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Original Article

Emerging Antibiotic Resistance and Limited Therapeutic Options for Common Infections in Sylhet, Bangladesh

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Abstract

Rising antimicrobial resistance (AMR) substantially undermines infection management worldwide. In Bangladesh, regional variations in resistance hinder empirical therapy. This study characterizes local AMR patterns among clinical isolates in a private tertiary level hospital in Sylhet, Bangladesh. We retrospectively reviewed culture and sensitivity records from July 2023 to February 2024 at Mount Adora Hospital. Specimens included urine, sputum, blood, and wound swabs. Identification and antibiotic sensitivity testing followed Clinical and Laboratory Standards Institute guidelines. Descriptive statistics summarized pathogen distribution and resistance rates. Of 1,360 culture-positive specimens, urine dominated (57.6%), followed by sputum (24.1%), blood (15.9%), and wound swabs (2.4%). Escherichia coli (54.5%) and Klebsiella spp. (20.4%) led urinary isolates; Staphylococcus aureus predominated blood cultures (70.8%); Streptococcus spp. (36.6%) and Klebsiella spp. (32.9%) were common in sputum; wound swabs chiefly yielded S. aureus (42.4%). High resistance in urine isolates was noted for azithromycin (80.9%), cefixime (78.3%), and nalidixic acid (79.1%); carbapenems retained >80% activity. Bloodstream isolates showed >75% resistance to cefixime and ceftazidime but remained >80% sensitive to imipenem and amikacin. Sputum and wound pathogens exhibited similar resistance trends to first-line agents, with tigecycline and carbapenems preserving efficacy. Common antibiotics demonstrate alarming resistance rates, whereas reserve antibiotic particularly carbapenems and tigecycline remain reliable. Updated, region-specific antibiotic guidelines and stewardship interventions are immediately needed.

Keywords: *Antimicrobial resistance; antibiotic sensitivity; carbapenems; tigecycline; Bangladesh*

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INTRODUCTION

Antimicrobial agents including antibiotics, antivirals, antifungals, and antiparasitic are critical for treating infections. However, the rise of antimicrobial resistance (AMR) threatens these treatments. Resistance occurs when microorganisms acquire and pass on survival traits through genetic elements like plasmids[1]. The overuse and misuse of antibiotics in different sectors are fueling an AMR crisis, described as a 'silent pandemic'[2]. In 2019, antibiotic-resistant infections led to an estimated 5 million deaths, with projections indicating a sharp increase by 2050[3].

Recognizing this threat, the WHO introduced the Global Antimicrobial Resistance Surveillance System (GLASS) in 2015, aiming for standardized data collection[4]. Bangladesh followed suit in 2016 by establishing a national AMR surveillance program, collaborating with WHO and the US CDC[5]. Despite these efforts, regional differences in resistance patterns persist, highlighting the need for local

data to guide treatment[6]. Numerous studies in Bangladesh have shown that resistance to first-line antibiotics is common across various diseases, with even reserve drugs often showing resistance. This variation in resistance is region-specific[6]. Data from northeast Bangladesh, especially Sylhet, remain scarce, limiting the ability to tailor empirical therapy. This study analyses recent culture and sensitivity results from a tertiary care private hospital in Sylhet to delineate local AMR profiles and inform evidence-based antibiotic stewardship.

MATERIALS AND METHODS

Study design and setting

A retrospective record review was performed at Mount Adora Hospital, Sylhet, Bangladesh, covering July 2023 to February 2024.

Specimen selection and processing

All culture-positive reports for urine, sputum, blood, and wound swabs were included (n = 1,360). Specimens lacking demographic or susceptibility data were excluded. During the procedure, specimens were collected and transported in strict adherence to standard guidelines and processed aseptically:

- Urine: automated culture; significant growth subcultured on blood agar, MacConkey, chromogenic media.
- Blood: aerobic vials in an automated system; subculture on blood, chocolate, MacConkey, chromogenic media.
- Sputum & wound: Gram stain screening; positive samples cultured on the above media.

Identification and susceptibility testing

Isolates were identified by standard biochemical methods. Antibiotic susceptibility was determined by disk diffusion (CLSI 2023). Multidrug resistance definitions followed ECDC criteria.

The inclusion criteria for pathogens were defined as follows-

Organism growth was observed with a significant colony count; additionally, samples containing more than three types of pathogenic bacteria were identified and classified as contaminants. Patients' demographic data were also retrieved from the hospital record form. Patient demographic characteristics, culture-positive pathogens, and antibiotic susceptibility profiles were included as key variables.

