Original Article

IAHS Medical Journal
Volume 08 Issue 02 December 2025; 29-34

Hospital-Based Surveillance of Carbapenem-Resistant Bacterial Infections in A Tertiary Care Center of Chattogram

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ABSTRACT

Background: *The global rise of Carbapenem-Resistant Organisms (CROs) represents a significant challenge to modern healthcare, limiting treatment options, increasing morbidity and mortality among hospitalized patients. These multidrug-resistant pathogens, particularly among Enterobacteriaceae, Pseudomonas and Acinetobacter species, have emerged as critical nosocomial threats in tertiary care settings. Early detection and continuous surveillance are essential to guide infection control practices and optimize antimicrobial management. This study aimed to determine the occurence, phenotypic characteristics, and antimicrobial susceptibility patterns of carbapenem-resistant bacterial isolates in a tertiary care hospital, thereby assessing the local epidemiology and informing clinical management strategies.*

Materials and methods: *A cross-sectional hospital-based study was conducted for 6 months from January to June 2025 in the Department of Microbiology at Institute of Applied Health Sciences (IAHS) targeting clinical specimens from patients admitted to various departments. Isolates were identified using standard microbiological techniques and carbapenem resistance was screened using disk diffusion method. Antimicrobial susceptibility profiles were determined according to CLSI (Clinical and Laboratory Standard Institutes) guidelines.*

Results: *Over the 6-month period (January-June 2025) 721 clinical specimens were examined, yielding 184 significant bacterial isolates. The study population had a mean age of 35.0 ± 21.34 years (IQR 20.5–51.0 years). Urine constituted the majority of specimens (140/184, 76.1%) followed by wound swab/pus (30/184, 16.3%) and sputum (14/184, 7.6%). Most isolates originated from the Outpatient Department (n=94), Medicine Ward (n=33) and Pediatrics Ward (n=22). Escherichia coli predominated in urine (50.7%) Klebsiella spp. in sputum (78.6%) and Pseudomonas spp. in wound/pus samples (37.5%). Out of 142 isolates tested for carbapenem resistant, the highest carbapenem resistance was observed in Proteus spp. and E. coli from wound swabs (100%) and Pseudomonas spp. from sputum (100%) and urine (75%). Klebsiella spp. showed moderate resistance across all sample types. Carbapenem-resistant isolates were most frequent in the Medicine Ward (26.32%) and Pediatric Ward (26.32%).*

Conclusion: *Carbapenem-resistant organisms are increasingly prevalent in tertiary care hospitals, posing a significant therapeutic challenge. Regular hospital-based surveillance, coupled with stringent infection control measures and rational antimicrobial use, is crucial to curb the spread of these resistant pathogens and improve patient outcomes.*

Key words: Antimicrobial stewardship; Carbapenem-resistant organisms; Hospital-acquired infections; Multidrug resistance; Surveillance; Tertiary care.

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Date of Submission : 18th November 2025
Date of Acceptance : 20th December 2025

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Volume 08 Issue 02 December 2025; 29-34

Introduction

Carbapenem-resistant bacterial infections have become a major global health concern, particularly in tertiary care hospitals of Bangladesh where critically ill patients are exposed to invasive procedures and broad-spectrum antimicrobial therapy. Carbapenems are often considered last-line agents for severe infections caused by multidrug-resistant Gram-negative bacteria, however, the emergence and rapid dissemination of carbapenem resistance have significantly compromised their effectiveness.[1] The most commonly implicated pathogens include *Klebsiella pneumoniae, Escherichia coli, Acinetobacter baumanniiand Pseudomonas aeruginosa,* all of which are associated with high rates of healthcare-associated infections.[2]

Hospital-based surveillance studies had consistently demonstrated increasing trends in carbapenem resistance, particularly in intensive care unitsand had reported higher mortality rates, prolonged hospitalizationand increased healthcare costs among affected patients.[3,4] In low- and middle-income countries, the burden of carbapenem-resistant organisms is further exacerbated by limited infection control resources, irrational antibiotic use and inadequate surveillance systems.[5] Active and continuous surveillance within hospital settings is therefore essential to monitor resistance patterns, guide empirical therapy and support antimicrobial stewardship programs.[6]

Despite the growing threat, data on the epidemiology and antimicrobial susceptibility patterns of carbapenem-resistant bacterial infections remain limited in many tertiary care hospitals. Generating local surveillance data is crucial for understanding institutional resistance trends and for developing targeted infection prevention and control strategies. So, the study was carried out to determine the cases and distribution of carbapenem-resistant bacterial infections among patients admitted to a tertiary care hospital.

