R	2(11.8)	5(38.5)	5(62.5)	7(87.5)	4(100)	1(50)	1(50)	1(50)	26(46.4)
	S	15(88.2)	8(61.5)	3(37.5)	1(12.5)	0(0)	1(50)	1(50)	1(50)	30(53.6)
Macrolides	Clarithromycin (N, %)	4	4	6	4	0	0	0	1	19
	I	1(25)	2(50)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	3(15.8)
	R	1(25)	2(50)	6(100)	3(75)	0(0)	0(0)	0(0)	0(0)	12(63.2)
	S	2(50)	0(0)	0(0)	1(25)	0(0)	0(0)	0(0)	1(100)	4(21)
	Azithromycin (N, %)	2	5	6	4	1	1	1	1	21
	I	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	R	2(100)	5(100)	6(100)	4(100)	1(100)	1(100)	1(100)	0(0)	20(95.2)
	S	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(100)	1(4.8)
	Erythromycin (N, %)	17	15	14	10	10	1	1	2	70
	I	1(5.9)	2(13.3)	0(0)	2(20)	1(10)	0(0)	0(0)	0(0)	6(8.6)
	R	13(76.5)	12(80)	12(85.7)	7(70)	7(70)	1(100)	1(100)	1(50)	54(77.1)
	S	3(17.6)	1(6.7)	2(14.3)	1(10)	2(20)	0(0)	0(0)	1(50)	10(14.3)
	Ciprofloxacin (N, %)	12	15	12	9	9	2	1	1	61
	I	0(0)	0(0)	1(8.3)	1(11.1)	0(0)	0(0)	0(0)	0(0)	2(3.3)
	R	5(41.7)	10(66.7)	6(50)	4(44.4)	6(66.7)	2(100)	1(100)	1(100)	35(57.4)
	S	7(58.3)	5(33.3)	5(41.7)	4(44.4)	3(33.3)	0(0)	0(0)	0(0)	24(39.3)
	Levofloxacin (N, %)	20	15	13	11	8	2	2	1	72
	I	0(0)	4(26.7)	1(7.7)	2(18.2)	2(25)	0(0)	0(0)	0(0)	9(12.5)
	R	4(20)	8(53.3)	7(53.8)	3(27.3)	3(37.5)	1(50)	2(100)	1(100)	29(40.3)
	S	16(80)	3(20)	5(38.5)	6(54.5)	3(37.5)	1(50)	0(0)	0(0)	34(47.2)

