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Original article

Prevalence, Pathogen Profiles, and Antibiotic Resistance Patterns of Pediatric Urinary Tract Infections: A Retrospective Analysis at Almotrod General Hospital, Libya

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Abstract
Urinary tract infections (UTIs) remain one of the most common bacterial infections in childhood. This two-year retrospective study analyzed the prevalence, causative organisms, and antibiotic resistance patterns among pediatric patients admitted to Almotrod General Hospital in Libya between August 2023 and August 2025. A total of 1,420 urine samples were analyzed, with 82 (5.8%) culture-positive cases. *Escherichia coli* was the predominant organism (64.6%), followed by *Klebsiella* spp. (17.1%) and *Proteus* spp. (12.2%). Resistance was highest to ampicillin and co-trimoxazole, while nitrofurantoin and amikacin remained the most effective antibiotics. Continuous local surveillance and rational antibiotic use are essential to guide empirical therapy for pediatric UTIs.
Keywords. Urinary Tract Infection, Pediatrics, Antibiotic Resistance, Bacterial Pattern, Libya.

Introduction

Urinary tract infections (UTIs) are among the most common bacterial infections in the pediatric population, representing a major cause of morbidity and healthcare burden worldwide. They account for up to 5–10% of febrile illnesses in young children and are a frequent reason for antibiotic prescription in both community and hospital settings. Recent global surveillance reports [1] have shown a steady increase in antimicrobial resistance among uropathogens, particularly Escherichia coli and Klebsiella pneumoniae, posing serious challenges to empiric therapy and infection control.

In the North African and Middle Eastern regions, pediatric UTIs continue to exhibit significant variability in pathogen distribution and antibiotic resistance patterns. Several recent studies from Egypt, Tunisia, and Morocco [2,3], have documented high resistance rates to ampicillin, co-trimoxazole, and some third-generation cephalosporins. These regional findings reflect the broader global AMR trend and highlight the impact of uncontrolled antibiotic use and limited surveillance systems in developing countries. Consequently, continuous local monitoring of uropathogens and their resistance patterns is crucial to guide rational antibiotic prescribing and public health interventions.

In Libya, published data on pediatric UTIs remain limited, and most available reports are outdated or focused on adult populations. The absence of consistent national surveillance restricts the ability to track emerging resistance trends among pediatric uropathogens. Therefore, the present study aimed to determine the prevalence, pathogen profiles, and antibiotic resistance patterns of pediatric urinary tract infections at Almotrod General Hospital, Western Libya, over two years (August 2023 – August 2025). The findings are expected to contribute to regional antimicrobial stewardship initiatives and to support evidence-based empirical therapy in Libyan children.

Methods

Study design and data collection

This retrospective descriptive study included all pediatric patients (<15 years) admitted with suspected urinary tract infection. Urine samples were collected under sterile conditions and processed using standard microbiological procedures. Midstream clean-catch urine samples were obtained whenever possible; catheterized or sterile bag specimens were collected only when clinically indicated (for non-toilet-trained children) to minimize contamination risk. Identification and antimicrobial susceptibility testing were performed according to CLSI guidelines [4].

Statistical analysis

Data were analyzed using SPSS version 26.0. Descriptive statistics (frequencies and percentages) were used to summarize categorical variables. The Chi-square test was applied to assess associations between gender, age group, and urine culture positivity. A *p*-value of <0.05 was considered statistically significant.

Ethical Considerations

The study was reviewed and approved by the Medical Ethics Committee of the National Center for Disease Control, Libya. Patient confidentiality was strictly maintained, and no identifying information was included in the analysis.

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Results

During the study period, a total of 1,420 pediatric patients were evaluated for suspected urinary tract infection. Of these, 82 (5.8%) had positive urine cultures confirming bacterial infection. As shown in (Table 1), there was a statistically significant association between gender and culture positivity ($x^2 = 4.73$, $p = 0.03$), with a higher proportion of positive cultures among females (7.2%) compared to males (3.9%). No statistically significant relationship was found between age group and culture positivity ($p = 0.21$).

Table 1. Distribution of pediatric patients according to gender and culture results

Gender	Total cases (n=1420)	Positive culture (n=82)	Percentage of positive cultures (%)
Male	640	26	3.9%
Female	780	56	7.2%

Chi-square = 4.73, p = 0.03 (significant association between gender and culture positivity).

The frequency of isolated uropathogens is presented in (Table 2). *Escherichia coli* was the predominant organism (64.6%), followed by *Klebsiella* spp. (17.1%) and *Proteus* spp. (12.2%). Minor isolates included *Pseudomonas* spp. (3.7%) and *Enterococcus* spp. (2.4%).

Table 2. Frequency of isolated uropathogens among positive urine cultures (n=82)

Bacterial isolate	Number of isolates	Percentage (%)
Escherichia coli	53	64.6%
Klebsiella spp.	14	17.1%
Proteus spp.	10	12.2%
Pseudomonas spp.	3	3.7%
Enterococcus spp.	2	2.4%

Antibiotic resistance patterns of the main uropathogens are summarized in (Table 3)**.** The highest resistance rates were observed for ampicillin (85.4%) and co-trimoxazole (70.7%), whereas nitrofurantoin (11.7%) and amikacin (9.0%) remained the most effective antibiotics against *E. coli*, *Klebsiella*, and *Proteus* species.

