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ORIGINAL RESEARCH

Bacterial Isolates and Their Antimicrobial Susceptibility Patterns Among Pediatric Patients with Urinary Tract Infections: A Retrospective Cross-Sectional Study at Tertiary Level in Afghanistan

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Introduction: The widespread use of antibiotics is a serious and alarming situation in terms of the development of antimicrobial resistance. The current study was conducted to demonstrate the types of organism isolated from the urine of patients presenting with UTI symptoms as well as their antimicrobial sensitivity spectrum.

Methodology: A descriptive cross-sectional study was conducted, and 272 positive urine cultures from children under 5 years of age with signs and symptoms of a UTI were included in the study. The types of organisms isolated from the urine cultures and their susceptibility to antibiotics were identified. The data collection form was designed as an Excel spreadsheet that included both dependent and independent variables, such as patient age, gender, WBC, red blood cell (RBC) count, nitrite, organism isolated, and antiprogram results.

Results: Of the patients included, 64% were female. The majority were under one year of age, followed by children aged one to three. Among these children, 63% had pyuria and hematuria, and 64% had nitrite-positive urine samples. The most commonly isolated organisms included *Escherichia coli, Klebsiella species, Candida species, Candida albicans*, and *Enterococcus species*. In this study, 62% of gram-negative organisms were ESBL positive, among which the *Proteus species* demonstrated the highest ESBL positivity, followed by the *Klebsiella species* and *E. coli*. The majority of *Enterobacteriaceae* isolates in this study showed resistance to Augmentin and Ampicillin. Similarly, *E. coli* was highly resistant to third-generation cephalosporins, ceftazidime, and ceftriaxone.

Conclusion: Due to the high prevalence of UTIs in pediatric patients and their nonspecific signs and symptoms, particularly in infants or young children, diagnosing and treating them, whilst difficult, is crucial. Urine samples should be analyzed for all pediatric patients with fever and, if pyuria is present, a urine culture is necessary.

Keywords: bacterial isolates, antimicrobial susceptibility, pediatric patients, UTI

Introduction

One of the most common causes of antibiotic use in pediatric patients is a urinary tract infection (UTI), which is a significant public health problem and burden. A UTI is defined as significant bacterial growth of a single pathogen, at least 10,000 colony-forming units (CFU)/mL in clean-catch midstream urine, the presence of leukocytes (WBC) more than 5/high power field (hpf) in spot urine samples, and UTI symptoms.[1]

In a study conducted at the University of Pittsburgh including 945 febrile infants, 5.3% had >10,000 colony-forming units of a single pathogen per milliliter in a urine specimens obtained by catheterization. Female and white infants had significantly

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more UTIs than male and black infants. Overall, 17% of white female infants with temperatures of ~39 ~ C had a UTI, significantly higher ($p < 0.05$) than any other group of infants by sex, race, and temperature.[2]

The most common symptom of a UTI in infants is fever. Although it can also be seen in other conditions, the presence of fever in infants means that a UTI cannot be excluded.[3] A UTI should be considered in any patient younger than two years of age presenting with an unexplained fever.[4] Other symptoms, such as abdominal pain, urinary frequency, dysuria, urgency, hesitancy, enuresis, and hematuria, can also be seen in UTI patients. However, these symptoms are not common in young patients, who often present with nonspecific signs, including hypothermia, feeding difficulties, lethargy or irritability, jaundice, vomiting, and sometimes even no fever. According to many guidelines, use of a urine dipstick is indicated for all children with fever, that is, a core temperature of >38°C.[5–8] Similarly, the combination of leukocyte esterase and nitrite shows elevated sensitivity and specificity for diagnosis of UTI. The presence of bacteriuria and leukocytes on microscopic examination of urine in urinalysis is associated with high specificity and sensitivity for the diagnosis of UTI.[2,9]

UTIs are the second most common cause of antibiotic use in patients with otitis media.[10] The widespread use of antibiotics is a serious and alarming situation in terms of development of resistance to various antibiotics, specifically in the form of pathogens that produce extended-spectrum beta-lactamases (ESBL).[11] Multidrug-resistant organisms are increasingly emerging that present a challenge to clinicians treating patients with UTIs. Therefore, controlling the spread of multidrug resistance is important.[12] In the current study, we aimed to demonstrate the types of organisms isolated from the urine of patients presenting with UTI symptoms in order to correlate their clinical features with laboratory findings, demonstrate the antimicrobial sensitivity spectrum of the isolated microorganisms, and identify the rate of multidrug resistance among cases diagnosed at FMIC, Kabul, Afghanistan.