Data analysis: Demographics, organism distribution, and resistance frequencies were analyzed in SPSS 27. Descriptive statistics (n, %) are displayed.

RESULTS

Patient's demographics characteristics

A total of 1,360 culture-positive samples from record were analyzed between July 2023 and February 2024. Reviewed data showed 48% (653) were in age group 19-60 years followed by 43.4% (590) and 8.6% (117) were in >60 years and 0-18 years respectively. Regarding gender distribution, 56.8% (n=772) were female and 43.2% (n=588) were male, yielding a male-to-female ratio of 1:1.31. The mean age of the population was 54.03±21.68 years. cohort's mean age was 54.0 ± 21.7 years; 56.8% were female and male-to-female ratio was 1:1.31.

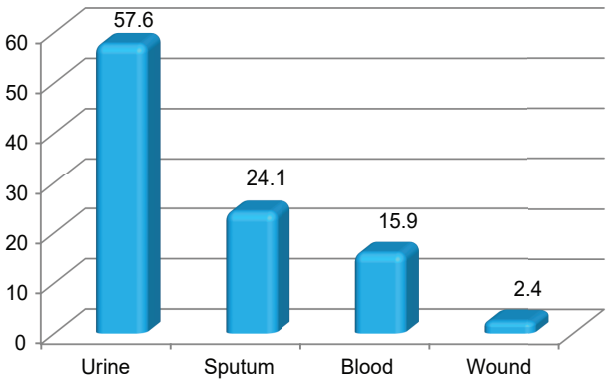

Figure-1: Distribution of culture-positive specimens (n=1,360)

Figure 1 presents the distribution of culture-positive specimen types. A total of 1,360 culture-positive specimens were analyzed across four specimen types. Among these, urine constituted the majority 783 (57.6%), followed by sputum 328 (24.1%), blood 216 (15.9%), and wound swabs 33 2.4%).

Figure 2 Distribution of organisms isolated from urine, blood, sputum, and wound swab samples. Here, Escherichia coli was the predominant isolate in urine samples (54.5%), whereas Staphylococcus aureus dominated blood cultures (70.8%) and wound swabs (42.4%). Streptococcus spp. (36.6%) and Klebsiella spp. (32.9%) were the leading isolates in sputum cultures. Pseudomonas spp. appeared frequently across all sample types, particularly in sputum (14.0%) and wound swabs (18.2%). Fungal isolates were limited (1.9%), and Enterococcus spp. and Acinetobacter spp. were rarely identified. This distribution highlights Escherichia coli as the primary urinary pathogen, Staphylococcus aureus as the major bloodstream and wound organism, and Streptococcus spp. as the predominant respiratory isolate in this study cohort.