Fluoroquinolones	Moxifloxacin (N, %)	13	13	14	11	5	2	2	2	62
	I	0(0)	0(0)	1(7.1)	0(0)	0(0)	0(0)	0(0)	0(0)	1(1.6)
	R	3(23.1)	3(23.1)	3(21.4)	2(18.2)	3(60)	2(100)	1(50)	1(50)	18(29)
	S	10(76.9)	10(76.9)	10(71.4)	9(81.8)	2(40)	0(0)	1(50)	1(50)	43(69.4)
	Norfloxacin (N, %)	3	1	0	1	1	0	0	0	6
	I	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	R	2(66.7)	1(100)	0(0)	0(0)	1(100)	0(0)	0(0)	0(0)	4(66.7)
	S	1(33.3)	0(0)	0(0)	1(100)	0(0)	0(0)	0(0)	0(0)	2(33.3)
	Ofloxacin (N, %)	3	2	5	4	0	0	0	0	14
	I	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	R	1(33.3)	2(100)	4(80)	4(100)	0(0)	0(0)	0(0)	0(0)	11(78.6)
	S	2(66.7)	0(0)	1(20)	0(0)	0(0)	0(0)	0(0)	0(0)	3(21.4)
Sulfonamides	Trimethoprim-Sulfamethoxazole (N, %)	16	14	14	11	4	1	2	2	64
	I									
	R	0(0)	2(14.3)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	2(3.1)
	S	12(75)	2(14.3)	5(35.7)	5(45.5)	4(100)	1(100)	2(100)	2(100)	33(51.6)
		4(25)	10(71.4)	9(64.3)	6(54.5)	0(0)	0(0)	0(0)	0(0)	29(45.3)
Glycopeptides	Vancomycin (N, %)	13	14	13	9	10	1	2	2	64
	I	0(0)	0(0)	0(0)	1(11.1)	0(0)	0(0)	0(0)	0(0)	1(1.6)
	R	1(7.7)	1(7.1)	0(0)	0(0)	2(20)	1(100)	1(50)	0(0)	6(9.4)
	S	12(92.3)	13(92.9)	13(100)	8(88.9)	8(80)	0(0)	1(50)	2(100)	57(89)
	Teicoplanin (N, %)	3	12	8	8	11	1	1	1	45
	I	0(0)	0(0)	1(12.5)	1(12.5)	0(0)	0(0)	0(0)	0(0)	2(4.4)
	R	1(33.3)	0(0)	0(0)	1(12.5)	4(36.4)	1(100)	0(0)	0(0)	7(15.6)
	S	2(66.7)	12(100)	7(87.5)	6(75)	7(63.6)	0(0)	1(100)	1(100)	36(80)
	Daptomycin (N, %)	3	12	8	4	4	0	0	0	31
	I	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	R	0(0)	0(0)	1(12.5)	1(25)	1(25)	0(0)	0(0)	0(0)	3(9.7)
	S	3(100)	12(100)	7(87.5)	3(75)	3(75)	0(0)	0(0	0(0	28(90.3)
Lincosamide	Clindamycin (N, %)	18	15	14	10	4	1	2	2	66
	I	0(0)	0(0)	1(7.1)	1(10)	0(0)	0(0)	0(0)	0(0)	2(3)
	R	8(44.4)	13(86.7)	5(35.7)	5(50)	4(100)	1(100)	2(100)	2(100)	40(60.6)
	S	10(55.6)	2(13.3)	8(57.1)	4(40)	0(0)	0(0)	0(0)	0(0)	24(36.4)
Tetracyclines	Tetracycline (N, %)	14	14	14	11	10	2	2	1	68
	I	0(0)	1(7.1)	2(14.3)	0(0)	1(10)	0(0)	0(0)	0(0)	4(5.9)
	R	7(50)	9(64.3)	8(57.1)	8(72.7)	7(70)	1(50)	2(100)	1(100)	43(63.2)
	S	7(50)	4(28.6)	4(28.6)	3(27.3)	2(20)	1(50)	0(0)	0(0)	21(30.9)
	Doxycycline (N, %)	5	4	7	4	7	1	1	1	30
	I	1(20)	0(0)	1(14.3)	2(50)	0(0)	0(0)	0(0)	1(100)	5(16.7)
	R	0(0)	4(100)	2(28.6)	2(50)	5(71.4)	1(100)	1(100)	0(0)	15(50)
	S	4(80)	0(0)	4(57.1)	0(0)	2(28.6)	0(0)	0(0)	0(0)	10(33.3)
	Minocycline (N, %)	0	3	3	2	4	0	0	0	12
	I	0(0)	0(0)	0(0)	0(0)	3(75)	0(0)	0(0)	0(0)	3(25)
	R	0(0)	0(0)	0(0)	0(0)	1(25)	0(0)	0(0)	0(0)	1(8.3)
	S	0(0)	3(100)	3(100)	2(100)	0(0)	0(0	0(0	0(0)	8(66.7)
	Tigecycline (N, %)	0	12	8	3	0	0	0	0	23
	I	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	R	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	S	0(0)	12(100)	8(100)	3(100)	0(0	0(0	0(0	0(0)	23(100)

