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Research Article

CLINICAL PROFILE AND OUTCOME OF URINARY TRACT INFECTIONS CAUSED BY EXTENDED-SPECTRUM BETA-LACTAMASE-PRODUCING *ESCHERICHIA COLI:* A RETROSPECTIVE OBSERVATIONAL STUDY FROM INTENSIVE CARE UNITS OF A TERTIARY CARE TEACHING HOSPITAL IN SOUTH INDIA

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ABSTRACT

Objective: The objective of the study is to compare the clinical profile, antimicrobial susceptibility pattern, severity indicators, and outcomes of urinary tract infections (UTIs) caused by extended-spectrum beta-lactamase (ESBL)-producing and non-ESBL-producing *Escherichia coli* among critically ill patients admitted to intensive care units (ICUs).

Methods: This retrospective observational study was conducted in a tertiary care teaching hospital over a three-year period and included 1237 culture-confirmed *E. coli* UTI isolates from ICU patients. Patients were categorized into ESBL and non-ESBL groups based on phenotypic ESBL detection. Demographic variables, clinical presentation, comorbidities, complications, antimicrobial susceptibility, ICU stay, Acute Physiology and Chronic Health Evaluation (APACHE IV) and Sequential Organ Failure Assessment (SOFA) scores, and clinical outcomes were analyzed.

Results: Among 1237 isolates, 742 (60.0%) were ESBL producers and 495 (40.0%) were non-ESBL producers. ESBL infections were associated with higher complication rates, including renal failure (58.0%), septic shock (18.0%), and multi-organ dysfunction syndrome (10.0%). Mean ICU stay was significantly longer in the ESBL group than in the non-ESBL group (5.1 vs. 3.6 days; $p<0.01$). Mortality was higher among ESBL patients than among non-ESBL patients (12.4% vs. 6.8%), with an absolute risk difference of 5.5% (95% confidence interval: 2.3–8.8%). APACHE IV and SOFA scores showed good mortality prediction, with area under the curve values of 0.82 and 0.79, respectively. Carbapenems showed the highest sensitivity among ESBL isolates.

Conclusion: ESBL-producing *E. coli* UTIs in ICU patients are associated with increased morbidity, prolonged ICU stay, higher complication rates, and greater mortality. Early identification, appropriate empirical therapy, severity-based risk stratification, and antimicrobial stewardship are essential to improve clinical outcomes.

Keywords: Extended-spectrum beta-lactamase, *Escherichia coli*, Urinary tract infection, Antimicrobial resistance, Intensive care unit, Carbapenem.

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INTRODUCTION

Urinary tract infection (UTI) is one of the most frequently encountered bacterial infections in community as well as hospital settings and remains an important contributor to morbidity, antimicrobial use, and healthcare burden worldwide [1]. Among bacterial uropathogens, *Escherichia coli* is the leading etiological agent and is responsible for nearly 70–80% of UTI cases [1]. In recent years, the emergence of antimicrobial resistance among uropathogens, particularly extended-spectrum beta-lactamase (ESBL)-producing *E. coli*, has created a major challenge in clinical management [2].

ESBLs are mainly plasmid-mediated enzymes that hydrolyze several beta-lactam antibiotics, including third-generation cephalosporins and monobactams, thereby reducing the efficacy of commonly used empirical antimicrobial agents [3]. The increasing spread of ESBL-producing Enterobacteriaceae has been linked to inappropriate antibiotic use, prolonged hospitalization, invasive procedures, recurrent healthcare exposure, and use of indwelling devices [4]. In developing countries, including India, the burden is considerably high, with ESBL prevalence rates reported between 40% and 70% among clinical isolates [5].

Patients admitted to intensive care units (ICUs) are particularly vulnerable to severe infections because of advanced illness, underlying comorbidities, immune dysfunction, invasive monitoring, mechanical ventilation, urinary catheterization, and frequent exposure to broad-spectrum antibiotics [6]. UTIs in critically ill patients may present with atypical clinical features and are often associated with serious complications such as acute kidney injury (AKI), septic shock, and multi-organ dysfunction syndrome (MODS) [7]. Infections caused by ESBL-producing organisms in ICU settings are also associated with delayed initiation of appropriate therapy, prolonged hospital stay, increased treatment cost, and higher mortality [8].