Materials and methods

This hospital-based surveillance study was conducted as a prospective observational study at Institute of Applied Health Sciences Hospital (IAHS-H) over a defined study period of June 2025 to December 2025. The hospital provides comprehensive medical and surgical services and caters to both inpatient and outpatient populations, including Intensive Care Units (ICUs).

184 patients of IPD and OPD, including ICU cases were selected as samples. All clinical specimens received in the Microbiology Laboratory from patients with suspected bacterial infections during the study period were included. Specimens were collected as part of routine patient care and included blood, urine, respiratory samples, pus, wound swabs, body fluids and other relevant samples.

Inclusion criteria

- Clinical specimens yielding Gram-negative bacterial isolates
- Isolates tested for carbapenem susceptibility
- Patients of all age groups and both sexes.

Exclusion criteria

- Duplicate isolates from the same patient with identical antimicrobial susceptibility patterns
- Environmental samples
- Colonization isolates obtained solely for screening purposes.

Specimens were processed according to standard microbiological procedures. Samples were inoculated onto Blood agar, MacConkey agar and incubated aerobically at 35–37°C for 18–24 hours. Bacterial isolates were identified based on colony morphology, Gram staining and conventional biochemical tests, including oxidase, catalase, Motility indole urease test, Tripple sugar iron test, Citrate Utilization test and Bile esculin test.

Antimicrobial Susceptibility Testing (AST) was performed using the Kirby–Bauer disk diffusion method on Mueller–Hinton agar, following Clinical and Laboratory Standards Institute (CLSI) guidelines M100. A standardized 0.5 McFarland bacterial suspension was prepared for inoculation. Plates were incubated at 35 ± 2°C for 16–18 hours, and zone diameters were measured and interpreted according to CLSI breakpoints.[7]

The antimicrobial panel included carbapenems (Imipenem and meropenem) and other relevant antibiotics such as aminoglycosides, fluoroquinolones, β-lactam/β-lactamase inhibitor combinationsand tetracyclines.

Isolates showing resistance or intermediate susceptibility to at least one carbapenem (Imipenem or meropenem) according to CLSI interpretive criteria were classified as Carbapenem-Resistant Organisms (CROs).[8]

Quality control procedures were performed in accordance with CLSI recommendations. Reference strains, including *Escherichia coli* ATCC 25922 and *Pseudomonas aeruginosa* ATCC 27853, were used to validate media, reagents and susceptibility testing procedures.

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Demographic and clinical data, including age, sex, hospital ward, specimen type and antimicrobial susceptibility results, were recorded using a structured data collection form. Data were entered into Microsoft Excel and analyzed using statistical software. Results were expressed as frequencies, percentages and proportions to describe the proportion and distribution of carbapenem-resistant infections.

Ethical approval was obtained from the Institutional Review Boardof the hospital prior to study initiation. As the study utilized routine laboratory data without direct patient identifiers, informed consent was waived. Confidentiality of patient information was strictly maintained throughout the study.

Results

During the study period, among 721 clinical samples, i.e.Urine, Sputum, Wound Swab and Pus, significant bacterial isolates were recovered among admitted and outdoor patients. Growth Positivity were 184 (25.52%).

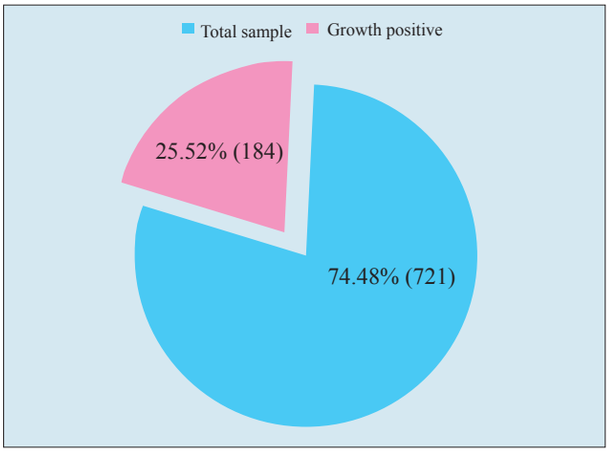

Figure 1 Growth positivity among the samples (n=721)

The average age was about 35 years with standard deviation of 21.34 years. This shows how spread out the ages were around the mean. A value of 21.34 is quite large, meaning ages vary a lot—people are not clustered tightly around 35, instead, the dataset includes both very young and much older individuals. The middle half of the group lies between 20.5 and 51.0 years, a span of 30.5 years(IQR-Interquartile range), which indicates a broad mix even among the central ages (Not just extremes).