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Carbapenems	Imipenem (N, %)	11	1	2	2	8	1	2	1	28
	I	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	R	0(0)	0(0)	1(50)	1(50)	1(12.5)	0(0)	0(0)	0(0)	3(10.7)
	S	11(100)	1(100)	1(50)	1(50)	7(87.5)	1(100)	2(100)	1(100)	25(89.3)
	Meropenem (N, %)	15	2	1	2	0	2	2	1	25
	I									
	R	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	S	0(0)	1(50)	0(0)	1(50)	0(0)	0(0)	0(0)	0(0)	2(8)
		15(100)	1(50)	1(100)	1(50)	0(0)	2(100)	2(100)	1(100)	23(92)
Nitrofuran	Nitrofurantoin (N, %)	2	12	8	7	4	0	0	0	33
	I									
	R	0(0)	0(0)	0(0)	1(14.3)	0(0)	0(0)	0(0)	0(0)	1(3)
	S	1(50)	0(0)	0(0)	0(0)	2(50)	0(0)	0(0)	0(0)	3(9.1)
		1(50)	12(100)	8(100)	6(85.7)	2(50)	0(0)	0(0)	0(0)	29(87.9)
Others	Linezolid (N, %)	7	13	13	10	11	1	1	1	57
	I	0(0)	0(0)	0(0)	0(0)	1(9.1)	0(0)	0(0)	0(0)	1(1.8)
	R	1(14.3)	0(0)	1(7.7)	1(10)	1(9.1)	1(100)	1(100)	0(0)	6(10.5)
	S	6(85.7)	13(100)	12(92.3)	9(90)	9(81.8)	0(0)	0(0)	1(100)	50(87.7)
	Rifampin (N, %)	7	15	14	10	7	2	2	1	58
	I	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	R	3(42.9)	1(6.7)	1(7.1)	3(30)	3(42.9)	1(50)	2(100)	0(0)	14(24.1)
	S	4(57.1)	14(93.3)	13(92.9)	7(70)	4(57.1)	1(50)	0(0)	1(100)	44(75.9)
	Chloramphenicol (N, %)	7	3	6	3	7	0	0	1	27
	I									
	R	1(14.3)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(3.7)
	S	0(0)	3(100)	1(16.7)	1(33.3)	1(14.3)	0(0)	0(0)	0(0)	6(22.2)
		6(85.7)	0(0)	5(83.3)	2(66.7)	6(85.7)	0(0)	0(0)	1(100)	20(74.1)
	Mupirocin High level (N, %)	0	11	8	5	3	0	0	0	27
	I									
	R	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	S	0(0)	0(0)	2(25)	2(40)	0(0)	0(0)	0(0)	0(0)	4(14.8)
		0(0)	11(100)	6(75)	3(60)	3(100)	0(0)	0(0)	0(0)	23(85.2)
Total	Total (N, %)	345	342	304	240	191	36	41	36	1535
	I	8(2.3)	13(3.8)	10(3.3)	13(5.4)	12(6.3)	0(0)	0(0)	1(2.8)	57(3.7)
	R	128(37.1)	121(35.4)	118(38.8)	110(45.8)	93(48.7)	23(63.9)	30(73.2)	14(38.9)	637(41.5)
	S	209(60.6)	208(60.8)	176(57.9)	117(48.8)	86(45)	13(36.1)	11(26.8)	21(58.3)	841(54.8)
	Total AMR (N, %)					637/1535 (41.5)				

I; intermediate, R: resistant, S: sensitive, AMR: antimicrobial resistance

Table 4. Antimicrobial Susceptibility Profile of Gram-negative Bacteria Isolated from different body fluids.

