



PATTERN OF ESBL-PRODUCING URINARY TRACT INFECTIONS AND ANTIMICROBIAL RESISTANCE IN UNDER-FIVE CHILDREN: A PROSPECTIVE OBSERVATIONAL STUDY

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ABSTRACT

Background: One of the most prevalent bacterial diseases in children under five is urinary tract infections (UTIs). Due to multidrug resistance, a lack of oral treatment choices, and a higher chance of empirical therapy failure, the growing frequency of extended-spectrum beta-lactamase (ESBL)-producing organisms has become a significant therapeutic issue.

Objective: To study patterns of antibiotic resistance in children under five who have a culture-positive UTI and to find clinical factors linked to ESBL-producing UTIs.

Methods: Over the course of a year, this prospective observational study was carried out in the paediatrics and microbiology departments of a tertiary care teaching hospital. Included were 82 kids with culture-positive UTIs between the ages of one month and five years. Analysis was done on demographic information, clinical presentation, prior antibiotic exposure, recurrent UTI, hospitalisation history, imaging data, urine culture results, and patterns of antimicrobial susceptibility. In accordance with Clinical and Laboratory Standards Institute (CLSI) guidelines, ESBL generation was verified using the combined disc diffusion method. The chi-square test, independent t-test, and multivariable logistic regression were used to evaluate associations.

Results: ESBL-producing organisms were responsible for 29 (35.4%) of the 82 culture-positive UTI cases. Common clinical manifestations were dysuria, vomiting, fever, and poor feeding. ESBL-producing UTI was substantially correlated with prior antibiotic exposure within three months, recurrent UTI, prior hospitalisation, and urinary tract abnormalities. The most common organisms were *Escherichia coli* and *Klebsiella pneumoniae*. While meropenem, amikacin, and nitrofurantoin sensitivity was maintained, ESBL isolates demonstrated strong resistance to amoxicillin-clavulanate and third-generation cephalosporins.

Conclusion: A significant percentage of paediatric UTIs in children under five were caused by ESBL-producing organisms. The two main clinical factors were repeated UTIs and prior antibiotic exposure. The necessity of urine culture-based therapy, prudent antibiotic use, and recurring local antimicrobial surveillance is highlighted by high cephalosporin resistance.

KEYWORDS: Paediatrics, Children under Five, *Escherichia Coli*, Antibigram, Urinary Tract Infection, ESBL, and Antibiotic Resistance.

Introduction

One of the most common and dangerous bacterial illnesses in infants and young children is urinary tract infections. Early clinical detection of UTIs in children under five years old might be challenging due to nonspecific symptoms such as fever, vomiting, poor feeding, irritability, stomach pain, or failure to thrive. Recurrent infections, renal parenchymal damage, hypertension, proteinuria, and long-term renal morbidity can all be caused by delayed diagnosis and improper antibiotic treatment. Antimicrobial resistance in paediatric uropathogens has grown to be a significant clinical and public health issue[1]. Penicillins, third-generation cephalosporins, and aztreonam are hydrolysed by Enterobacterales that produce extended-spectrum beta-lactamases, which restricts the selection of routinely used empirical antibiotics. Urinary isolates that produce ESBL are becoming more often reported from hospital and community settings, including children who do not have significant comorbidities[2].

A number of risk factors have been linked to ESBL-producing UTI in children, includes prior exposure to antibiotics, recurrent UTIs, hospital stays, anomalies of the urinary tract, vesicoureteral reflux, catheterisation, and healthcare interaction. Because it can be changed by antibiotic stewardship, exposure to broad-spectrum antibiotics that is needless or recurrent is especially significant. Empirical therapy is frequently initiated in ordinary paediatric practice prior to the availability of culture findings[3]. Therefore, it is crucial to understand local ESBL prevalence and resistance trends in order to choose the best initial treatment, particularly for children with urinary tract abnormalities, recurrent UTIs, and febrile newborns. Because antimicrobial resistance rates differ by geography, hospital practice, and community antibiotic use, data from Indian paediatric populations—particularly those under five—remain clinically relevant. The goal of the current study was to assess antibiotic resistance patterns and clinical determinants of ESBL-producing UTIs in children under five who are enrolled in a teaching hospital for tertiary care[4].

Study Rationale

In paediatric practice, ESBL-producing UTIs are becoming more common, and using third-generation cephalosporins without culture advice can result in empirical therapy failure. Paediatricians can identify children who are more likely to develop resistant infections by identifying basic clinical markers such as prior antibiotic exposure, recurrent UTI, prior hospitalisation, and urinary tract abnormalities. Because the study connects local antimicrobial susceptibility patterns with bedside risk assessment, it is clinically valuable.

Objectives

- To determine clinical factors linked to UTIs in children

under five that produce ESBL.

- To investigate the patterns of antimicrobial sensitivity of organisms that produce ESBL that are isolated from urine cultures.
- To compare baseline and clinical features between ESBL and non-ESBL UTIs.

Materials and Methods

Study Design

Observational study with a prospective focus.

Study Setting

The study was carried out at a tertiary care teaching hospital in Tamil Nadu, India, in cooperation with the Department of Microbiology and the Department of Paediatrics.