In the specimen distribution analysis,urine samples comprised the majority (76.1%) followed bypus and wound swab specimen (16.3%). Sputum samples accounted for the smallest proportion (7.6%) of the total specimens collected.

Table I Age-group distribution (n=184)

Age group (Years)	Count	Percentage
0–9	26	14.13
10–19	14	7.61
20–29	32	17.39
30–39	36	17.93
40–49	22	11.96
50–59	20	10.89
60–69	16	8.70
70–79	10	5.43
80–89	4	2.17
90+	3	1.63
Total	184	100

Table I described the age distribution of the study participants (n = 184) covered a wide range from childhood to advanced age. The largest proportions were observed in the 30–39 years group (36, 17.93%) and 20–29 years group (32, 17.39%), indicating that young adults formed the core of the sample. Children aged 0–9 years also represented a substantial share (26, 14.13%). Middle-aged participants were distributed across 40–49 years (22, 11.96%) and 50–59 years (20, 10.89%). Older adults accounted for 8.70% (16) in the 60–69 years group and 5.43% (10) in the 70–79 years group. Very elderly participants were relatively few, with 2.17% (4) in the 80–89 years group and 1.63% (3) aged 90 years or above. Overall, the distribution shows a predominance of young to middle-aged individuals, with progressively fewer participants in the higher age categories.

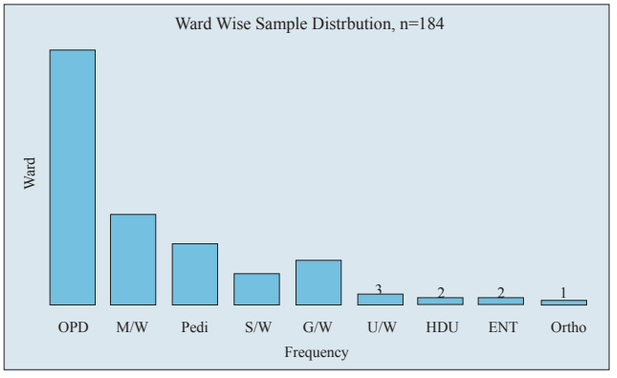

Figure 2 Ward wise sample distribution (Urine, Wound Swab and Pus, Sputum) (n=184)

OPD=Outpatient Department, M/W=Medicine Ward, Pedi=Pediatric Ward, S/W=Surgery Ward, G/W=Gynae and Obstetrics Ward, U/W=Urology Ward, HDU=High Dependency Unit, ENT=Ear Nose and Throat Ward, Ortho=Orthopedics Ward*.

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A total of 184 clinical specimens were collected from different hospital wards/units. The majority of samples were obtained from the Outpatient Department (OPD) contributing 94 specimens. This was followed by the Medicine Ward (M/W) with 33 specimens and the Pediatric Ward with 22 specimens. Additional contributions were recorded from the Gynecology Ward (G/W) (16 specimens) and the Surgical Ward (S/W) (11 specimens). Relatively few samples were received from the Urology Ward (U/W) (3 specimens) High Dependency Unit (HDU) (2 specimens), and ENT ward (2 specimens) while the lowest number of samples was collected from the Orthopedics ward(1 specimen). Overall, specimen collection was highest in OPD, with progressively smaller numbers from inpatient wards and specialized units (Figure-2).

Table II Frequency distribution of sample (n=184)

Specimen type	Frequency (n)	Percentage (%)
Urine	140	76.09
Wound swab	16	8.69
Sputum	14	7.61
Pus	14	7.61
Total	184	100.00

Table II depicts that the Urine samples constituted the majority, with 140 specimens (76.09%) indicating that most isolates were obtained from urinary sources. Wound swab and pus samples were the second most common, accounting for 30 specimens (16.30%). Sputum samples represented the smallest proportion, with 14 specimens (7.61%).