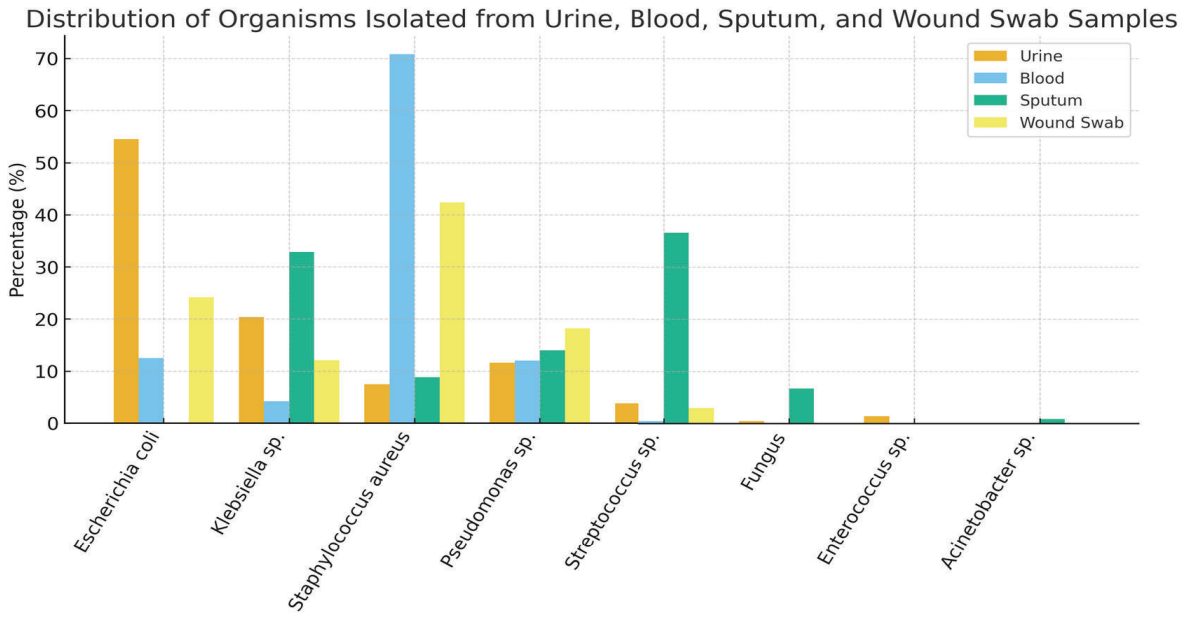

Figure- 2: Bar diagram showing distribution of organisms isolated from urine, blood, sputum, and wound swab samples (n = 1,360).

Figure 3 illustrates the antibiotic susceptibility pattern of bacterial isolates from urine cultures, here urinary isolates exhibited extensive resistance to most first-line antibiotics. Resistance was highest against azithromycin (80.9%), cefixime (78.3%), and nalidixic acid (79.1%), while moderate resistance was observed for amoxicillin (65.1%) and cefaclor (73.7%). Carbapenems demonstrated the greatest efficacy, with imipenem (83.8%) and meropenem (79.6%) showing high sensitivity rates. Among aminoglycosides, amikacin (61.2%) retained moderate activity, whereas gentamicin (49.0%) was less effective. Tigecycline (89.4%) and colistin (84.7%) exhibited the strongest overall activity against urinary isolates, while nitrofurantoin (52.3%) and doxycycline (55.7%) provided reasonable oral coverage.

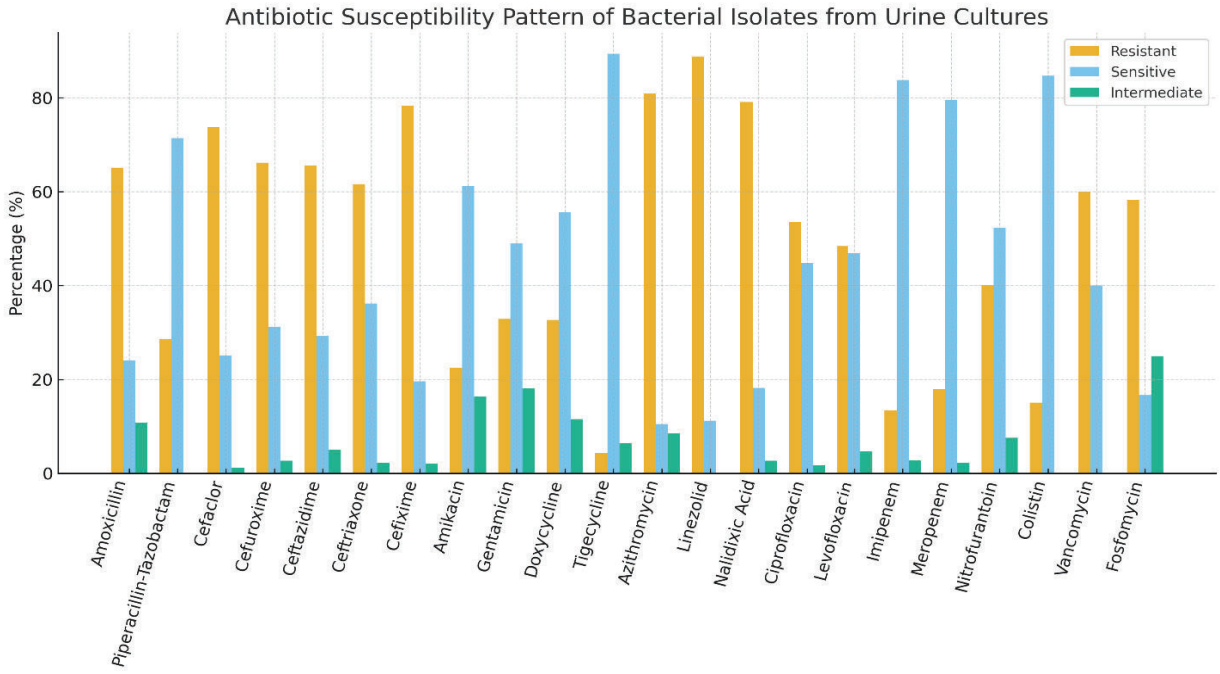

Figure- 3: Antibiotic susceptibility pattern of bacterial isolates from urine cultures (n= 783)

