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Antibiotic Sensitivity Pattern of *Escherichia coli* Isolated from Various Clinical Samples in a Tertiary Care Hospital in Maharashtra: A Retrospective Observational Study

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ABSTRACT

Background: *Escherichia coli* remains a leading bacterial pathogen in routine diagnostic microbiology and is frequently implicated in urinary tract infection, wound infection and bloodstream infection. Rising antimicrobial resistance has reduced the reliability of many empirical regimens; therefore, institution-specific susceptibility data are required for rational antibiotic selection and stewardship.
Methods: This retrospective observational study was conducted in a tertiary care hospital in Maharashtra, India. Clinical specimens received from January 2023 to June 2023 were processed by standard bacteriological methods. *E. coli* isolates were identified using colony morphology, Gram staining and conventional biochemical reactions. Antimicrobial susceptibility testing was performed by the Kirby-Bauer disc diffusion method on Mueller-Hinton agar, and results were interpreted according to CLSI recommendations.
Results: Of 2,559 clinical samples processed, 579 (22.62%) yielded *E. coli*. Urine was the commonest source of isolation (363; 62.69%), followed by wound swab or pus (150; 25.90%), blood (36; 6.21%) and sputum (30; 5.18%). Very high resistance was observed to ampicillin (95.85%), cefazolin (94.82%), cefuroxime (92.23%), ceftriaxone (83.94%), cefepime (80.83%) and ciprofloxacin (79.79%). Imipenem showed the highest susceptibility (93.26%), followed by piperacillin-tazobactam (77.73%) and amikacin (72.02%). Among urinary isolates, nitrofurantoin retained good activity (85.12% susceptible), whereas norfloxacin susceptibility was low (20.67%).
Conclusion: The isolates demonstrated extensive resistance to commonly used beta-lactams and fluoroquinolones. Imipenem, piperacillin-tazobactam and amikacin showed comparatively better in vitro activity, and nitrofurantoin remained a useful oral option for uncomplicated lower urinary tract infection. Periodic local antibiogram review and judicious antimicrobial use are essential to preserve treatment options.

Key Words: *Escherichia coli*; antimicrobial resistance; antibiogram; urinary tract infection; beta-lactam resistance.

INTRODUCTION

Escherichia coli is a Gram-negative bacillus of the order Enterobacterales. Although it forms part of the normal intestinal microbiota, it is also among the most frequently encountered opportunistic pathogens in clinical practice. It is associated with a broad clinical spectrum, including uncomplicated and complicated urinary tract infection, wound and soft-tissue infection, intra-abdominal sepsis, neonatal sepsis and bloodstream infection. Accurate microbiological identification and prompt susceptibility reporting are therefore important for guiding patient care. [1,2]

In many clinical settings, antimicrobial therapy is initiated empirically before culture reports are available, particularly in emergency and inpatient care. If empirical therapy does not cover the causative organism, clinical improvement may be delayed and the risk of complications, prolonged hospitalization and higher treatment cost may increase. Local antibiograms are therefore valuable because they reflect institutional pathogen distribution and provide a practical basis for empirical therapy and subsequent de-escalation. [3,4]

Treatment of *E. coli* infection has become increasingly difficult because resistance to commonly prescribed antimicrobials has expanded. Extended-spectrum beta-lactamase production can compromise penicillins, third-generation cephalosporins and aztreonam, and ESBL-producing isolates often show co-resistance to fluoroquinolones, cotrimoxazole and aminoglycosides. This resistance pattern restricts oral and parenteral options and increases reliance on beta-lactam/beta-lactamase inhibitor combinations and carbapenems. [5]

The emergence of carbapenem-resistant Enterobacterales, including carbapenemase-producing E. coli, is an additional concern. Carbapenems are commonly reserved for severe multidrug-resistant Gram-negative infections; loss of activity in this group can leave very limited therapeutic alternatives and is associated with major infection-control and stewardship implications. [6]

Resistance rates vary substantially across regions, hospitals, specimen types, patient populations and prescribing practices. Tertiary care hospitals receive both community-acquired and healthcare-associated infections, and factors such as referral bias, previous antibiotic exposure, invasive procedures and intensive care admission may influence susceptibility profiles. National and global surveillance programmes have consistently emphasized the need for repeated local resistance monitoring and rational antimicrobial use. [9-13]

In this background, the present study was undertaken to determine the distribution of *E. coli* isolated from different clinical specimens in a tertiary care hospital and to describe its antimicrobial susceptibility profile. The results are intended to support evidence-based empirical prescribing and strengthen local antimicrobial stewardship practices.

