

Research Article

Prevalence and Antimicrobial Susceptibility Patterns of Extended-Spectrum Beta-Lactamase-Producing Enterobacteriaceae Isolated from Patients with Urinary Tract Infections at a Tertiary Care Centre

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ABSTRACT

Background: Urinary tract infections (UTIs) are among the most common bacterial infections encountered in clinical practice. The increasing prevalence of extended-spectrum beta-lactamase (ESBL)-producing Enterobacteriaceae complicates treatment because these organisms can hydrolyse several beta-lactam antibiotics, including third-generation cephalosporins.

Aim: To determine the prevalence of ESBL-producing Enterobacteriaceae isolated from patients with suspected UTI and describe the antimicrobial susceptibility patterns of the isolates at a tertiary care centre.

Materials and Methods: This hospital-based observational study included 400 urine samples collected from patients with clinically suspected UTI. Samples were processed by standard urine culture methods, and bacterial isolates were identified using conventional microbiological procedures. Antimicrobial susceptibility testing was performed using the Kirby-Bauer disc diffusion method on Mueller-Hinton agar, following the applicable laboratory standards. ESBL production was assessed using screening and confirmatory phenotypic methods. Data were analysed descriptively and expressed as frequencies and percentages.

Results: Of the 400 urine samples examined, 304 (76.0%) yielded significant bacterial growth. Enterobacteriaceae accounted for 258 isolates, representing 84.8% of culture-positive samples. *Escherichia coli* was the predominant organism (157/258; 60.9%), followed by *Klebsiella pneumoniae* (70/258; 27.1%), *Proteus* spp. (21/258; 8.1%) and *Enterobacter* spp. (10/258; 3.9%). ESBL production was detected in 107 of the 258 Enterobacteriaceae isolates (41.5%). Among ESBL-positive isolates, *E. coli* accounted for 79 (73.8%), followed by *K. pneumoniae* (25; 23.4%), *Proteus* spp. (2; 1.9%) and *Enterobacter* spp. (1; 0.9%). Among all Enterobacteriaceae isolates, the highest reported antimicrobial resistance was to ampicillin (219/258; 84.9%), followed by ceftriaxone (55.4%), cefotaxime (50.4%) and ceftazidime (41.9%).

Conclusion: ESBL production was detected in 41.5% of Enterobacteriaceae isolated from urine samples in this study. *E. coli* was the predominant isolate and contributed the largest proportion of ESBL-positive organisms. The observed resistance to commonly used antibiotics highlights the importance of routine urine culture, ESBL detection and antimicrobial susceptibility testing to support appropriate treatment and local antimicrobial-resistance surveillance.

Keywords: Urinary tract infection; Enterobacteriaceae; extended-spectrum beta-lactamase; antimicrobial susceptibility; *Escherichia coli*.

Introduction:

Antimicrobial resistance, especially in Gram negative bacilli is a growing public health

concern. [1] The burden of antimicrobial resistance is higher in low- and middle-income countries like India due to unregulated and indiscriminate use of antibiotics.[2] A persistent

exposure of bacterial strains to a multitude of beta-lactam antibiotics has induced a dynamic, continuous production and mutation of beta lactamase in the bacteria leading to the development of extended spectrum beta-lactamases (ESBLs) causing resistance to broad spectrum beta-lactam antibiotics. [3-5]

Infections caused by Multidrug-resistant (MDR) Enterobacteriaceae pose a significant public threat due to their association with high mortality rates. One of the most common bacterial infections in both community and hospital settings is Urinary Tract Infection (UTI). UTIs are a serious public health issue in India, where they greatly increase hospital admissions and outpatient morbidity. [6,7]

Hospital environment is a potential source of nosocomial infections, since it houses both patients with diverse pathogenic microorganism and a large number of susceptible individuals. [8,9]