Antibiotic class	Antibiotics	*Escherichia coli*	*Pseudomonas aeruginosa*	*Klebsiella pneumonia*	*Achromobacter species*	*Moraxella species*	*Acinetobacter baumannii*	*Burkholderia cepacia*	*Klebsiella species*	Proteus species	Total (N, %)
Aminoglycosides	Amikacin (N, %)	20	11	9	5	1	2	2	2	2	54
	I	1(5)	0(0)	1(11.1)	0(0)	0(0)	0(0)	0(0)	0(0)	1(50)	3(5.6)
	R	2(10)	2(18.2)	1(11.1)	5(100)	1(100)	1(50)	2(100)	0(0)	0(0)	14(25.9)
	S	17(85)	9(81.8)	7(77.8)	0(0)	0(0)	1(50)	0(0)	2(100)	1(50)	37(68.5)
	Gentamicin (N, %)	19	10	9	5	4	1	2	2	2	54
	I	0(0)	1(10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(1.9)
	R	4(21.1)	1(10)	2(22.2)	5(100)	1(25)	1(100)	2(100)	0(0)	0(0)	16(29.6)
	S	15(78.9)	8(80)	7(77.8)	0(0)	3(75)	0(0)	0(0)	2(100)	2(100)	37(68.5)
Penicillin's	Ampicillin-sulbactam (N, %)	5	1	2	0	0	1	1	0	1	11
	I	0(0)	0(0)	1(50)	0(0)	0(0)	0(0)	0(0)	0(0)	1(100)	2(18.2)
	R	1(20)	0(0)	1(50)	0(0)	0(0)	1(100)	1(100)	0(0)	0(0)	4(36.4)
	S	4(80)	1(100)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	5(45.4)
	Ampicillin (N, %)	14	10	7	1	0	1	1	2	1	37
	I	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(50)	0(0)	1(2.7)
	R	14(100)	10(100)	7(100)	0(0)	0(0)	1(100)	1(100)	1(50)	1(100)	35(94.6)
	S	0(0)	0(0)	0(0)	1(100)	0(0)	0(0)	0(0)	0(0)	0(0)	1(2.7)
	Amoxicillin-Clavulanate (N, %)	19	11	9	5	3	2	2	2	2	55
	I	6(31.6)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	6(10.9)
	R	7(36.8)	10(90.9)	7(77.8)	5(100)	0(0)	1(50)	2(100)	1(50)	0(0)	33(60)
	S	6(31.6)	1(9.1)	2(22.2)	0(0)	3(100)	1(50)	0(0)	1(50)	2(100)	16(29.1)
	Piperacillin-Tazobactam (N, %)	19	11	9	5	0	2	2	2	2	52
	I	5(26.3)	0(0)	2(22.2)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	7(13.5)
	R	2(10.5)	0(0)	1(11.1)	0(0)	0(0)	1(50)	2(100)	0(0)	0(0)	6(11.5)
	S	12(63.2)	11(100)	6(66.7)	5(100)	0(0)	1(50)	0(0)	2(100)	2(100)	39(75)
Cephalosporins	Cefuroxime (N, %)	18	11	9	3	0	2	2	2	2	49
	I	0(0)	0(0)	1(11.1)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(2)
	R	16(88.9)	10(90.9)	6(66.7)	3(100)	0(0)	2(100)	2(100)	1(50)	2(100)	42(85.7)
	S	2(11.1)	1(9.1)	2(22.2)	0(0)	0(0)	0(0)	0(0)	1(50)	0(0)	6(12.3)
	Ceftriaxone (N, %)	19	11	9	5	4	2	1	2	2	55
	I	0(0)	0(0)	0(0)	0(0)	0(0)	1(50)	0(0)	0(0)	0(0)	1(1.8)
	R	15(78.9)	10(90.9)	6(66.7)	4(80)	4(100)	0(0)	1(100)	0(0)	1(50)	41(74.6)
	S	4(21.1)	1(9.1)	3(33.3)	1(20)	0(0)	1(50)	0(0)	2(100)	1(50)	13(23.6)
	Cefepime (N, %)	20	11	8	3	2	2	2	2	2	52
	I	3(15)	0(0)	1(12.5)	0(0)	0(0)	0(0)	0(0)	0(0)	1(50)	5(9.6)
	R	14(70)	2(18.2)	4(50)	2(66.7)	2(100)	1(50)	1(50)	0(0)	0(0)	26(50)
	S	3(15)	9(81.8)	3(37.5)	1(33.3)	0(0)	1(50)	1(50)	2(100)	1(50)	21(40.4)