Carbapenems are commonly considered important therapeutic agents for serious infections caused by ESBL-producing organisms. However, increasing carbapenem use has raised concern regarding the emergence of carbapenem-resistant Enterobacteriaceae, which further restricts available treatment options [9]. This situation highlights the need for rational antibiotic use, continuous antimicrobial susceptibility surveillance, and effective antimicrobial stewardship programs. In critically ill patients, severity scoring systems such as Acute Physiology and Chronic Health Evaluation IV (APACHE IV) and Sequential Organ Failure Assessment (SOFA) may help in early risk stratification, mortality prediction, and clinical decision-making [10].

Although ESBL-associated infections are increasingly recognized as a major public health concern, large-scale clinical data comparing ESBL-

producing and non-ESBL-producing *E. coli* UTIs among ICU patients from tertiary care centers in India remain limited. Many available studies are restricted by smaller sample sizes or lack detailed clinical correlation. Therefore, the present study was undertaken to analyze and compare the clinical characteristics, antimicrobial susceptibility patterns, severity indicators, complications, and outcomes of UTIs caused by ESBL-producing and non-ESBL-producing *E. coli* in a large cohort of critically ill patients.

METHODS

Study design and setting

This was a combined retrospective and laboratory-based observational study integrating phenotypic antimicrobial susceptibility testing with molecular characterization of resistance and virulence genes in *E. coli* isolates. The study was conducted in the Department of Microbiology and Central Research Laboratory of tertiary care institutions in Karnataka, India, over a three-year period from January 2022 to December 2024.

Study population

A total of 1237 adult patients admitted to the ICU with clinically suspected UTI and microbiologically confirmed *E. coli* growth from urine samples were included in the study. To avoid duplication, only the first *E. coli* isolate from each patient was considered for analysis.

Inclusion criteria

Patients were included if they fulfilled the following criteria:

- Age ≥18 years
- ICU admission with clinical features suggestive of UTI, such as fever, dysuria, increased urinary frequency, flank pain, altered sensorium, or sepsis
- Positive urine culture showing significant growth of *E. coli*, defined as $\geq 10^5$ CFU/mL
- Availability of complete clinical, laboratory, microbiological, treatment, and outcome data.

Exclusion criteria

Patients were excluded if they had:

- Polymicrobial growth in urine culture
- Asymptomatic bacteriuria
- Immunocompromised status, including human immunodeficiency virus infection, malignancy, neutropenia, or current immunosuppressive therapy
- Death within 48 h of initiation of antibiotic therapy
- Incomplete medical records.

Microbiological methods

Midstream urine samples or catheterized urine specimens were collected under aseptic precautions and processed promptly in the microbiology laboratory. Samples were inoculated on Cysteine Lactose Electrolyte Deficient agar and MacConkey agar using a calibrated loop technique. Significant bacteriuria was defined as colony counts of $\geq 10^5$ CFU/mL.

Identification of *E. coli* isolates was performed using standard biochemical tests and/or automated identification systems. Antimicrobial susceptibility testing was carried out by the Kirby–Bauer disk diffusion method on Mueller–Hinton agar and interpreted according to Clinical and Laboratory Standards Institute (CLSI) guidelines. Carbapenem susceptibility was also assessed using the Kirby–Bauer disk diffusion method and interpreted according to CLSI criteria.

Screening for ESBL production was performed using ceftazidime and cefotaxime discs. Phenotypic confirmation of ESBL production was done by the combined disc diffusion method using ceftazidime and cefotaxime with and without clavulanic acid. An increase in zone diameter of ≥5 mm in the presence of clavulanic acid was considered confirmatory for ESBL production.