Antimicrobial resistance, especially in Gram negative bacilli is a growing public health concern. Treatment options for the multi-drug-resistant strains are limited due to paucity of newer antimicrobials in the pipeline. Infections with antimicrobial resistant strains lead to longer duration of hospital stay, increased cost of health care and contribute to higher rates of morbidity and mortality.[10]

Extended spectrum beta lactamases (ESBL) are a group of enzymes that are capable of hydrolysing Penicillins, first, second and third generation cephalosporins and monobactams like Aztreonam but are inhibited by beta lactam inhibitors like Clavulanic acid. They do not have any effect on Cephamycins and Carbapenems. [5]

MATERIALS AND METHODS-

The present Research was carried out in the Department of Biochemistry at Index Medical College, Hospital & Research Center, Indore (M.P.), over the period from July 2023 to July 2026. All the samples are taken from the OPD and IPD of Index Medical College, Indore (M.P).

A total of 400 urine samples from patients with clinically suspected UTI were included in the study. Samples were received from outpatient and inpatient services.

Inclusion criteria:

- Patients in the age group 10 to 65.
- Patients providing informed consent (or consent from guardians in the case of minors).

- Patients with culture-positive Enterobacteriaceae isolates.

Exclusion Criteria:

- Patients already on broad-spectrum antibiotics for more than 48 hours before sample collection.
- Samples showing contamination or mixed bacterial growth.
- Culture showing gram positive organisms.

Sample collection and Biochemical analysis:

Samples will be obtained from all patients with clinically suspected urinary tract infections (UTIs) who attended the tertiary care Center during the study period. Approximately 10–20 mL of urine was collected. Samples were transported to the Laboratory as soon as possible, preferably within 2 hours of collection. If immediate processing was not possible, the sample was appropriately refrigerated at 2–8°C and processed as soon as feasible. The samples were subjected to microscopy, quantitative culture, bacterial identification, and antimicrobial susceptibility testing according to the study protocol. Samples showing significant bacterial growth were further evaluated for Enterobacteriaceae and beta-lactamase production.

Antimicrobial susceptibility testing:

Antimicrobial susceptibility testing was performed using the Kirby–Bauer disc diffusion method on Mueller–Hinton agar. A standardized bacterial suspension was prepared, inoculated onto the agar surface and tested using the antimicrobial discs included in the study protocol. After incubation under the recommended conditions, inhibition-zone diameters were measured and interpreted as susceptible, intermediate or resistant according to the applicable Clinical and Laboratory Standards Institute (CLSI) criteria for the study period.

RESULT-

Of the 400 urine samples examined, 304 (76.0%) yielded significant bacterial growth. Enterobacterales accounted for 258 isolates, representing 84.8% of culture-positive samples. *Escherichia coli* was the predominant organism (157/258; 60.9%), followed by *Klebsiella pneumoniae* (70/258; 27.1%), *Proteus* spp. (21/258; 8.1%) and *Enterobacter* spp. (10/258; 3.9%). The mean number of Enterobacteriaceae isolates per positive sample