Table I describes the antibiotic susceptibility pattern of bacterial isolates from blood cultures, here bloodstream isolates showed moderate to high resistance to beta-lactam antibiotics. Resistance was particularly high to cefixime (82.5%), ceftazidime (77.8%), and azithromycin (75.9%), while amoxicillin displayed resistance in 36.8% of cases. Aminoglycosides retained substantial efficacy, with amikacin (82.5%) and gentamicin (68.4%) showing high sensitivity. Tetracyclines demonstrated favorable activity (doxycycline 88.7% sensitive), and tigecycline maintained good performance (85.7% sensitive). Among carbapenems, imipenem (86.8%) remained the most effective, followed by meropenem (72.9%). Vancomycin (76.3%) and colistin (67.5%) were effective against most resistant isolates.

Table- I: Antibiotic susceptibility pattern of bacterial isolates from blood cultures (n = 216)

Antibiotic Group	**Antibiotic**	**Rst. n (%)**	**Snt. n (%)**	**Imd. n (%)**
Penicillin	Amoxicillin	79 (36.8%)	127 (59.0%)	9 (4.2%)
	Piperacillin-Tazobactam	62 (28.9%)	142 (65.9%)	11 (5.2%)
Cephalosporin	Cefaclor	87 (40.1%)	115 (53.3%)	14 (6.6%)
	Cefuroxime	72 (33.2%)	141 (65.4%)	3 (1.5%)
	Ceftazidime	168 (77.8%)	44 (20.3%)	4 (1.9%)
	Ceftriaxone	91 (42.0%)	107 (49.5%)	18 (8.5%)
	Cefixime	178 (82.5%)	31 (14.2%)	7 (3.3%)
Aminoglycoside	Amikacin	24 (11.3%)	178 (82.5%)	13 (6.1%)
	Gentamicin	61 (28.3%)	148 (68.4%)	7 (3.3%)
Tetracycline	Doxycycline	19 (9.0%)	192 (88.7%)	5 (2.4%)
	Tigecycline	0 (0.0%)	185 (85.7%)	31 (14.3%)
Macrolide	Azithromycin	164 (75.9%)	41 (18.9%)	11 (5.2%)
Oxazolidinone	Linezolid	61 (28.3%)	154 (71.1%)	1 (0.6%)
Fluoroquinolone	Ciprofloxacin	70 (32.5%)	137 (63.2%)	9 (4.2%)
	Levofloxacin	54 (25.0%)	150 (69.3%)	12 (5.7%)
Carbapenem	Imipenem	22 (10.4%)	187 (86.8%)	6 (2.8%)
	Meropenem	48 (22.4%)	157 (72.9%)	10 (4.8%)
Polymyxin	Colistin	68 (31.6%)	146 (67.5%)	2 (0.9%)
Others	Vancomycin	47 (21.8%)	165 (76.3%)	4 (1.9%)
	Fosfomycin	154 (71.4%)	62 (28.6%)	0 (0.0%)

(Snt. = Sensitive, Rst. = Resistant, Imd. = Intermediate)

Table II states the antibiotic susceptibility pattern of bacterial isolates from sputum cultures; respiratory isolates displayed high levels of resistance to several antibiotic classes. Cefixime (81.2%), azithromycin (80.5%), and linezolid (78.4%) showed poor activity, whereas amoxicillin (51.0%) and ceftazidime (63.9%) were moderately resistant. Piperacillin-tazobactam (68.5%) retained satisfactory sensitivity, and amikacin (65.6%) was the most effective among aminoglycosides. Tigecycline (76.5%), imipenem (88.3%), and meropenem (84.4%) remained highly effective, confirming the sustained potency of carbapenems. Levofloxacin (64.0%) performed better than ciprofloxacin (55.8%) among fluoroquinolones.