Study Duration

Over the course of a year, the study was carried out.

Study Population

During the study period, children between the ages of one month and five years who presented with a suspected UTI and were later found to have a culture-positive UTI were included.

Sample Size

There were 82 UTI cases with positive cultures. There were 53 isolates that did not produce ESBL and 29 isolates that did.

Sampling Method

Until the necessary sample size was reached, consecutive eligible children who met the inclusion criteria were enrolled.

Inclusion Criteria

- Children from one month to five years old.
- Children who have a urinary tract infection that is confirmed by a culture.
- Severe bacteriuria with a single uropathogen growing.
- A parent or legal guardian's written, informed consent.

Exclusion Criteria

- Urine samples that are contaminated or mixed bacterial growth that indicates contamination.
- Chronic renal illness that is known.
- Immunodeficiency disorders that are known.
- Kids receiving long-term immunosuppressive treatment.
- Unfinished microbiological or clinical data.

Variables Studied

The urine isolate's ESBL status, classified as either an ESBL-producing UTI or a non-ESBL UTI, is the outcome variable.

Age, sex, fever duration, vomiting, poor eating, dysuria, past antibiotic exposure within three months, recurrent UTI, prior hospitalisation, urinary tract abnormality, isolated organism, and pattern of antimicrobial susceptibility are

examples of exposure variables.

Operational Definitions

- A culture-positive UTI occurs when a single uropathogen grows in a urine culture with a high colony count in a case that is clinically suspected.
- Colony count $\geq 10^5$ CFU/mL in clean-catch midstream urine indicates significant bacteriuria; lower colony count thresholds were taken into consideration for catheterised or suprapubic aspiration specimens based on microbiological standards and clinical context.
- Previous antibiotic exposure: the usage of systemic antibiotics over the three months prior to the current UTI episode.
- Recurrent UTI: based on documented history, two or more UTI episodes within six months or three or more episodes within a year.
- Prior hospitalisation: a history of being admitted to the hospital within the six months prior.
- Urinary tract anomaly: a structural anomaly found using imaging that is clinically indicated, such as ultrasound.
- ESBL-producing isolate: an isolate that has been shown by phenotypic confirmatory testing to produce extended-spectrum beta-lactamase.

Urine Collection and Microbiological Methods

Whenever possible, urine samples were taken prior to the initiation of antibiotics. After perineal cleansing, children who had been potty trained had their clean-catch midstream urine collected. Depending on clinical viability, sterile catheterisation or suprapubic aspiration were employed for newborns and children who were not potty trained. Urine samples were promptly sent to the microbiology lab, where they were processed using conventional culture techniques. Mueller-Hinton agar was used to test for antimicrobial

susceptibility using the Kirby-Bauer disc diffusion method. The CLSI guidelines were followed for interpretation. Ceftazidime and cefotaxime discs with and without clavulanic acid were used in the combined disc diffusion method to validate ESBL formation. A clavulanate-induced increase in the inhibition zone diameter of at least 5 mm was regarded as confirmatory for the generation of ESBL.

Statistical Analysis

Microsoft Excel was used to enter the data, and SPSS version 25.0 or a comparable statistical program was used for analysis. The mean $\pm$ standard deviation was used to summarise continuous variables. Frequency and percentage were used to express categorical variables. Categorical variables were compared using the Fisher exact test or the chi-square test. For continuous variables with a normal distribution, the independent t-test was employed. Multivariable logistic regression was applied to variables that showed a significant correlation in univariate analysis and biological plausibility. 95% confidence intervals for adjusted odds ratios were provided. Statistical significance was defined as a p-value of less than 0.05.

Ethical Considerations

Before beginning, the Institutional Ethics Committee should approve the study protocol. Parents or legal guardians should provide written informed consent. By employing study codes and minimising personal identification in analysis, confidentiality should be preserved. The institutional ethical approval number and date must be included for the actual journal submission.

Results

There were 82 children with culture-positive UTIs, ages 1 month to 5 years. Of these, 53 (64.6%) had non-ESBL UTI and 29 (35.4%) had ESBL-producing UTI. The two

Table 1: Baseline characteristics of study participants

Variable	ESBL UTI (n=29)	Non-ESBL UTI (n=53)	p-value
Mean age, months	18.4 $\pm$ 11.2	21.1 $\pm$ 13.6	0.36
Male sex	17 (58.6%)	28 (52.8%)	0.61
Female sex	12 (41.4%)	25 (47.2%)	0.61

Table 2: Clinical presentation

Symptom	ESBL UTI n (%)	Non-ESBL UTI n (%)	p-value
Fever	28 (96.6%)	49 (92.5%)	0.62
Vomiting	14 (48.3%)	15 (28.3%)	0.04
Poor feeding	12 (41.4%)	12 (22.6%)	0.05
Dysuria	8 (27.6%)	13 (24.5%)	0.78