Table III Distribution of microorganisms in different sample isolates (n=184)

Sample	Organism	Frequency (%)
	E. coli	71 (50.71)
Urine	*Klebsiella spp.*	32 (22.88)
	Enterococci spp.	24 (17.14)
	CONS	7 (5)
	Pseudomonas spp.	4 (2.88)
	Staphylococcus saprophyticus	1 (0.71)
	Proteus spp.	1 (0.71)
	Total	140
	Pseudomonas spp.	6 (37.5)
	Klebsiella spp.	5 (31.25)
Wound Swab	*Staphylococcus aureus*	2 (12.5)
	E. coli	1 (6.25)
	Proteus spp.	1 (6.25)
	CONS	1 (6.25)
	Total	16
	Staphylococcus aureus	5 (35.71)
	CONS	2 (14.29)
	E. coli	2 (14.29)
Pus	*Klebsiella spp.*	2 (14.29)
	Pseudomonas spp.	2 (14.29)
	Proteus spp.	1 (7.14)
	Total	14
	Klebsiella spp.	11 (78.57)
Sputum	*E. coli*	2 (14.29)
	Pseudomonas spp.	1 (7.14)
	Total	14

Table III Showed Across the four specimen groups, Gram-negative bacilli predominated overall. In the largest group (n = 140) *E. coli* was the leading isolate (71/140, 50.7%) followed by *Klebsiella spp.* (32/140, 22.9%) and *Enterococci spp.* (24/140, 17.1%) while other organisms each contributed ≤5%. In the second group (n = 16) *Pseudomonas spp.* (37.5%) and *Klebsiella spp.* (31.3%) were most frequent. The third group (n = 14) was dominated by *Staphylococcus aureus* (35.7%) with CONS, *E. coli, Klebsiella spp.* and *Pseudomonas spp.* each accounting for 14.3%. In the fourth group (n=14) *Klebsiella spp.* was overwhelmingly predominant (78.6%) followed by *E. coli* (14.3%) and *Pseudomonas spp.* (7.1%).

Table IV Sample Tested for Organism Wise Distribution of Carbapenem Resistant, n=142

Sample	Organism	Isolates Tested (n)	Carbapenem R Isolates (n)	Carbapenem R (%)
Pus	*Proteus spp.*	1	1	100
	E. coli	2	1	50
	Pseudomonas spp.	2	0	00
	Klebsiella spp.	2	1	50
Wound Swab	*Pseudomonas spp.*	6	1	16.67
	Klebsiella spp.	5	2	40
	E. coli	1	1	100
	Proteus spp.	1	1	100
Sputum	*Klebsiella spp.*	11	1	9.09
	Pseudomonas spp.	1	1	100
	E. coli	2	1	50
Urine	*E. Coli*	71	2	2.82
	Pseudomonas spp.	4	3	75
	Klebsiella spp.	32	3	9.36
	Proteus spp.	1	0	00
	Tolal	142	19	13.38

*Carbapenem- Meropenem, Imipenem
*R- Resistant.

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Table IV described, A total of 142 clinical isolates were tested for carbapenem resistance, of which 19 (13.38%) were resistant. Resistance varied by organism and sample type. In pus, *Proteus spp.* (100%) and *Klebsiella spp.* (50%) showed notable resistance, while E. coli was 50% and *Pseudomonas spp.* showed no resistance. Wound swabs demonstrated 100% resistance in *E. coli* and *Proteus spp.* 40% in *Klebsiella spp.* and 16.67% in *Pseudomonas spp.* Sputum isolates had 100% resistance in *Pseudomonas spp.* 50% in *E. coli* and 9.09% in *Klebsiella spp.* Urine isolates showed lower resistance, except for *Pseudomonas spp.* (75%) *Klebsiella spp.* (9.36%) and *E. coli* (2.82%).

Table V Ward-wise distribution of carbapenem-resistant organisms (n = 19)

Hospital ward	Number of isolates carbapenem resistant	Percentage (%)
Medicine ward	5	26.31
Gynecology and Obstetrics ward	4	21.05
Surgery ward	3	15.79
Pediatric ward	5	26.32
Other wards	2	10.53
Total	19	100.0

Table V showed Among the 19 carbapenem-resistant isolates, the highest proportions were detected from the Medicine ward (5 isolates, 26.31%) and Pediatric ward (5 isolates, 26.32%) together accounting for over half (52.64%) of all resistant cases. The Gynecology and Obstetrics ward contributed 4 isolates (21.05%) followed by the Surgery ward with 3 isolates (15.79%). The remaining 2 isolates (10.53%) originated from other wards.