Methodology

This descriptive cross-sectional study was conducted in the microbiology section of the Pathology Department of FMIC, Kabul, Afghanistan. Permission was obtained from FMIC's Ethical Research Committee (ERC). Data were collected from reports of urine samples received from the FMIC microbiology section for culture and antibiogram testing and the Integrated Laboratory Management System (ILMS) over a six-month period from August 27, 2023, to the end of January 2024. The data covers the entire year of 2023, from January 1, 2023, to December 31, 2023. The samples were collected using clean-catch midstream urine. For infants, a sterile urine collection bag was provided. All cases with positive urine cultures that were less than five years of age including both male and female and had single pathogen isolations were included in the current study and Cases were excluded if they involved individuals over five years of age, had negative urine cultures, or showed growth of more than one organism. CLED and UTI chrome agar were used for isolation of pathogens. Analytical profile index (API) 10s, 20 E (specific identification systems used for the identification of microorganisms, particularly bacteria, developed by bioMérieux, The "10S" refers to the fact that the test panel contains 10 different biochemical tests that provide a profile to identify various bacterial species. The API 20E is used for identifying Enterobacteriaceae and other Gram-negative bacilli. This system includes 20 tests (in a strip format) for identifying a broad range of Gram-negative bacteria, especially enteric bacteria) catalase (it is a biochemical test used to identify organisms that produce the enzyme catalase, which breaks down hydrogen peroxide ($H_{22}O_2$) into water (H_2O) and oxygen (O_2). This test is used to differentiate between Staphylococci (catalase-positive) and Streptococci (catalase-negative)) and coagulase (coagulase is an enzyme produced by certain bacteria that can cause blood plasma to clot, and this ability is used as a key feature for bacterial identification such as Staphylococcus *aureus* (coagulase-positive) from other species of Staphylococcus (which are coagulase-negative, such as Staphylococcus *epidermidis* and Staphylococcus *saprophyticus*) tests were used for identification of pathogens and the disk diffusion method was used to assess the susceptibility of antibiotics to Muller-Henton ager-2 (MH2). The data collection form was designed as an Excel spreadsheet that included both dependent and independent variables, such as patient age, gender, WBC, red blood cell (RBC) count, nitrite, organism isolated, and antibiogram results. Data were analyzed using Statistical Package for Social Science (SPSS) software, version 25 to generate the descriptive statistics.

Results

A total of 272 positive urine cultures from children under 5 years of age from both the outpatient and inpatient departments who had pyuria and/or hematuria, with signs and symptoms of UTI, were included in the current study. Of the total, 175 (64%) were female and 97 (36%) were male. According to age distribution, the sample population was divided into three age groups: <1 year, 1–3 years and 3–5 years. The majority (133, 49%) were under one year of age, followed by children aged one to three years. Similarly, 171 children (63%) had pyuria greater than 5 WBC/hpf, 168 (62%) had hematuria, and 175 (64%) were nitrite-positive according to their urine sample, as shown in Figure 1. The most commonly isolated organisms were *E. coli* (117, 65%), *Klebsiella species* (34, 12.5%), Candida *species* (34, 12.5%), Candida *albicans* (22, 8%), and Enterococcus *species* (17, 6.2%), as shown in Figure 2.