Grouping of patients

Based on phenotypic ESBL detection, patients were divided into two groups:

1. ESBL-producing *E. coli* UTI group
2. Non-ESBL-producing *E. coli* UTI group.

Data collection

Clinical and microbiological data were retrieved from hospital medical records using a structured data collection format. The following variables were recorded: Age, gender, presenting symptoms, comorbidities, laboratory parameters, empirical and definitive antibiotic therapy, antimicrobial susceptibility pattern, duration of ICU stay, complications, and clinical outcome.

The complications assessed included AKI, septic shock, hepatic dysfunction, encephalopathy, and MODS. Clinical outcome was recorded as recovery or in-hospital death.

Severity scoring

Severity of illness was assessed using the APACHE IV score and SOFA score. Both scores were calculated using clinical and laboratory data recorded during the first 24 h of ICU admission. Scores were calculated retrospectively by two trained physicians, and discrepancies were resolved by consensus. The relationship of APACHE IV and SOFA scores with mortality was analyzed.

Outcome measures

The primary outcome measure was in-hospital mortality. Secondary outcome measures included duration of ICU stay, complication rates, antimicrobial susceptibility pattern, and antibiotic usage pattern.

Statistical analysis

Data were entered in Microsoft Excel and analyzed using the Statistical Package for the Social Sciences software version 25. Continuous variables were expressed as mean ± standard deviation, whereas categorical variables were expressed as frequencies and percentages. Between-group comparison was performed using Student's t-test for continuous variables and Chi-square test for categorical variables. A $p<0.05$ was considered statistically significant. As multiple between-group comparisons were performed, the reported p-values were interpreted cautiously. Formal Bonferroni correction was not applied; therefore, the results of multiple subgroup comparisons were considered exploratory, and borderline significant findings were not overinterpreted.

Ethical considerations

The study was conducted after obtaining approval from the Institutional Ethics Committee of B. M. Patil Medical College, BLDE [Deemed to be University], Vijayapura, Karnataka, India, vide approval number BLDE[DU]/IEC/403/2019-20, dated December 27, 2019. The study used anonymized laboratory data and archived bacterial isolates. No patient names, hospital numbers, or other personal identifiers were included during data extraction, analysis, or reporting.

RESULTS

A total of 1237 patients with culture-confirmed *E. coli* UTI admitted to the ICU during the study period were included in the analysis. Based on phenotypic detection of ESBL production, 742 (60.0%) isolates were categorized as ESBL-producing *E. coli* and 495 (40.0%) as non-ESBL-producing *E. coli.*

Demographic characteristics

The overall mean age of the study population was 56.7±14.2 years. Patients in the ESBL group were older than those in the non-ESBL group (58.1±13.8 years vs. 54.6±14.5 years). A higher proportion of patients aged >60 years was observed in the ESBL group compared with the non-ESBL group (412 [55.5%] vs. 238 [48.1%]; p=0.03). Female predominance was noted in both groups, and the sex distribution was comparable between the groups (p=0.34) (Table 1).

Clinical presentation

Fever was the most common presenting symptom in both groups, observed in 459 (61.8%) patients in the ESBL group and 336 (67.9%) patients in the non-ESBL group. Dysuria, abdominal pain, vomiting, altered sensorium, and reduced urine output were also frequently documented. Altered sensorium was more common among ESBL patients (168 [22.6%]) than among non-ESBL patients (78 [15.8%]), suggesting greater clinical severity at presentation. Dysuria was more frequent in the non-ESBL group (Table 2).

Comorbid conditions

Diabetes mellitus was the most common comorbidity in both groups and was more frequent among ESBL patients than among non-ESBL patients (406 [54.7%] vs. 237 [47.9%]; p=0.02). Hypertension was also more common in the ESBL group (314 [42.3%] vs. 178 [36.0%]; p=0.04). Chronic kidney disease (CKD) was slightly more frequent in the non-ESBL group, whereas coronary artery disease (CAD), chronic liver disease (CLD), and cerebrovascular accident (CVA) were more frequent in the ESBL group. As multiple comorbidity comparisons were performed, borderline findings such as CKD and CAD were interpreted cautiously and were not overemphasized because they would not remain robust under conservative multiple-comparison adjustment (Table 3).