Cephalosporins	Cefpodoxime (N, %)	2	0	1	2	2	0	0	0	0	7
	I	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	R	2(100)	0(0)	1(100)	1(50)	2(100)	0(0)	0(0)	0(0)	0(0)	6(85.7)
	S	0(0)	0(0)	0(0)	1(50)	0(0)	0(0)	0(0)	0(0)	0(0)	1(14.3)
	Cefixime (N, %)	7	3	4	3	3	0	1	0	1	22
	I	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	R	6(85.7)	2(66.7)	3(75)	3(100)	3(100)	0(0)	1(100)	0(0)	1(100)	19(86.4)
	S	1(14.3)	1(33.3)	1(25)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	3(13.6)
	Cefotaxime (N, %)	8	4	4	2	3	0	1	0	1	23
	I	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(100)	1(4.3)
	R	6(75)	3(75)	3(75)	2(100)	3(100)	0(0)	1(100)	0(0)	0(0)	18(78.3)
	S	2(25)	1(25)	1(25)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	4(17.4)
Macrolides	Azithromycin (N, %)	2	2	2	1	2	0	0	0	0	9
	I	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	R	2(100)	2(100)	1(50)	1(100)	2(100)	0(0)	0(0)	0(0)	0(0)	8(88.9)
	S	0(0)	0(0)	1(50)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(11.1)
	Erythromycin (N, %)	5	2	1	3	3	0	0	0	0	14
	I	0(0)	0(0)	0(0)	1(33.3)	0(0)	0(0)	0(0)	0(0)	0(0)	1(7.1)
	R	5(100)	2(100)	1(100)	2(66.7)	3(100)	0(0)	0(0)	0(0)	0(0)	13(92.9)
	S	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Fluoroquinolones	Ciprofloxacin (N, %)	20	11	9	5	3	2	2	2	2	56
	I	0(0)	0(0)	0(0)	0(0)	1(33.3)	0(0)	0(0)	0(0)	0(0)	1(1.8)
	R	14(70)	2(18.2)	5(55.6)	3(60)	0(0)	1(50)	0(0)	0(0)	0(0)	25(44.6)
	S	6(30)	9(81.8)	4(44.4)	2(40)	2(66.7)	1(50)	2(100)	2(100)	2(100)	30(53.6)
	Levofloxacin (N, %)	18	10	9	5	4	1	2	2	2	53
	I	0(0)	1(10)	1(11.1)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	2(3.8)
	R	13(72.2)	2(20)	3(33.3)	3(60)	0(0)	1(100)	0(0)	0(0)	0(0)	22(41.5)
	S	5(27.8)	7(70)	5(55.6)	2(40)	4(100)	0(0)	2(100)	2(100)	2(100)	29(54.7)
Sulfonamides	Trimethoprim-Sulfamethoxazole (N, %)	20	11	9	5	3	1	2	2	2	55
	I	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(50)	1(1.8)
	R	15(75)	1(9.1)	4(44.4)	2(40)	3(100)	0(0)	2(100)	0(0)	1(50)	28(50.9)
	S	5(25)	10(90.9)	5(55.6)	3(60)	0(0)	1(100)	0(0)	2(100)	0(0)	26(47.3)
Lincosamide	Clindamycin (N, %)	6	4	2	4	3	1	0	0	0	20
	I	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	R	6(100)	4(100)	2(100)	4(100)	3(100)	1(100)	0(0)	0(0)	0(0)	20(100)
	S	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)