Table- II : Antibiotic susceptibility pattern of bacterial isolates from sputum cultures (n = 328)

Antibiotic Group	Antibiotic	Rst. n (%)	Snt. n (%)	Imd. n (%)
Penicillin	Amoxicillin	167 (51.0%)	135 (41.2%)	26 (7.8%)
	Piperacillin-Tazobactam	84 (25.6%)	225 (68.5%)	19 (5.8%)
Cephalosporin	Cefaclor	201 (61.4%)	115 (35.1%)	12 (3.6%)
	Cefuroxime	167 (50.9%)	152 (46.4%)	9 (2.7%)
	Ceftazidime	210 (63.9%)	98 (29.9%)	20 (6.2%)
	Ceftriaxone	162 (49.5%)	152 (46.3%)	14 (4.2%)
	Cefixime	266 (81.2%)	58 (17.8%)	3 (1.0%)
Aminoglycoside	Amikacin	72 (21.8%)	215 (65.6%)	42 (12.7%)
	Gentamicin	97 (29.5%)	181 (55.2%)	50 (15.3%)
Tetracycline	Doxycycline	97 (29.5%)	202 (61.7%)	29 (8.8%)
	Tigecycline	19 (5.9%)	251 (76.5%)	58 (17.6%)
Macrolide	Azithromycin	264 (80.5%)	36 (11.0%)	28 (8.4%)
Oxazolidinone	Linezolid	257 (78.4%)	70 (21.2%)	1 (0.4%)
Fluoroquinolone	Ciprofloxacin	131 (39.9%)	183 (55.8%)	14 (4.2%)
	Levofloxacin	94 (28.6%)	210 (64.0%)	25 (7.5%)
Carbapenem	Imipenem	30 (9.1%)	290 (88.3%)	9 (2.6%)
	Meropenem	46 (14.0%)	277 (84.4%)	5 (1.6%)
Polymyxin	Colistin	103 (31.5%)	223 (67.9%)	2 (0.6%)
Others	Vancomycin	238 (72.5%)	88 (26.8%)	2 (0.7%)
	Fosfomycin	328 (100.0%)	0 (0.0%)	0 (0.0%)

(Snt. = Sensitive, Rst. = Resistant, Imd. = Intermediate)

Table III presents Antibiotic Susceptibility Pattern of Bacterial Isolates from Wound Swabs Wound isolates showed widespread resistance across multiple antibiotic classes. Resistance was highest to cefixime (97.0%), azithromycin (90.9%), and ceftazidime (84.8%), while amoxicillin (75.8%) also showed poor efficacy. Aminoglycosides and tetracyclines retained moderate activity, with amikacin (54.5%), gentamicin (51.5%), and doxycycline (57.6%) showing comparable sensitivity. Imipenem (63.6%) and meropenem (57.6%) demonstrated better performance among carbapenems. Notably, tigecycline exhibited 100% sensitivity, highlighting its role as the most effective agent against wound pathogens.

Table- III : Antibiotic susceptibility pattern of bacterial isolates from wound swabs (n = 33)

Antibiotic Group	**Antibiotic**	**Rst. n (%)**	**Snt. n (%)**	**Imd. n (%)**
Penicillin	Amoxicillin	25 (75.8%)	6 (18.2%)	2 (6.1%)
	Piperacillin-Tazobactam	18 (54.6%)	10 (30.3%)	5 (15.2%)
Cephalosporin	Cefaclor	27 (81.8%)	6 (18.2%)	0 (0.0%)
	Cefuroxime	24 (72.7%)	9 (27.3%)	0 (0.0%)
	Ceftazidime	28 (84.8%)	2 (6.1%)	3 (9.1%)
	Ceftriaxone	23 (69.7%)	8 (24.2%)	2 (6.1%)
	Cefixime	32 (97.0%)	0 (0.0%)	1 (3.0%)
Aminoglycoside	Amikacin	11 (33.3%)	18 (54.5%)	4 (12.1%)
	Gentamicin	12 (36.4%)	17 (51.5%)	4 (12.1%)
Tetracycline	Doxycycline	11 (33.3%)	19 (57.6%)	3 (9.1%)
	Tigecycline	0 (0.0%)	33 (100.0%)	0 (0.0%)
Macrolide	Azithromycin	30 (90.9%)	0 (0.0%)	3 (9.1%)
Oxazolidinone	Linezolid	23 (69.0%)	9 (27.6%)	1 (3.4%)
Fluoroquinolone	Ciprofloxacin	26 (78.8%)	7 (21.2%)	0 (0.0%)
	Levofloxacin	23 (69.7%)	8 (24.2%)	2 (6.1%)
Carbapenem	Imipenem	10 (30.3%)	21 (63.6%)	2 (6.1%)
	Meropenem	14 (42.4%)	19 (57.6%)	0 (0.0%)
Polymyxin	Colistin	15 (45.5%)	18 (54.5%)	0 (0.0%)
Others	Vancomycin	19 (57.6%)	14 (42.4%)	0 (0.0%)
	Fosfomycin	33 (100.0%)	0 (0.0%)	0 (0.0%)