Microbiological profile and antimicrobial susceptibility

All isolates were confirmed as *E. coli* by standard biochemical methods and/or automated identification systems. Among ESBL-producing isolates, resistance to third-generation cephalosporins was high, as expected. Carbapenems showed the highest sensitivity among ESBL isolates, with imipenem and meropenem sensitivity of 96.5% and 95.8%, respectively. Amikacin and nitrofurantoin retained moderate activity, while fluoroquinolone sensitivity was low in both groups. Piperacillin-tazobactam retained activity in only 54.6% of ESBL isolates, limiting its reliability as empirical therapy in critically ill patients with suspected ESBL-associated UTI (Table 4).

Complications

Complications were more frequent in the ESBL group. AKI was the most common complication in both groups and was observed in 430 (57.9%) ESBL patients and 255 (51.5%) non-ESBL patients. Septic shock requiring vasopressor support was documented in 135 (18.2%) ESBL patients compared with 51 (10.3%) non-ESBL patients (p<0.01). Hepatic dysfunction and MODS were also more frequent in the ESBL group. MODS was observed in 74 (10.0%) ESBL patients and 20 (4.0%) non-ESBL patients (p<0.001) (Table 5).

ICU stay and antibiotic therapy

The mean duration of ICU stay was significantly longer in the ESBL group than in the non-ESBL group (5.1±2.4 days vs. 3.6±1.8 days; p<0.01). The mean duration of antibiotic therapy was also longer among patients with ESBL infections than among those with non-ESBL infections (7.2 days vs. 6.1 days), although this difference was only marginally significant.

Mortality outcomes

The overall in-hospital mortality rate was 10.2% (126/1237). Mortality was significantly higher in the ESBL group than in the non-ESBL group (92/742 [12.4%] vs. 34/495 [6.8%]; p<0.01). The absolute risk difference for mortality between ESBL and non-ESBL infections was 5.5% (95% CI: 2.3–8.8%). Patients with MODS had the highest mortality in both groups. Among ESBL patients with MODS, 68 of 74 patients (91.9%) died, whereas among non-ESBL patients with MODS, 17 of 20 patients (85.0%) died despite appropriate antibiotic therapy.

Severity scoring (APACHE IV and SOFA)

Severity scoring was performed within the first 24 h of ICU admission. The mean APACHE IV score was significantly higher in the ESBL group than in the non-ESBL group (68.4±15.2 vs. 59.3±13.8; p<0.001). Similarly, the mean SOFA score was higher among ESBL patients than

Table 1: Demographic profile of the study populations

Parameter	ESBL group (n=742) (%)	Non-ESBL group (n=495) (%)	p-value
Mean age (years)	58.1±13.8	54.6±14.5	>0.05
Age >60 years	412 (55.5)	238 (48.1)	0.03
Male	338 (45.5)	212 (42.8)	0.34
Female	404 (54.5)	283 (57.2)	-

Values are expressed as mean±standard deviation for continuous variables and number (percentage) for categorical variables; Student's t-test was used for continuous variables and Chi-square test for categorical variables. ESBL: Extended-spectrum beta-lactamase

Table 2: Clinical features at presentation

Symptom	ESBL group (n=742) (%)	Non-ESBL group (n=495) (%)
Fever	459 (61.8)	336 (67.9)
Dysuria	252 (34.0)	208 (42.0)
Abdominal pain	178 (24.0)	146 (29.5)
Vomiting	210 (28.3)	168 (33.9)
Altered sensorium	168 (22.6)	78 (15.8)
Reduced urine output	98 (13.2)	54 (10.9)

Values are expressed as number (percentage). Percentages were calculated based on the total number of patients in each group. ESBL: Extended-spectrum beta-lactamase