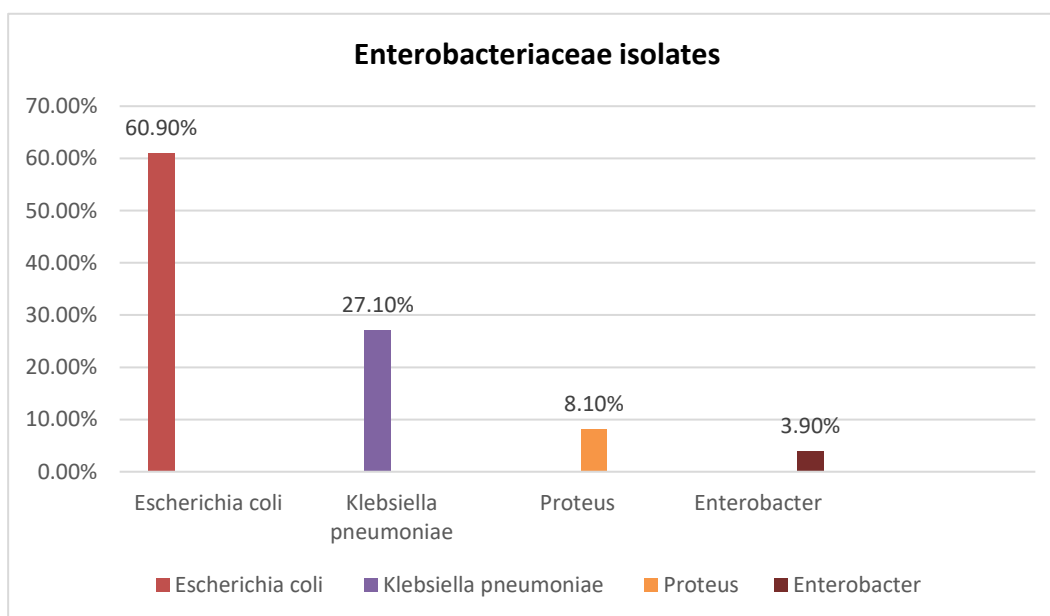
was 0.85 ± 0.36 , reflecting occasional polymicrobial infections. (Table no.1/ Graph no.1)

ESBL production was detected in 107 of the 258 Enterobacterales isolates (41.5%). Among ESBL-positive isolates, *E. coli* accounted for 79 (73.8%), followed by *K. pneumoniae* (25; 23.4%), *Proteus* spp. (2; 1.9%) and *Enterobacter* spp. (1; 0.9%). Among all

Enterobacterales isolates, the highest reported antimicrobial resistance was to ampicillin (219/258; 84.9%), followed by ceftriaxone (55.4%), cefotaxime (50.4%) and ceftazidime (41.9%). The mean number of ESBL-producing isolates per species was 0.268 ± 0.443 , reflecting a notable prevalence of ESBL-mediated resistance across different Enterobacteriaceae species. (Table no.2/ Graph no.2)

S.No.	Enterobacteriaceae isolates	Growth in No.	Percentage
01.	<i>Escherichia coli</i>	157	60.9%
02.	<i>Klebsiella pneumoniae</i>	70	27.1%
03.	<i>Proteus</i>	21	8.1%
04.	<i>Enterobacter</i>	10	3.9%
	Total	258	100%