Discussion

The findings of this hospital-based surveillance study reveal a notable occurrence of Carbapenem-Resistant Organisms (CROs) in a tertiary care setting of Chattogram, Bangladesh, with 19 out of 142 tested Gram-negative isolates (13.38%) exhibiting resistance to at least one carbapenem. This rate aligns with regional trends in low- and middle-income countries, where carbapenem resistance poses a growing threat to patient outcomes. Organism-specific patterns showed *Klebsiella spp.* as a key contributor to resistance (9-50% across specimens), followed by *Pseudomonas spp.* (33-100%) and *E. coli* (5.63-50%) with urine samples yielding the majority of isolates (76.09%). Resistance was most prevalent in the Medicine and Pediatric wards (Each 26.32%) highlighting vulnerabilities in these settings.

Comparisons with other studies demonstrate several similarities. First, the overall prevalence of 13.38% is comparable to the 10.6% CRE rate reported in a tertiary hospital in Dhaka, Bangladesh, where clinical specimens from diverse patients were analyzed, suggesting consistent institutional resistance burdens in urban Bangladeshi settings driven by similar antibiotic pressures and infection control challenges.[9] Second, the predominance of *Klebsiella spp.* and *E. coli* among CROs mirrors findings from a national surveillance in Thailand, where *Klebsiella pneumoniae* accounted for 72% and *Escherichia coli* for 22% of CRE isolates, indicating these Enterobacterales species as primary drivers of resistance in Southeast Asian healthcare facilities due to their adaptability and plasmid-mediated resistance mechanisms.[9] Third, the high carbapenem resistance in *Pseudomonas spp.* (55% pooled) is similar to the 39% CRPA prevalence in hospital environments in Dhaka, reflecting intrinsic resistance factors like efflux pumps and the selective pressure from broad-spectrum antibiotics in tertiary care environments.[10] Also the elevated resistance in non-ICU wards such as Medicine and Pediatrics is akin to hospital-wide colonization patterns in Bangladesh, where 37% of hospitalized patients carried CRE, underscoring the spillover of resistance beyond critical care units into general inpatient areas.[10]

However, notable dissimilarities exist. Resistance findingsas 13.38% is lower than the 30% carbapenemase-producing *Klebsiella pneumoniae* rate in a Bangladeshi ICU, likely because our study encompassed diverse wards and specimens, diluting the focused high-resistance environment of ICUs with stricter inclusion of clinical infections rather than colonization.[12] Unlike the 37% CRE colonization in hospitalized patients across Bangladeshi facilities, our lower rate may stem from phenotypic testing of isolates from symptomatic infections only, excluding asymptomatic carriers that inflate colonization-based estimates.[11] On the other hand while *Pseudomonas* resistance was high in our cohort, it contrasts with environmental studies showing 70% *Pseudomonas* positivity but only 39% carbapenem resistance, possibly due to our focus on clinical isolates versus surface swabs, where resistance may be less pronounced in non-patient sources.[12]

These results underscore the urgent need for enhanced surveillance, infection control and antimicrobial stewardship in Bangladeshi tertiary hospitals to mitigate resistance spread. Limitations include the phenotypic approach without molecular characterization, short study duration and exclusion of colonization isolates, which may underestimate the true reservoir.

Limitations

Current study include only the phenotypic approach without molecular characterization, short study duration and exclusion of colonization isolates, which may underestimate the true reservoir.

Conclusion

This hospital-based surveillance study revealed a 13.38% prevalence of carbapenem-resistant organisms among 142 tested Gram-negative isolates in a tertiary care setting in Chattogram, Bangladesh, with notably higher resistance in *Pseudomonas spp.* (~55%), *Klebsiella spp.* (14%) and certain specimen types (e.g. Pus/wound swabs). Urine samples predominated (76%) while resistance was most frequent in Medicine and Pediatric wards. These findings highlight the growing threat of carbapenem resistance in non-ICU settings and underscore the urgent need for strengthened infection control.

Recommendations

Implementation of regular hospital-wide surveillance of CROs, enforcing strict antimicrobial stewardship programs, promoting rational antibiotic use (Especially carbapenems) and enhancing infection prevention measures in high-burden wards (Medicine, Pediatrics, Gynecology). Molecular detection of carbapenemase genes should be considered in future studies to better guide targeted interventions and improve patient outcomes.

Disclosure

All the authors declared no conflict of interest.

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