MATERIALS AND METHODS

Study design and setting: This was a retrospective observational study conducted in the Department of Microbiology, Government Medical College, Miraj, Maharashtra, India.

Study period: Clinical samples received during the six-month period from January 2023 to June 2023 were included.

Samples and isolate selection: A total of 2,559 clinical specimens were processed during the study period. All non-duplicate *E. coli* isolates recovered from urine, wound swab or pus, blood and sputum samples were included in the analysis.

Isolation and identification: Samples were inoculated on appropriate bacteriological media and processed according to standard microbiological procedures. E. coli was identified using colony characteristics, Gram-stain morphology and conventional biochemical reactions. [1]

Antimicrobial susceptibility testing: Antimicrobial susceptibility testing was

performed by the Kirby-Bauer disc diffusion method on Mueller-Hinton agar using a 0.5 McFarland standard inoculum. Zone diameters were interpreted according to CLSI M100 performance standards. [7,8]

Antibiotic discs used: The panel included ampicillin (10 µg), cefazolin (30 µg), cefuroxime (30 µg), ceftriaxone or cefotaxime (30 µg), cefepime (30 µg), piperacillin-tazobactam (100/10 µg), cotrimoxazole (1.25/23.75 µg), ciprofloxacin (5 µg), gentamicin (10 µg), amikacin (30 µg) and imipenem (10 µg). Urinary isolates were additionally tested against norfloxacin (10 µg) and nitrofurantoin (300 µg). [8]

Ethical considerations: Patient identifiers were not included in the dataset. Institutional Ethics Committee approval had been obtained before analysis.

Statistical Methods

Data were analyzed using descriptive statistics and are presented as frequencies and percentages.

RESULTS

During the study period, 579 *E. coli* isolates were recovered from 2,559 processed clinical specimens, giving an overall isolation rate of 22.62%. Female patients contributed 64.25% of isolates, while 35.75% were from male patients.

Urine was the leading specimen source, accounting for 363 isolates (62.69%). Wound swab or pus samples contributed 150 isolates (25.90%), blood samples 36 isolates (6.21%) and sputum samples 30 isolates (5.18%). The distribution of isolates by specimen type is shown in Table 1.

Table 1: Distribution of *Escherichia coli* isolates from various clinical samples (n=579).

Sample	Number	Percentage (%)
Urine	363	62.69
Wound swab/pus	150	25.90
Blood	36	6.21
Sputum	30	5.18
Total	579	100.00

The antimicrobial susceptibility pattern is summarized in Table 2. Resistance was highest to ampicillin (555; 95.85%) and cefazolin (549; 94.82%). High resistance was also observed to cefuroxime (534; 92.23%), ceftriaxone (486; 83.94%), cefepime (468; 80.83%) and ciprofloxacin (462; 79.79%).

Among the tested agents, imipenem demonstrated the best activity, with 540 isolates (93.26%) susceptible. Piperacillin-tazobactam showed 77.73% susceptibility and amikacin showed 72.02% susceptibility. Among urinary isolates, nitrofurantoin was active against 309 of 363 isolates (85.12%), whereas norfloxacin showed susceptibility in only 75 urinary isolates (20.67%).

Table 2: Antimicrobial susceptibility pattern of *Escherichia coli* isolated from clinical specimens (n=579).

Antibiotic	Resistant (n)	Resistant (%)	Sensitive (n)	Sensitive (%)
Ampicillin	555	95.85	24	4.14
Cefazolin	549	94.82	30	5.18
Cefuroxime	534	92.23	45	7.77
Ceftriaxone	486	83.94	93	16.06
Cefepime	468	80.83	111	19.17
Cotrimoxazole	375	64.77	204	35.23
Ciprofloxacin	462	79.79	117	20.21
Gentamicin	243	41.97	336	58.03
Amikacin	162	27.98	417	72.02
Imipenem	39	6.74	540	93.26
Piperacillin-tazobactam	129	22.27	450	77.73
Norfloxacin*	288	79.33	75	20.67
Nitrofurantoin*	54	14.88	309	85.12