Table 3: Distribution of comorbidities

Comorbidity	ESBL group (n=742) (%)	Non-ESBL group (n=495) (%)	p-value
Diabetes mellitus	406 (54.7)	237 (47.9)	0.02
Hypertension	314 (42.3)	178 (36.0)	0.04
CKD	148 (19.9)	122 (24.6)	0.05
CAD	132 (17.8)	68 (13.7)	0.06
CLD	52 (7.0)	18 (3.6)	0.01
CVA	96 (12.9)	34 (6.8s)	0.002

Values are expressed as number (percentage). p-values were calculated using the Chi-square test. CKD: Chronic kidney disease, CAD: Coronary artery disease, CLD: Chronic liver disease, CVA: Cerebrovascular accident

Table 4: Antibiotic susceptibility pattern

Antibiotic	ESBL sensitive (%)	Non-ESBL sensitive (%)
Imipenem	96.5	98.2
Meropenem	95.8	97.5
Amikacin	68.2	88.4
Piperacillin-tazobactam	54.6	82.1
Ceftriaxone	12.3	78.5
Ciprofloxacin	28.7	46.9
Nitrofurantoin	62.5	74.3

Values are expressed as a percentage of isolates sensitive to each antibiotic. Antimicrobial susceptibility was interpreted according to CLSI guidelines. ESBL: Extended-spectrum beta-lactamase

Table 5: Complications observed

Complication	ESBL group (n=742) (%)	Non-ESBL group (n=495) (%)	p-value
AKI	430 (57.9)	255 (51.5)	0.03
Septic shock	135 (18.2)	51 (10.3)	<0.01
Hepatic dysfunction	178 (24.0)	59 (11.9)	<0.001
MODS	74 (10.0)	20 (4.0)	<0.001
Encephalopathy	142 (19.1)	72 (14.5)	0.04

Values are expressed as number (percentage). p-values were calculated using the Chi-square test. AKI: Acute kidney injury, MODS: Multi-organ dysfunction syndrome, ESBL: Extended-spectrum beta-lactamase

Table 6: Severity scores and mortality predictions

Severity score	ESBL group (n=742)	Non-ESBL group (n=495)	p-value	AUC for mortality prediction
APACHE IV score	68.4±15.2	59.3±13.8	<0.001	0.82 (95% CI: 0.78–0.86)
SOFA score	9.2±3.1	7.4±2.6	<0.001	0.79 (95% CI: 0.74–0.84)

Values are expressed as mean±standard deviation. AUC values are presented with 95% confidence intervals for mortality prediction. APACHE IV: Acute physiology and chronic health evaluation IV, SOFA: Sequential organ failure assessment, AUC: Area under the curve, CI: Confidence interval

among non-ESBL patients (9.2±3.1 vs. 7.4±2.6; p<0.001). Both scoring systems demonstrated good predictive performance for mortality. The area under the receiver operating characteristic curve for mortality prediction was 0.82 (95% CI: 0.78–0.86) for APACHE IV and 0.79 (95% CI: 0.74–0.84) for SOFA. Patients with APACHE IV scores >70 and SOFA scores >10 had higher mortality (Table 6).

DISCUSSION

The present study evaluated the clinical profile, antimicrobial susceptibility pattern, complications, severity scores, and outcomes of UTIs caused by ESBL-producing and non-ESBL-producing *E. coli* among critically ill patients. In this cohort of 1237 ICU patients, ESBL-producing *E. coli* accounted for 60.0% of isolates, indicating a high burden of antimicrobial resistance in the critical care setting. This finding is consistent with reports from India and other developing countries, where ESBL prevalence among clinical isolates has been reported to be high [2,3].

The high prevalence of ESBL-producing *E. coli* has important clinical implications. ESBL enzymes hydrolyze several beta-lactam antibiotics, especially third-generation cephalosporins, thereby limiting the effectiveness of commonly used empirical regimens [3]. In ICU patients, inappropriate or delayed initiation of active antimicrobial therapy can rapidly worsen clinical outcomes. The present findings therefore emphasize the need for early identification of ESBL production and institution-specific empirical antibiotic policies.