In this study, 120 (62%) gram-negative organisms were ESBL-positive, among which *Proteus species* demonstrated the highest ESBL positivity (90%), followed by *Klebsiella species* (78%), and *E. coli* (59%), as shown in Figure 3. All *Enterobacteriaceae* families isolated in this study demonstrated 94% resistance to AMC and AMP and a specifically high resistant rate of *E. coli* to the third-generation cephalosporins, CAZ (98%) and CRO (82%), and probably to *Klebsiella* also (CAZ [80] and CRO [77%]). E. *coli* demonstrated sensitivity to nitrofurantoin (F) in 99% of cases, fosfomycin in 97%, sensitivity to TZP in 96%, and sensitivity to IMP in 96%. *Klebsiella species* was less sensitive to the above antibiotics as compared to *E. coli*, as shown in Table 1. In this study, *Enterococcus* demonstrated a higher rate of resistance, ie in more than 70% cases, to the most commonly used antibiotics, such as amikacin (AK), gentamicin (CN), rifampicin (RD), clindamycin. (DA), erythromycin (E), ciprofloxacin (CIP), CRO, and 100% sensitivity to vancomycin (VA). *Staphylococcus species* demonstrated 100% sensitivity to VA, RD, and 100% resistance to E and fusidic acid (FD) (Table 2). *Candida albicans* was more sensitive to clotrimazole (CTR) and nystatin (NY, 95%), to ketoconazole (KET, 90%), and demonstrated strong resistance to Polymyxin B (PB, 63%) and miconazole (MCZ, 41%). *Candida species* were highly sensitive to Amphotericin B (AB, 97%) and NY (88%), and more resistant to PB (59%) and Fluconazole (FCA, 50%), as shown in Table 3.