Table No. 1-Distribution of Enterobacteriaceae isolates

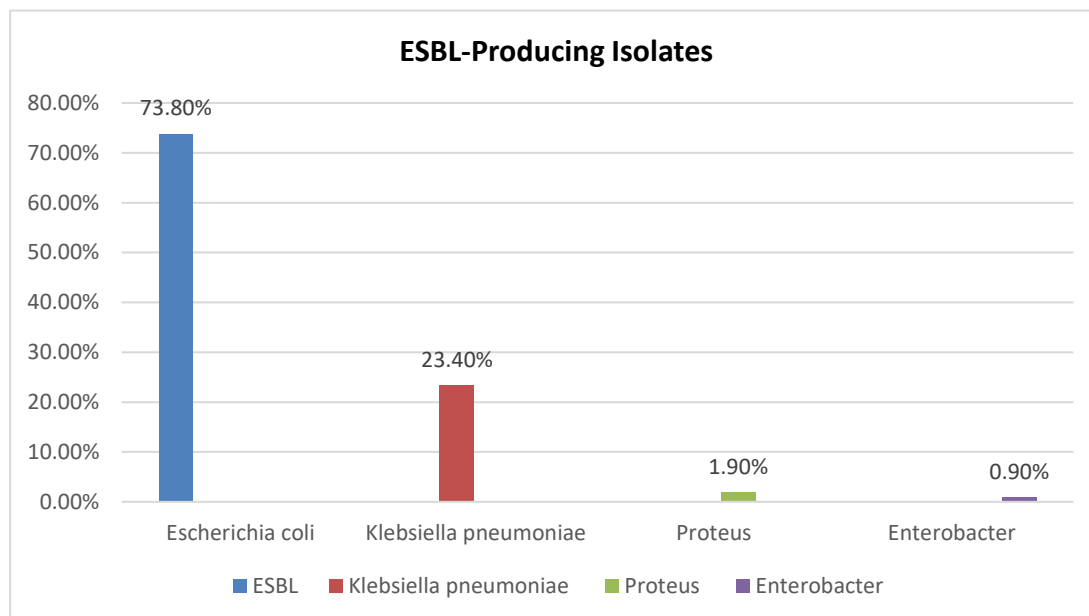


Graph no. 1: Distribution of Enterobacteriaceae isolates

S.No.	Enterobacteriaceae isolates	ESBL Isolates	Percentage (%) of ESBL Isolates
01.	<i>Escherichia coli</i>	79	73.8 %
02.	<i>Klebsiella pneumoniae</i>	25	23.4 %
03.	<i>Proteus mirabilis</i>	2	1.9 %

04.	Enterobacter	1	0.9 %
	Total	107	100%

Table No. 2- Distribution of Prevalence of ESBL-Producing Isolates



Graph no. 2: Prevalence of ESBL-Producing Isolates

DISCUSSION-

Muhammad Muqaddas Mustafai et al, A majority of participants (58.3%) in the current study were living in urban areas. A total of 227 (59.1%) patients were hospitalized. Furthermore, 26.04% of the patients were determined to be suffering from infections with Enterobacteriaceae. *Escherichia coli* was the most prevalent (9.1%) isolate overall, followed by *Klebsiella pneumoniae* (8.07%), *Acinetobacter baumannii* (2.6%), *Pseudomonas aeruginosa* (3.1%), *Enterobacter cloacae* (1.3%), *Proteus* spp. (1.3%), and *Morganella* spp. (0.5%). The studied patients were suffering from urinary tract infections (48.6%), blood stream infections (32.2%), wounds infection (11.9%), and respiratory infections (7.03%), confirmed with bacterial cultures. The resistance against carbapenems was seen in 31.4% of *E. coli* isolates, 25.8% in *K. pneumoniae*, 50% in *P. aeruginosa*, 25% in *A. baumannii*, and 20% in *E. cloacae* isolates. [11]

Mohammad Reza Sharif et al, one hundred and two (40.8%) of all strains were ESBL producers, of which 54 (52.9%) were *E. coli* and 48 (47.1%) were *K. pneumoniae* ($p = 0.86$). Furthermore, 40.3% of *E. coli* and 41.4% of *K. pneumoniae* isolates were ESBL producers ($p = 0.86$). The most antimicrobial resistance was to ampicillin, and no imipenem resistance

was detected. Risk factors for ESBL producing *E. coli* included admission duration exceeding 7 days ($p = 0.011$) and antibiotic use in the last month ($p < 0.001$), and the associated risk factor for ESBL producing *K. pneumoniae* was antibiotic use during the recent month ($p = 0.002$).[12]

Conclusion-

The present study revealed a high prevalence of ESBL production (41.5%) among Enterobacterales isolated from patients with urinary tract infections at a tertiary care center. *Escherichia coli* was the predominant isolate, followed by *Klebsiella pneumoniae*. Considerable antimicrobial resistance was observed, particularly against ampicillin and third-generation cephalosporins, whereas carbapenem resistance was comparatively low (6.2%). ESBL production was significantly associated with indwelling urinary catheterization and recurrent UTI. These findings emphasize the importance of routine urine culture, antimicrobial susceptibility testing, regular resistance surveillance, and judicious antibiotic use to guide effective treatment and control the spread of antimicrobial resistance.

Conflict of Interest: The authors declare that there is no conflict of interest regarding the publication of this study.

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