In the present study, patients with ESBL-producing *E. coli* infections were relatively older than those with non-ESBL infections. A higher proportion of patients aged more than 60 years was observed in the ESBL group. Advanced age is a known risk factor for severe infection because of reduced immune response, frequent healthcare exposure, recurrent antibiotic use, and higher prevalence of comorbid illnesses [4]. Female predominance was noted in both groups, which is consistent with the established epidemiology of UTIs and may be explained by anatomical and physiological factors predisposing women to urinary infection [5].

Fever was the most common presenting symptom in both ESBL and non-ESBL groups. However, altered sensorium was more frequent among patients with ESBL infections, suggesting greater systemic involvement and severity at presentation. In critically ill patients, classical urinary symptoms may be absent or masked by sepsis, altered consciousness, catheterization, or associated organ dysfunction. Therefore, a high index of clinical suspicion is necessary for early diagnosis of UTI in ICU patients [6].

Comorbid conditions were frequently observed in both groups. Diabetes mellitus was the most common comorbidity and was more frequent among patients with ESBL infections. Hyperglycemia impairs neutrophil function, cellular immunity, and host defense mechanisms, thereby increasing susceptibility to severe bacterial infections [7]. Hypertension, CKD, CLD, CAD, and CVA were also observed in the study population. However, because multiple comorbidity comparisons were performed, borderline findings such as CKD and CAD should be interpreted cautiously. These associations should be considered exploratory rather than definitive, particularly because conservative correction for multiple comparisons may reduce their statistical significance.

Complications were more frequent among patients with ESBL-producing *E. coli* infections. AKI was the most common complication, followed by hepatic dysfunction, encephalopathy, septic shock, and MODS. Septic shock and MODS were notably more frequent in the ESBL group, indicating greater disease severity. This may be related to delayed appropriate therapy, limited empirical antibiotic coverage, higher bacterial resistance burden, and underlying host vulnerability. Similar associations between multidrug-resistant infections and adverse clinical outcomes have been reported in critically ill patients [8,9].

The antimicrobial susceptibility pattern observed in this study highlights the restricted therapeutic options available for ESBL-associated UTIs in ICU patients. Carbapenems showed the highest sensitivity among ESBL isolates, with imipenem and meropenem sensitivity exceeding 95%. This supports the continued role of carbapenems in severe ESBL infections [10]. However, increasing dependence on carbapenems is a matter of concern because it may promote the emergence of carbapenem-resistant Enterobacteriaceae [11]. Therefore, carbapenem use should be guided by culture reports, local antibiograms, clinical severity, and antimicrobial stewardship principles.

Piperacillin-tazobactam retained activity in only 54.6% of ESBL isolates in the present study. This finding is clinically important because it limits the reliability of piperacillin-tazobactam as empirical therapy in critically ill patients with suspected ESBL-associated UTI. Although beta-lactam/beta-lactamase inhibitor combinations may have a role in selected infections, their use in ICU patients should be cautious when local ESBL prevalence is high or when severe sepsis is present [10]. Amikacin and nitrofurantoin retained moderate activity, while fluoroquinolone sensitivity was low in both groups, reflecting the growing problem of resistance to commonly used oral and parenteral agents [12].

The mean duration of ICU stay was significantly longer among patients with ESBL infections compared with those with non-ESBL infections. Prolonged ICU stay increases healthcare costs, resource utilization, exposure to invasive devices, and risk of additional nosocomial infections. This finding is consistent with earlier observations that antimicrobial resistance is associated with longer hospitalization and higher healthcare burden [13].

Mortality was significantly higher in the ESBL group than in the non-ESBL group. In the present study, mortality was 12.4% among patients with ESBL-producing *E. coli* infections compared with 6.8% among patients with non-ESBL infections. The absolute risk difference for mortality was 5.5%, suggesting a clinically relevant increase in risk among ESBL-infected patients. This increased mortality may be due to delayed initiation of effective therapy, higher severity of illness, increased frequency of septic shock and MODS, and greater comorbidity burden. Early appropriate antimicrobial therapy has been shown to be a critical determinant of survival in severe infections and septic shock [14].