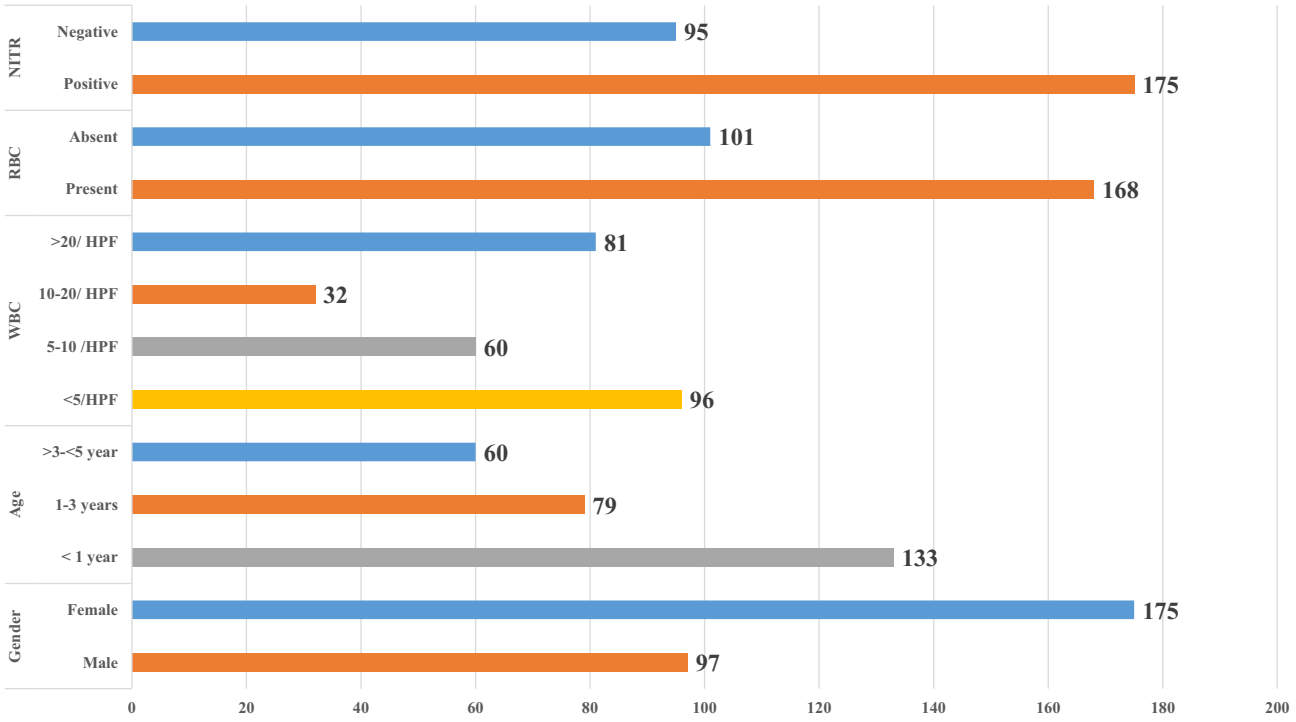

Figure 1 Patient characteristics.
Abbreviations: NITR, Nitrate; WBC, White blood cell; RBC, Red blood cell.

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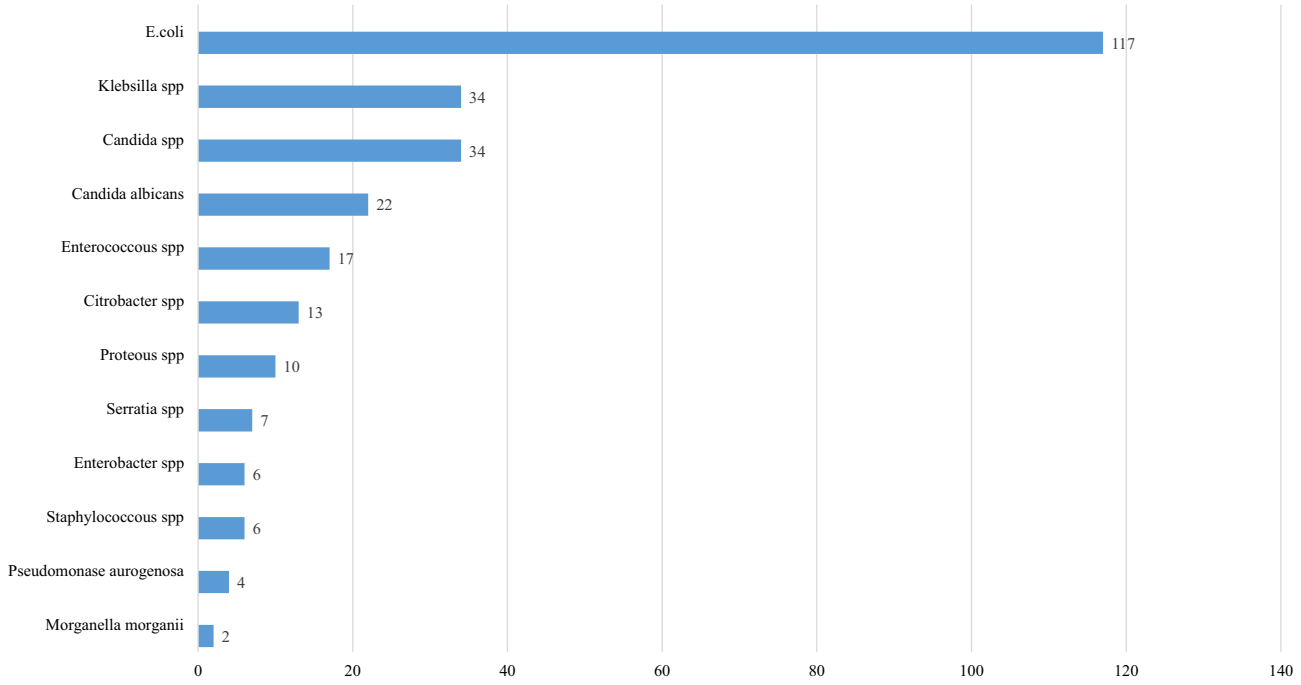

Figure 2 Types of Microorganism isolated.