(Snt. = Sensitive, Rst. = Resistant, Imd. = Intermediate)

DISCUSSION

This study highlights the alarming prevalence of antimicrobial resistance (AMR) among clinical isolates in Sylhet, Bangladesh. The predominance of *Escherichia coli* in urine samples (54.5%) aligns with national trends, where *E. coli* consistently emerges as the leading uropathogen[1–4]. The high resistance observed against azithromycin (80.9%), cefixime (78.3%), and nalidixic acid (79.1%) is consistent with previous reports from Dhaka and northern Bangladesh, which documented similar resistance profiles among Gram-negative urinary pathogens[5–7]. These findings reinforce the limited efficacy of first-line oral agents and underscore the need for carbapenem-based regimens, given the retained sensitivity to imipenem (83.8%) and meropenem (79.6%)[6–8].

In bloodstream infections, *Staphylococcus aureus* was the dominant isolate (70.8%), a pattern corroborated by studies from tertiary hospitals in Bangladesh[9–11]. The elevated resistance to cefixime (82.5%) and ceftazidime (77.8%) mirrors findings from Nakib et al. and Talha et al., who reported similar resistance among septicemia isolates[10, 11]. Notably, amikacin (82.5%) and imipenem (86.8%) demonstrated robust activity, supporting their role in empirical therapy for suspected bacteremia[12].

Sputum cultures revealed *Streptococcus* spp. (36.6%) and *Klebsiella* spp. (32.9%) as the most frequent pathogens. These results are consistent with Morgan et al., who identified *Streptococcus oralis* and *S. aureus* as common respiratory isolates in TB patients[13]. Resistance to azithromycin (80.5%) and linezolid (78.4%) was notably

high, echoing findings from Sorwer et al. and Islam et al., who reported diminished efficacy of macrolides and oxazolidinones in respiratory infections[14,15]. Carbapenems retained superior sensitivity, with imipenem (88.3%) and meropenem (84.4%) outperforming other agents.

Wound swabs, though fewer in number, revealed *S. aureus* (42.4%) and *Pseudomonas* spp. (18.2%) as key pathogens. These findings are supported by Nobel et al. and Munawar et al., who reported similar distributions in surgical site infections[16, 17]. The extreme resistance to cefixime (97.0%) and azithromycin (90.9%) underscores the ineffectiveness of conventional antibiotics in wound management. Tigecycline's 100% sensitivity highlights its potential as a reserve agent for multidrug-resistant wound infections.

Overall, the study confirms widespread resistance to commonly prescribed antibiotics across specimen types. The consistent efficacy of carbapenems and tigecycline across urine, blood, sputum, and wound isolates suggests their critical role in empirical therapy. However, reliance on reserve antibiotics without stewardship risks accelerating resistance even among last-line agents.

THowever, this study provides a valuable snapshot of resistance trends within a defined setting, covering multiple specimen types and a wide range of antimicrobial classes. The strength lies in its comprehensive sampling and methodical assessment of clinically relevant antibiotics.

CONCLUSIONS

This study demonstrates a high prevalence of antimicrobial resistance across all specimen types, particularly against first-line agents such as azithromycin, cefixime, and nalidixic acid. Carbapenems and tigecycline consistently showed superior sensitivity and may serve as reliable therapeutic options in multidrug-resistant infections. Specimen-specific trends—such as the efficacy of doxycycline and nitrofurantoin in urinary isolates, and aminoglycosides in wound infections—should inform empirical treatment decisions. We recommend regular updates to regional antibiotic guidelines and the implementation of robust antimicrobial stewardship strategies to mitigate resistance and preserve the efficacy of reserve antibiotics

Author contributions

a. Conception and design, or design of the research; or the acquisition, analysis, or interpretation of data: Benzamin M, Chakroborty P, Mahmud S, Das K, Dhar P, Sharma N, Roy D, Ahmed R.

b. Drafting the manuscript or revising it critically for important intellectual content: Benzamin M, Chakroborty P, Khatoon M.

c. Final approval of the version to be published: Benzamin M, Khatoon M.

d. Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved: Benzamin M, Khatoon M.

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Conflict of interest

We do not have any conflicts of interest.

Ethical approval

The study involved routine clinical procedures and non-invasive data collection. Confidentiality was maintained by removing all identifying information.

Data availability statement

We confirm that the data supporting the findings of this study will be shared upon reasonable request.

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