***Norfloxacin and nitrofurantoin were tested only for urinary isolates (n=363).**

DISCUSSION

The present study found *E. coli* in 579 of 2,559 processed clinical specimens, corresponding to an isolation rate of 22.62%. This confirms that *E. coli* continues to contribute substantially to the routine bacterial workload in tertiary care microbiology laboratories. The female predominance in the present series is clinically plausible because urinary tract infections, a major source of *E. coli* isolation, occur more frequently in women because of anatomical and physiological factors. [3,4]

Urine constituted nearly two-thirds of all isolates, while wound swab or pus samples formed the second largest category. Blood and sputum contributed smaller proportions, but their clinical relevance is considerable because *E. coli* bacteraemia and lower respiratory infection may be associated with severe disease, especially among hospitalized or immunocompromised patients. National surveillance reports from India have also identified *E. coli* as a major priority pathogen and urine as a common specimen source, supporting the pattern observed in the present study. [9,10]

A key finding was the very high resistance to ampicillin and cephalosporins. Resistance exceeded 90% for ampicillin, cefazolin and cefuroxime and remained high for ceftriaxone and cefepime. This profile strongly suggests a heavy burden of beta-lactam resistance and possible ESBL-mediated mechanisms, although phenotypic ESBL confirmation was not performed in this study. From a clinical perspective, these data indicate that routine empirical use of these beta-lactams is unlikely to provide dependable coverage in comparable hospital settings. [5,9,10]

Fluoroquinolone activity was also poor. Only 20.21% of all isolates were susceptible to ciprofloxacin, and urinary isolates showed 20.67% susceptibility to norfloxacin. This finding argues against routine empirical fluoroquinolone use for suspected *E. coli* infection in this setting. Similar concerns have been reported in Indian uropathogen studies and in international guidance, where fluoroquinolone use is discouraged when local resistance is high. [3,4,12]

Cotrimoxazole susceptibility was 35.23%, indicating limited reliability for empirical therapy. Treatment guidelines for uncomplicated urinary tract infection recommend cotrimoxazole only when local resistance is acceptably low. The present susceptibility pattern therefore does not support cotrimoxazole as a dependable empirical option unless culture reports confirm sensitivity. [3]

In contrast, amikacin and piperacillin-tazobactam retained comparatively better activity, with susceptibility rates of 72.02% and 77.73%, respectively. Gentamicin showed moderate activity. These agents may be considered in selected complicated urinary, wound or invasive infections, but clinical use should be individualized according to infection severity, renal function, source of infection, local policy and stewardship recommendations.

Imipenem was the most active drug tested, with 93.26% susceptibility. This is reassuring for severe multidrug-resistant Gram-negative infections; however, carbapenem preservation remains critical because carbapenemase-producing Enterobacterales have emerged worldwide. Carbapenems should therefore be reserved for appropriate indications, and therapy should be de-escalated whenever culture results permit. [6,9,10]

Among urinary isolates, nitrofurantoin retained good in vitro activity, with 85.12% susceptibility. This supports its continued role as an oral treatment option for uncomplicated lower urinary tract infection when renal function is adequate and tissue-invasive infection is not suspected. In contrast, norfloxacin showed poor activity and should not be preferred empirically in this setting. [3,4]

The findings reinforce the need for regularly updated hospital antibiograms. Empirical prescribing based on outdated assumptions may increase treatment failure and encourage broader-spectrum antibiotic use. Early culture sampling, syndrome-specific

empirical guidance, audit of antibiotic use and timely de-escalation remain essential elements of antimicrobial stewardship. [11-13]

This study has limitations. It was retrospective and single-centre in design, limiting generalizability. Important patient-level variables, including outpatient or inpatient status, prior antibiotic exposure, comorbidities, ICU admission and clinical outcome, were not available for subgroup analysis. Phenotypic ESBL confirmation, carbapenemase testing and minimum inhibitory concentration testing were not performed. Despite these limitations, the study provides useful contemporary local data across multiple specimen types and can support empirical therapy decisions and stewardship planning.

CONCLUSION

E. coli isolates in this study showed marked resistance to ampicillin, cephalosporins and fluoroquinolones. Imipenem remained the most active agent, followed by piperacillin-tazobactam and amikacin. Nitrofurantoin retained useful activity among urinary isolates, whereas norfloxacin showed poor susceptibility. These results highlight the importance of periodic local resistance surveillance, culture-guided therapy and rational antimicrobial prescribing to reduce further selection of resistant strains.

Declaration By Authors

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Conflict of Interest: The authors declare no conflict of interest.

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