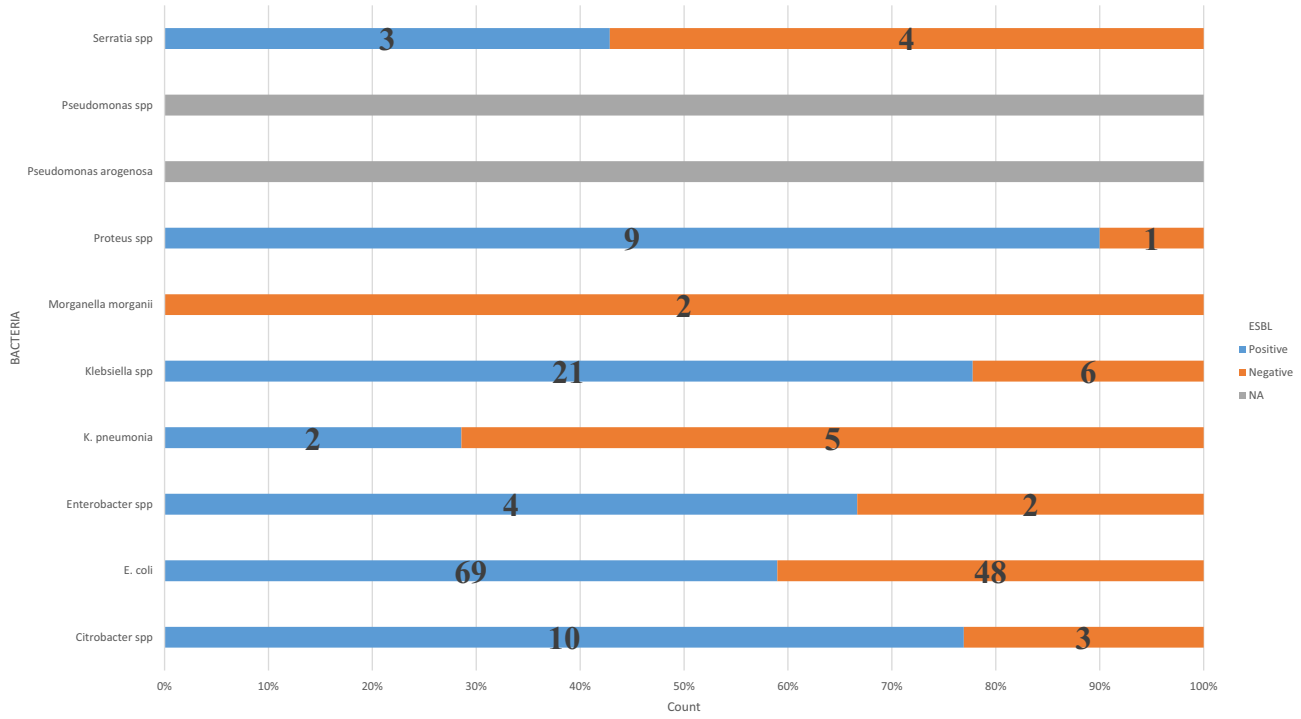

Figure 3 ESBL distribution among Bacteria.

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Table 1 Antibiotic Sensitivity Pattern of Gram-negative Bacteria Total of 163 Isolated