Tetracyclines	Tetracycline (N, %)	2	2	2	5	3	1	0	0	0	15
		1(5)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(6.7)
	I	1(50)	2(100)	2(100)	5(100)	2(66.7)	1(100)	0(0)	0(0)	0(0)	13(86.7)
	R	0(0)	0(0)	0(0)	0(0)	1(33.3)	0(0)	0(0)	0(0)	0(0)	1(6.7)
	S										
	Doxycycline (N, %)	3	2	1	0	1	1	0	0	0	8
		0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	I	3(100)	2(100)	1(100)	0(0)	0(0)	1(100)	0(0)	0(0)	0(0)	7(87.5)
	R	0(0)	0(0)	0(0)	0(0)	1(100)	0(0)	0(0)	0(0)	0(0)	1(12.5)
	S										
	Tigecycline (N, %)	19	9	7	1	0	2	1	1	2	42
		0(0)	0(0)	1(14.3)	0(0)	0(0)	0(0)	1(100)	0(0)	2(100)	4(9.5)
	I	1(5.3)	9(100)	1(14.3)	1(100)	0(0)	0(0)	0(0)	0(0)	0(0)	12(28.6)
	R	18(94.7)	0(0)	5(71.4)	0(0)	0(0	2(100)	0(0	1(100)	0(0)	26(61.9)
	S										
Carbapenems	Imipenem (N, %)	19	11	9	5	3	2	2	2	2	55
	I	1(5.3)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(50)	0(0)	2(3.6)
	R	3(15.8)	1(9.1)	0(0)	1(20)	1(33.3)	1(50)	2(100)	0(0)	2(100)	11(20)
	S	15(78.9)	10(90.9)	9(100)	4(80)	2(66.7)	1(50)	0(0)	1(50)	0(0)	42(76.4)
	Meropenem (N, %)	19	11	9	3	3	2	2	2	2	53
		0(0)	0(0)	0(0)	0(0)	1(33.3)	0(0)	1(50)	0(0)	2(100)	4(7.6)
	I	3(15.8)	0(0)	0(0)	1(33.3)	0(0)	1(50)	0(0)	0(0)	0(0)	5(9.4)
	R	16(84.2)	11(100)	9(100)	2(66.7)	2(66.7)	1(50)	1(50)	2(100)	0(0)	44(83)
	S										
Nitrofuran	Nitrofurantoin (N, %)	15	10	6	4	0	2	1	2	1	41
		1(6.7)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(50)	0(0)	2(4.9)
	I	1(6.7)	0(0)	4(66.7)	0(0)	0(0)	2(100)	1(100)	1(50)	1(100)	10(24.4)
	R	13(86.7)	10(100)	2(33.3)	4(100)	0(0)	0(0)	0(0)	0(0)	0(0)	29(70.7)
	S										
	Rifampin (N, %)	1	4	2	3	3	1	0	0	0	14
	I	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	R	1(100)	4(100)	2(100)	3(100)	3(100)	1(100)	0(0)	0(0)	0(0)	14(100)
	S	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Total	Total (N, %)	319	183	148	83	53	31	29	29	31	906
	I	18(5.6)	2(1.1)	8(5.4)	1(1.2)	2(3.7)	1(3.2)	2(6.9)	3(10.3)	9(29)	46(5.1)
	R	157(49.2)	81(44.3)	68(46)	56(67.5)	33(62.3)	19(61.3)	21(72.4)	4(13.8)	9(29)	448(49.5)
	S	144(45.1)	100(54.6)	72(48.6)	26(31.3)	18(34)	11(35.5)	6(20.7)	22(75.9)	13(42)	412(45.4)
	Total AMR (N, %)						448/906 (49.5)				

I: intermediate, R: resistant, S: sensitive, AMR: antimicrobial resistance

Table 5. Distribution of Resistance Levels and Multidrug Resistance in Various Bacterial Species isolated from body fluids.