A particularly important finding was the high mortality among patients who developed MODS. Among ESBL patients with MODS, 68 of 74 patients (91.9%) died, whereas among non-ESBL patients with MODS, 17 of 20 patients (85.0%) died despite appropriate antibiotic therapy. These exact figures indicate that once MODS develops, mortality becomes extremely high irrespective of ESBL status. This emphasizes the need for early recognition of sepsis, prompt source

control, rational empirical antibiotic selection, and aggressive organ-supportive management before progression to irreversible organ dysfunction [15].

Severity scoring using APACHE IV and SOFA further supported the clinical impact of ESBL infections. Both scores were significantly higher in the ESBL group, indicating greater physiological derangement and organ dysfunction. The area under the receiver operating characteristic curve for mortality prediction was 0.82 for APACHE IV and 0.79 for SOFA, demonstrating good predictive performance. These findings suggest that APACHE IV and SOFA scores may be useful tools for early risk stratification, prognosis assessment, and treatment prioritization in ICU patients with *E. coli* UTI [16].

The findings of this study have practical implications for critical care and microbiology practice. High ESBL prevalence in ICU patients should prompt regular surveillance of local resistance patterns and periodic revision of empirical antibiotic policies. Infection control measures, including hand hygiene, catheter care bundles, isolation precautions, and antimicrobial stewardship programs, are essential to reduce transmission and prevent further emergence of resistant organisms [17,18].

This study has several strengths, including a large sample size, comparison between ESBL and non-ESBL *E. coli* infections, assessment of clinical complications, antimicrobial susceptibility profile, ICU stay, mortality, and severity scoring. However, certain limitations should be acknowledged. The retrospective design may be associated with selection bias and incomplete documentation. As this was a single-center study, the findings may not be generalizable to all hospital settings. In addition, several between-group comparisons were performed; therefore, uncorrected p-values, especially borderline values, should be interpreted cautiously. Carbapenem susceptibility was assessed by routine phenotypic susceptibility testing, and minimum inhibitory concentration testing or detailed molecular detection of carbapenem resistance mechanisms was not performed for all isolates. Future prospective multicentric studies incorporating molecular epidemiology, treatment timing, antibiotic appropriateness, and long-term outcomes would provide more comprehensive evidence.

CONCLUSION

The present study demonstrates a high burden of ESBL-producing *E. coli* UTIs among ICU patients, with ESBL isolates accounting for 60.0% of cases. Compared with non-ESBL infections, ESBL-producing *E. coli* infections were associated with higher complication rates, prolonged ICU stay, increased severity scores, and greater in-hospital mortality. Piperacillin-tazobactam showed limited activity against ESBL isolates, whereas carbapenems retained the highest sensitivity, although their use must be balanced against the risk of emerging carbapenem resistance.

Mortality was particularly high among patients who developed MODS, highlighting the need for early diagnosis, timely effective antimicrobial therapy, close severity-based monitoring, and aggressive supportive care. APACHE IV and SOFA scores showed good predictive performance for mortality and may help in early risk stratification of critically ill patients. Strengthening antimicrobial stewardship, improving infection control practices, and using local antibiogram-guided empirical therapy are essential to reduce the clinical and healthcare burden of ESBL-producing *s* infections in ICU settings.

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AUTHORS' CONTRIBUTIONS

Mrs. Rashmi S B contributed to study conceptualization, data collection, retrieval of clinical and laboratory records, organization of microbiological and antimicrobial susceptibility data, analysis of ESBL and non-ESBL groups, interpretation of results, literature review, and preparation of the initial manuscript draft. Dr. Annapurna Sajjan contributed to study design, scientific supervision, methodological guidance, interpretation of microbiological findings, critical revision of the manuscript for important intellectual content, and final approval of the version to be submitted. Dr. Nawaz Umar contributed to laboratory supervision, support in isolate identification and antimicrobial susceptibility interpretation, review of clinical and microbiological findings, manuscript revision, and final approval of the manuscript.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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