		E.coli (n= 117)	*Klebsiella spp* (n=34)	*Citrobacter spp* (n=13)	*Enterobacter spp* (n=6)	*Morganella spp* (n=2)	*Proteus spp* (n=10)	*Seratia spp* (n=7)	*Pseudomonas spp* (n=4)
ESBL	P	69 (59%)	23 (68%)	10 (77%)	4 (67%)	0 (0%)	9 (90%)	3 (43%)	NA
	N	48 (41%)	11 (32%)	3 (21)	2 (33)	2 (100%)	1 (10%)	4 (37%)	NA
	NA	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	4 (100%)
AMC	S	4 (3%)	2 (6%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (100%)	0 (0%)
	R	113 (97%)	32 (94%)	13 (100%)	6 (100%)	2 (100%)	10 (100%)	7 (100%)	4 (100%)
	AN	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
AMP	S	5 (4%)	2 (6%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (100%)	0 (0%)
	R	112 (96%)	32 (94%)	13 (100%)	6 (100%)	2 (100%)	10 (100%)	7 (100%)	4 (100%)
	AN	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
AK	S	108 (92%)	34 (100%)	11 (85%)	4 (67%)	2 (100%)	4 (40%)	6 (86%)	1 (25%)
	R	9 (8%)	0 (0%)	2 (15%)	2 (33%)	0 (0%)	6 (60%)	1 (14%)	2 (50%)
	AN	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (25%)
ATM	S	22 (19%)	6 (17%)	1 (8%)	0 (0%)	2 (100%)	1 (10%)	0 (100%)	2 (50%)
	R	95 (81%)	28 (83%)	12 (92%)	6 (100%)	0 (0%)	9 (90%)	7 (100%)	2 (50%)
	AN	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
CAZ	S	18 (15%)	7 (20%)	0 (0%)	6 (100%)	2 (100%)	1 (10%)	0 (100%)	0 (0%)
	R	98 (84%)	27 (80%)	13 (100%)	0 (0%)	0 (0%)	9 (90%)	7 (100%)	0 (0%)
	AN	1 (1%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	4 (100%)
TZP	S	96 (82%)	31 (91%)	10 (77%)	6 (100%)	2 (100%)	10 (100%)	4 (57%)	2 (50%)
	R	18 (15%)	2 (6%)	3 (23%)	0 (0%)	0 (0%)	0 (0%)	3 (43%)	2 (50%)
	AN	3 (3%)	1 (3%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
CN	S	81 (69%)	28 (82%)	7 (54%)	2 (34%)	1 (50%)	4 (40%)	4 (57%)	2 (50%)
	R	35 (30%)	8 (18%)	6 (46%)	2 (33%)	1 (50%)	6 (60%)	3 (43%)	2 (50%)
	AN	1 (1%)	0 (0%)	0 (0%)	2 (33%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
CRO	S	20 (17%)	8 (23%)	1 (8%)	0 (0%)	1 (50%)	2 (20%)	0 (100%)	2 (50%)
	R	96 (82%)	26 (77%)	12 (92%)	6 (100%)	1 (50%)	8 (80%)	7 (100%)	2 (50%)
	AN	1 (1%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
NIT	S	99 (85%)	20 (59%)	11 (85%)	4 (67%)	0 (0%)	2 (20%)	7 (100%)	1 (25%)
	R	15 (12%)	10 (29%)	2 (15%)	2 (33%)	2 (100%)	8 (80%)	0 (0%)	3 (75%)
	AN	3 (3%)	4 (12%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
FOS	S	97 (83%)	28 (82%)	10 (77%)	5 (83%)	0 (0%)	4 (40%)	2 (28%)	4 (100%)
	R	18 (15%)	6 (18%)	3 (23%)	1 (17%)	2 (100%)	6 (60%)	5 (72%)	0 (0%)
	AN	2 (2%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

(*Continued*)

Table 1 (Continued).

		E.coli (n= 117)	*Klebsiella spp* (n=34)	*Citrobacter spp* (n=13)	*Enterobacter spp* (n=6)	*Morganella spp* (n=2)	*Proteus spp* (n=10)	*Seratia spp* (n=7)	*Pseudomonas spp* (n=4)
CIP	S	30 (25%)	16 (50%)	2 (15%)	0 (0%)	0 (0%)	4 (40%)	2 (28%)	2 (50%)
	R	97 (83%)	16 (50%)	11 (85%)	6 (100%)	2 (100%)	6 (60%)	5 (72%)	2 (50%)
	AN	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
SXT	S	21 (18%)	4 (12%)	2 (15%)	2 (33%)	0 (0%)	0 (0%)	2 (28%)	0 (0%)
	R	82 (69%)	30 (88%)	9 (70%)	4 (67%)	2 (100%)	10 (100%)	5 (72%)	4 (100%)
	AN	14 (13%)	0 (0%)	2 (15%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
CFM	S	12 (10%)	1 (3%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (100%)	0 (0%)
	R	105 (90%)	33 (97%)	13 (100%)	6 (100%)	2 (100%)	10 (100%)	7 (100%)	4 (100%)
	AN	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
IMP	S	61 (92%)	16 (89%)	9 (90%)	6 (100%)	0 (0%)	5 (83%)	5 (100%)	1 (100%)
	R	5 (8%)	2 (11%)	1 (10%)	0 (0%)	0 (0%)	1 (17%)	0 (0%)	0 (0%)
	AN	51	14	3	0	2	4	2	3

Abbreviations: P, Positive; N, Negative; NA, Not applicable/ not tested; S, Sensitive; R, Resistance.