Isolated bacteria	Total	R0	R1	R2	R3	R4	R5	R6	R7	MDR
Streptococcus species (N, %)	22(100)	2(9.1)	2(9.1)	4(18.2)	3(13.6)	4(18.2)	6(27.3)	0(0)	1(4.5)	14(63.6)
Escherichia coli (N, %)	20(100)	0(0)	2(10)	1(5)	7(35)	6(30)	2(10)	1(5)	1(5)	17(85)
Staphylococcus aureus (N, %)	15(100)	1(6.7)	0(0)	0(0)	5(33.3)	7(46.7)	1(6.7)	1(6.7)	0(0)	14(93.3)
Staphylococcus epidermidis (N, %)	15(100)	1(6.7)	1(6.7)	4(26.7)	2(13.3)	3(20)	2(13.3)	2(13.3)	0(0)	9(60)
Staphylococcus species (N, %)	11(100)	0(0)	2(18.2)	4(36.1)	1(9.1)	0(0)	0(0)	4(36.4)	0(0)	5(45.5)
Enterococcus faecalis (N, %)	11(100)	0(0)	2(18.2)	2(18.2)	2(18.2)	2(18.2)	0(0)	1(9.1)	2(18.2)	7(63.6)
Pseudomonas aeruginosa (N, %)	11(100)	0(0)	1(9.1)	0(0)	0(0)	4(36.4)	4(36.4)	2(18.2)	0(0)	10(90.9)
Klebsiella pneumonia (N, %)	9(100)	0(0)	1(11.1)	1(11.1)	4(44.4)	2(22.2)	0(0)	0(0)	1(11.1)	7(77.8)
Achromobacter species (N, %)	5(100)	0(0)	0(0)	0(0)	0(0)	4(80)	1(20)	0(0)	0(0)	5(100)
Moraxella species (N, %)	4(100)	0(0)	0(0)	1(25)	0(0)	2(50)	1(25)	0(0)	0(0)	3(75)
Arcanobacterium haemolyticum (N, %)	2(100)	0(0)	0(0)	0(0)	1(50)	0(0)	0(0)	1(50)	0(0)	2(100)
Corynebacterium striatum (N, %)	2(100)	0(0)	0(0)	0(0)	0(0)	1(50)	0(0)	1(50)	0(0)	2(100)
Pediococcus pentosaceus (N, %)	2(100)	0(0)	0(0)	0(0)	1(50)	0(0)	1(50)	0(0)	0(0)	2(100)
Acinetobacter Baumannii (N, %)	2(100)	0(0)	0(0)	1(50)	0(0)	0(0)	1(50)	0(0)	0(0)	1(50)
Burkholderia cepacian (N, %)	2(100)	0(0)	0(0)	1(50)	1(50)	0(0)	0(0)	0(0)	0(0)	1(50)
Klebsiella species (N, %)	2(100)	1(50)	1(50)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Proteus species (N, %)	2(100)	0(0)	0(0)	1(50)	0(0)	1(50)	0(0)	0(0)	0(0)	1(50)
Kocuria Kristinae (N, %)	1(100)	0(0)	0(0)	1(100)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Kytococcus sedentarius (N, %)	1(100)	0(0)	1(100)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Aeromonas hydrophila (N, %)	1(100)	0(0)	0(0)	0(0)	0(0)	1(100)	0(0)	0(0)	0(0)	1(100)
Alcaligenes faecalis (N, %)	1(100)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(100)	0(0)	1(100)
Alloiococcus otitidis (N, %)	1(100)	0(0)	0(0)	0(0)	0(0)	1(100)	0(0)	0(0)	0(0)	1(100)
Escherichia hermannii (N, %)	1(100)	0(0)	0(0)	0(0)	0(0)	1(100)	0(0)	0(0)	0(0)	1(100)
Pseudomonas oryzihabitans (N, %)	1(100)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(100)	0(0)	1(100)
Rhizobium radiobacter (N, %)	1(100)	1(100)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Serratia odorifera (N, %)	1(100)	0(0)	0(0)	1(100)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Stenotrophomonas maltophilia (N, %)	1(100)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(100)	0(0)	1(100)

R0: sensitive to all classes of antibiotics, R1: Resistance to one class of antibiotic, R2: Resistance to two classes of antibiotic, R3: Resistance to three classes of antibiotic, R4: Resistance to four classes of antibiotic, R5: Resistance to five classes of antibiotic, R6: Resistance to six classes of antibiotic, R7: Resistance to seven classes of antibiotic, MDR: multidrug resistance.

Regarding the isolated microorganisms, a study involving 204 patients reported that gram-negative bacteria were the most frequently isolated, accounting for 70.6% of cases [1]. Similar findings were observed in other studies, with gram-negative bacteria constituting 64.3% of isolates in Eastern Ethiopia and 83.2% in South India [3,12]. In contrast, studies conducted in the USA and Northern Ethiopia reported a higher prevalence of gram-positive bacteria [4,14]. In the present study, gram-positive bacteria were the most frequently isolated microorganisms, accounting for 54.3% of cases. This variation could be attributed to differences in hospital-acquired infections and varying infection control standards [15].

Among the gram-negative isolates, *Escherichia coli* was the most prevalent in 20 cases (13.2%). This finding aligns with previous studies in Eastern Ethiopia and South India, where *E. coli* was also the most commonly isolated gram-negative bacterium [1,3]. Conversely, a study in Northwest Ethiopia identified E. cloacae as the most frequent gram-negative isolate [12]. Additionally, a study from Northern Ethiopia reported

Klebsiella pneumoniae as the most prevalent gram-negative bacterium [4].