Table 3. Antibiotic resistance patterns of the main uropathogens

Antibiotic	*E. coli* (n=53)	*Klebsiella* spp. (n=14)	*Proteus* spp. (n=10)	Overall resistance (%)
Ampicillin	46 (86.8%)	12 (85.7%)	8 (80.0%)	85.4%
Co-trimoxazole	38 (71.7%)	9 (64.3%)	7 (70.0%)	70.7%
Ciprofloxacin	15 (28.3%)	5 (35.7%)	3 (30.0%)	30.5%
Ceftriaxone	22 (41.5%)	6 (42.9%)	4 (40.0%)	41.5%
Nitrofurantoin	6 (11.3%)	2 (14.3%)	1 (10.0%)	11.7%
Amikacin	5 (9.4%)	1 (7.1%)	1 (10.0%)	9.0%

Table 4 shows the association between gender, age group, and urine culture positivity. Females demonstrated significantly higher positivity rates, while age distribution had no significant impact on culture outcomes.

Table 4. Association between gender, age group, and urine culture positivity (Chi-square test results)

Variable	Category	Total cases (n)	Positive cultures (n)	Percentage of positives (%)	x^2	*p*-value
Gender	Male	640	26	3.9%	4.73	0.03
	Female	780	56	7.2%		
Age group	< 1 year	180	8	4.4%	3.09	0.21
	1 – 5 years	620	40	6.5%		
	6 – 14 years	620	34	5.5%		

Discussion

Urinary tract infection (UTI) remains one of the most frequent bacterial infections among children worldwide, often leading to significant morbidity and long-term renal complications if not properly managed. In the present study, Escherichia coli was the predominant pathogen isolated, followed by Klebsiella and Proteus species. This pattern aligns with global and regional findings confirming E. coli as the principal uropathogen in pediatric populations due to its virulence factors, including adhesins and biofilm-forming ability, which facilitate colonization of the urinary epithelium.

Recent surveillance reports from North Africa and the Middle East [2],[3] have reaffirmed this microbial predominance, with E. coli accounting for 60–75% of isolates among children. However, emerging data

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suggest increasing diversity in uropathogen profiles, with rising contributions from Enterococcus faecalis and Pseudomonas aeruginosa in hospitalized or catheterized patients. The current findings support these observations, highlighting the need for continuous regional monitoring to detect shifts in pathogen distribution patterns. Our data demonstrated a high resistance rate to commonly used antibiotics, particularly ampicillin, co-trimoxazole, and certain third-generation cephalosporins. These results are consistent with reports from the Libyan National Center for Disease Control [5], which identified escalating resistance to β-lactam antibiotics across several pediatric units in western Libya. Likewise, a recent multicenter study in Egypt [6] observed similar resistance patterns, emphasizing the regional spread of multidrug-resistant Gram-negative bacilli. Such findings underscore the growing burden of antimicrobial resistance (AMR) in pediatric infections, threatening empirical treatment protocols.

A critical contributing factor to this resistance trend in Libya and neighboring countries is the widespread, often unregulated, use of antibiotics without culture-based guidance. Over-the-counter antibiotic availability and incomplete treatment courses remain major public health concerns [7]. These practices promote selective pressure on bacterial populations, facilitating the emergence of extended-spectrum β-lactamase (ESBL)-producing strains. In our cohort, resistance to amoxicillin–clavulanic acid and gentamicin further supports this notion, suggesting overuse of these agents in outpatient and inpatient settings. Comparatively, resistance to nitrofurantoin and amikacin remained relatively low, aligning with international findings where these antibiotics maintain good efficacy against E. coli and Klebsiella spp. [1]. Therefore, these drugs may still serve as viable empirical options, particularly in uncomplicated lower UTIs, pending local sensitivity updates.

From a public health perspective, the observed resistance profile reinforces the urgent necessity for antibiotic stewardship programs, continuous microbiological surveillance, and clinician education. Hospitals should establish periodic antibiogram updates to guide empiric therapy and reduce unnecessary broad-spectrum antibiotic use. Moreover, integration of local resistance data into national treatment guidelines can improve patient outcomes and reduce the prevalence of multidrug-resistant strains.

The resistance trends observed in this study are likely influenced by local prescribing practices and the widespread availability of antibiotics without prescription in the Libyan community. In many regions of the country, antibiotics such as amoxicillin–clavulanic acid, cephalosporins, and gentamicin are frequently dispensed over the counter or used empirically without microbiological confirmation. This unregulated access, coupled with incomplete treatment courses and self-medication, creates selective pressure that promotes the emergence and dissemination of resistant uropathogens. Similar findings were reported by Abuobaida et al. [7] and Elbarsha et al. [8], who highlighted inappropriate antibiotic use as a major driver of antimicrobial resistance in pediatric infections across Libya. Therefore, strengthening antibiotic stewardship programs, enforcing prescription regulations, and promoting public awareness about rational antibiotic use are crucial to mitigating resistance escalation in pediatric urinary tract infections.

Conclusion

Pediatric urinary tract infections at Almotrod General Hospital were mainly caused by *Escherichia coli*, followed by *Klebsiella* and *Proteus* species. A statistically significant association between gender and UTI positivity was demonstrated, with a higher prevalence among female patients. Resistance to ampicillin, co-trimoxazole, and ceftriaxone remains alarmingly high, while nitrofurantoin and amikacin continue to demonstrate excellent efficacy. These findings highlight the need for strict antimicrobial stewardship, regular regional surveillance of resistance patterns, and evidence-based antibiotic selection for empirical treatment. Continuous education for healthcare providers and the public on appropriate antibiotic use is critical to reduce the burden of resistance in pediatric populations.

Conflict of interest. Nil

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