Table 2 Antibiotic Sensitivity Pattern of Gram Positive Bacteria

	***Enterococcus spp* Total of 17 Isolated**			***Staphylococcus spp* Total of 6 Isolated**		
	Sensitive	**Resistance**	**NA**	**Sensitive**	**Resistance**	**NA**
AN	5 (29%)	12 (71%)	0 (0%)	5 (84%)	1 (16)	0 (0%)
C	5 (29%)	12 (71%)	0 (0%)	3 (50%)	3 (50%)	0 (0%)
RD	5 (29%)	12 (71%)	0 (0%)	6 (100)%	0 (0%)	0 (0%)
DA	5 (29%)	12 (71%)	0 (0%)	2 (34%)	4 (66%)	0 (0%)
E	1 (6%)	16 (94%)	0 (0%)	0 (0%)	6 (100%)	0 (0%)
CIP	0 (0%)	17 (100%)	0 (0%)	4 (66%)	2 (34%)	0 (0%)
FD	1 (6%)	16 (94%)	0 (0%)	0 (0%)	6 (100%)	0 (0%)
P	4 (24%)	12 (76%)	1 (6%)	3 (50)%	3 (50%)	0 (0%)
SXT	1 (6%)	15 (88%)	1 (6%)	3 (50)%	3 (50%)	0 (0%)
TEC	4 (24%)	4 (24%)	9 (52%)	3 (50)%	0 (0%)	3 (50)%
VA	17 (100%)	0 (0%)	0 (0%)	6 (100)%	0 (0%)	0 (0%)
FOS	6 (35%)	1 (6%)	10 (59%)	4 (66%)	2 (34%)	0 (0%)
CRO	3 (18%)	13 (76%)	1 (6%)	0 (0%)	2 (34%)	4 (66%)

Abbreviation: NA, Not applicable / not tested.

Table 3 Antibiotic Sensitivity Pattern of Candida

	Candida albicans Total of 22 Isolated			*Candida spp* Total of 34 Isolated		
	Sensitive	**Resistance**	**NA**	**Sensitive**	**Resistance**	**NA**
AB	17 (72%)	5 (28%)	0 (0%)	33 (97%)	1 (3%)	0 (0%)
NY	21 (95%)	1 (5%)	0 (0%)	30 (88%)	4 (12%)	0 (0%)
MCZ	13 (59%)	9 (41%)	0 (0%)	20 (59%)	14 (41%)	0 (0%)
KET	20 (90%)	2 (10%)	0 (0%)	24 (70%)	10 (30%)	0 (0%)
CTR	21 (95%)	1 (5%)	0 (0%)	25 (75)%	5 (14%)%	4 (11%)
PB	8 (37%)	14 (63%)	0 (0%)	14 (41%)	20 (59%)	0 (0%)
FCA	14 (63%)	8 (37%)	0 (0%)	17 (50%)	17 (50%)	0 (0%)

Abbreviation: NA, Not applicable/ not tested.