Among the gram-positive isolates, two studies—one conducted at a tertiary care hospital in South India and another at Hiwot Fana Specialized University Hospital in Eastern Ethiopia—identified *Staphylococcus aureus* as the most frequently isolated bacterium [1,3]. Conversely, a study on body fluids from a tertiary hospital in Northern Ethiopia found *Streptococcus pneumoniae* to be the most common gram-positive isolate, followed by *Staphylococcus aureus* [4]. In the present study, *Streptococcus species* were the most commonly isolated gram-positive bacteria, followed by *Staphylococcus aureus*.

High resistance rates were observed among the tested gram-positive isolates, with 100% and 77.8% resistant to ampicillin-sulbactam and cefixime, respectively. In contrast, 100%, 92%, 90.3%, 89.3%, and 89% of isolates were sensitive to tigecycline, meropenem, daptomycin, imipenem, and vancomycin. These findings are consistent with other studies in the literature, which reported high levels of resistance to beta-lactam agents in Ethiopia [1,3,12]. This resistance may be due to the production of beta-lactamase and/or the presence of mobile resistance elements. Additionally, the increased prescribing frequency of beta-lactam antibiotics and instances of irrational antibiotic use could contribute to rising levels of antibiotic resistance [16,17].

In this study, 23.1% of *Staphylococcus aureus* isolates were methicillin-resistant, consistent with a study by Madigubba et al., which reported a resistance rate of 27.1% [3]. However, this rate is lower than those reported in studies from Ethiopia, where all isolates were methicillin-resistant [1,4,12]. Additionally, 100% of *Staphylococcus aureus* isolates in this study were sensitive to linezolid, and 92.9% were sensitive to vancomycin, aligning with findings from South India, where all *Staphylococcus aureus* isolates were sensitive to both antibiotics [3].

Among the gram-negative isolates, 83%, 76.4%, and 68.5% were sensitive to meropenem, imipenem, and amikacin, respectively, indicating that fluoroquinolones and aminoglycosides were among the most effective antibiotics against these bacteria from various body fluids. Conversely, 94.6% of isolates were resistant to ampicillin, third-generation cephalosporins, macrolides, and rifampin, which were found to be the least effective against gram-negative bacteria. These findings align with studies conducted in Northwest Ethiopia and by Shume et al., where amikacin and imipenem were identified as the most effective antibiotics against gram-negative isolates, while beta-lactam antibiotics like ampicillin and third-generation cephalosporins were among the least effective [1,12]. The rising rate of this resistance may be attributed to factors such as self-medication, limited diagnostic facilities, inappropriate antibiotic use, and the issuance of prescriptions without susceptibility data. Additionally, antibiotic resistance can naturally occur through mechanisms such as efflux pumps, alterations in drug-binding sites, changes in membrane permeability, and the presence of degrading enzymes [11,18].

Inpatient status and comorbidities were found to have a statistically significant association with bacterial infections in sterile body fluids [1,12]. In the present study, a higher growth rate of bacterial infections was observed among individuals with hospital-acquired infections, as well as those with comorbidities such as hypertension, obesity, and diabetes. This association may be attributed to the level of environmental hygiene in hospitals and the prevalence of invasive surgical procedures. Additionally, comorbidities may contribute to a compromised immune status, resulting in a higher susceptibility to infections.

In this study, among 151 isolated microorganisms, 70.2% were found to have MDR, which is comparable to findings from studies in Northwest Ethiopia (78.57%) and Eastern Ethiopia (76.5%), but lower than the 90% MDR rate reported in Northern Ethiopia [4,12]. Several factors may explain the increased prevalence of MDR, including differing bacterial strains, geographic variations, varying patient awareness of antimicrobial use, disparities in infection control practices, differences in antibiotic prescribing policies, over-the-counter drug availability, and prolonged antibiotic use [5,19].

5. Conclusion

The high rates of resistance to commonly used antibiotics, coupled with the frequent occurrence of MDR strains, emphasize the need for stringent antibiotic stewardship and enhanced infection control measures.

Declarations

Conflicts of interest: The author(s) have no conflicts of interest to disclose.

Ethical approval: The study's ethical approval was obtained from the scientific committee of the Kscien Organization for Scientific Research.

Patient consent (participation and publication)**:** Written informed consent was obtained from patients for publication.

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