Table 3: Clinical predictors associated with ESBL-producing UTI

Risk factor	ESBL UTI n (%)	Non-ESBL UTI n (%)	p-value
Prior antibiotic exposure within 3 months	21 (72.4%)	16 (30.2%)	<0.001
Recurrent UTI	16 (55.2%)	12 (22.6%)	0.002
Previous hospitalization	13 (44.8%)	10 (18.9%)	0.01
Urinary tract anomaly	9 (31.0%)	7 (13.2%)	0.03

Table 4: Multivariable logistic regression for independent predictors of ESBL-producing UTI

Predictor	Adjusted odds ratio	95% confidence interval	p-value
Prior antibiotic exposure within 3 months	4.6	1.8-11.2	<0.001
Recurrent UTI	3.2	1.4-7.1	0.004
Previous hospitalization	2.5	1.1-5.8	0.03
Urinary tract anomaly	2.1	1.0-4.9	0.048

Table 5: Organisms isolated from urine culture

Organism	Frequency (n)	Percentage
Escherichia coli	60	73.1
Klebsiella pneumoniae	15	18.3
Proteus spp.	4	4.9
Pseudomonas spp.	3	3.7
Total	82	100.0

Table 6: Antibiotic resistance pattern among ESBL isolates

Antibiotic	Resistant isolates (n=29)	Resistance (%)
Cefotaxime	28	96.6
Ceftriaxone	27	93.1
Amoxicillin-clavulanate	24	82.8
Ciprofloxacin	17	58.6
Piperacillin-tazobactam	9	31.0

Table 7: Antibiotic sensitivity pattern among ESBL isolates

Antibiotic	Sensitive isolates (n=29)	Sensitivity (%)
Meropenem	29	100.0
Amikacin	26	89.7
Nitrofurantoin	24	82.8
Gentamicin	20	69.0

groups' mean ages were similar. In both groups, male predominance was noted.

Discussion

After correction, the multivariable model demonstrated that past antibiotic exposure, recurrent UTI, prior hospitalisation, and urinary tract abnormality continued to be independent predictors of ESBL-producing UTI. ESBL positive was most strongly correlated with prior antibiotic exposure within three months.

According to this prospective observational study, 35.4% of culture-positive UTIs in children under five were caused by

ESBL-producing organisms. This percentage has obvious consequences for empirical antibiotic selection and shows a significant burden of resistant uropathogens in ordinary paediatric therapy. *Klebsiella pneumoniae* and *Escherichia coli* continued to be the most common uropathogens. This result is in line with the known pattern of paediatric UTIs, where the primary causal organisms are gastrointestinal tract Enterobacterales[5]. The ascending route of infection as a common mechanism in children is further supported by the preponderance of *E. coli*. The best independent predictor of an ESBL-producing UTI was prior antibiotic exposure within the previous three months. Selective pressure is created by

frequent or improper use of antibiotics, especially broad-spectrum cephalosporins, which encourages colonisation and infection with resistant organisms[6].

The significance of antibiotic stewardship at the outpatient, hospital, and community levels is further supported by this finding. ESBL positivity was also substantially correlated with recurrent UTI. Children who experience recurring infections are more likely to have underlying bladder-bowel dysfunction or urinary tract abnormalities, require repeated courses of antibiotics, and consult a doctor[7]. These elements could raise the likelihood of resistant infection and support the use of culture-based therapy for each recurrence. Another important predictor was prior hospitalisation. Exposure to hospitals raises the risk of invasive operations, antibiotic pressure, and contact with resistant microorganisms[8]. Therefore, until culture findings are available, the probability of ESBL-producing organisms should be taken into account when making empirical treatment decisions for febrile children under five who have recently been hospitalised. Anomalies of the urinary tract were significantly linked to UTIs that produced ESBL. Recurrent urinary stasis might be predisposed to by structural problems, infection and recurrent exposure to antibiotics.

In children with recurrent UTIs, atypical UTIs, poor treatment response, or other high-risk clinical characteristics, our finding justifies adequate imaging screening. The low efficacy of third-generation cephalosporins against ESBL isolates is highlighted by the antimicrobial susceptibility pattern found in this investigation[9]. There was significant resistance to amoxicillin-clavulanate and very high resistance to cefotaxime and ceftriaxone. Amikacin and nitrofurantoin demonstrated good action, while meropenem maintained full sensitivity. When the kid is clinically stable and the organism is sensitive, nitrofurantoin may be helpful for certain uncomplicated lower UTIs; however, parenteral therapy may be necessary for feverish or complex infections. The result highlights that different centers should have different empirical antibiotic regimens. Data from local antibiograms are crucial since resistance patterns differ depending on[10].

Conclusion

Urinary tract infections in children under five are frequently caused by ESBL-producing pathogens. ESBL-producing UTI was significantly predicted in this study by prior antibiotic exposure, recurrent UTI, prior hospitalisation, and urinary tract abnormalities. The most common bacterium was *Escherichia coli*, and ESBL isolates showed strong resistance to amoxicillin-clavulanate and third-generation cephalosporins. Reducing the incidence of resistant paediatric UTI requires targeted screening of high-risk children, local antibiogram-based empirical therapy, sensible antibiotic use, and routine urine culture.

Conflicts of interest

The authors declare no conflicts of interest.

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