Discussion

Rapid urine sample testing has been demonstrated to be highly effective for diagnosing UTIs in children under five years of age. A review of information from 16 electronic databases and the results of 70 studies in the UK demonstrated the utility of the urine dipstick test for revealing positivity for both leukocyte esterase and nitrite (pooled LR+ = 28.2, 95% CI: 17.3, 46.0) and microscopic positivity for both pyuria and bacteriuria, which are significantly associated with UTI.[13]

A study conducted in Tehran, in which a total of 1177 pediatric UTI patients younger than 12 years of age demonstrating positive urine cultures and significant bacteriuria, pyuria and/or hematuria, and signs and symptoms of UTI, revealed that *E. coli* was the most frequently isolated organism, followed by *Klebsiella species, Proteus species*, and *Staphylococcus species*. It also demonstrated that the lowest resistance rate of microorganisms was against CIP (6.7%) and the highest resistance rate was that against penicillin (P, 83%).[14]

According to a study conducted in Iraq, the incidence of UTI was higher in children aged between 4 months and 2 years than in older children. Similarly, women have been reported to be at a higher risk of UTIs than men. The most common bacterial isolates were *E. coli, Klebsiella pneumoniae, Staphylococcus aureus, Proteus mirabilis, Staphylococcus epidermidis*, and *Pseudomonas aeruginosa*. It also demonstrated that all gram-negative isolates were sensitive to both azithromycin (AZM) and cefotaxim (CTX) (100%), whereas gram-positive bacteria were shown to have absolute sensitivity (100%) to Novabiocin (NV).[15]

In Turkey, a study involving 6515 patients investigated changes in antimicrobial resistance and UTI demographics and revealed that the majority were female. E. *coli* was the most frequent microorganism, demonstrating a strong resistance to ampicillin (AMP), followed by AMC, while the majority of the isolated microorganisms were sensitive to meropenem (MEM) and imipenem (IMP).[16]

In the current study, we describe UTI in pediatric patients, with a focus on patient characteristics, types of isolated organism, and antibiotic resistance patterns. The high percentage of UTIs in the female and younger age groups (<1 year) in our study is similar to the results of other studies,[6,9,15,17] which also found a high percentage of UTIs among young children aged from 4 days to 2 years in the female patient group. Nonspecific signs and symptoms of UTI, such as high fever and vomiting, irritability, and lethargy, make diagnosis much more difficult. According to many guidelines, rapid extemporaneous urinalysis (using the dipstick test) is indicated for all children with a fever (CT >38°C).[5–8] The combination of leukocyte esterase and nitrite shows elevated sensitivity and specificity in terms of enabling UTI diagnosis. The presence of bacteriuria and leukocytes on microscopic examination of urine in urinalysis is associated with high specificity and sensitivity for the diagnosis of UTI.[2,9] In this study, most patients had more than five WBC/ HPF, nitrite, and leukocyte positivity in the urine, while other studies found identical results.[3,18–20] The *Enterobacteriaceae* family, specifically *E. coli*, is the most common cause of UTI; indeed, some studies suggest the presence of up to 90% bacterial isolates in urine cultures.[1,2,18,21,22] The most frequent pathogen isolated in our study was

E. coli (117), followed by *Klebsiella spp*. (34). We found 34 (12.5%) isolated *Candida spp*. in urine cultures, which was a higher frequency than that found in other studies. One study found candiduria in 7% of UTIs, and *C. albicans* was the most frequent among other types of *Candida*.[22] This high frequency could be the result of immunocompromised patients receiving empirical antibiotics for UTI in our setting. The pattern of antibiotic resistance in pediatric UTI is changing and has been described in several studies. This study showed that more than 90% of negative isolated bacteria were resistant to P and AMC and more than 80% were resistant to third-generation cephalosporins (COR and CAZ), indicating that resistance to these antibiotics has been increasing over time, a finding similar to those of other studies.[16,22,23] *E. coli* and *Klebsiella* show more than 90% sensitivity to AN, FOS, and IMP.

The increasing prevalence of MDR *Enterobacteriaceae* and the increasing number of *Candida species* in urine samples indicate misuse or prolonged use of empirical antibiotics. In our opinion, standardized approaches must be implemented to help pediatric physicians manage UTI.

Conclusion

UTIs remain a significant public health issue, particularly among pediatric patients, where they are a common cause of antibiotic prescription. This study highlights key findings related to the prevalence, microbiological characteristics, and antimicrobial resistance patterns in pediatric UTI cases at FMIC, Kabul, Afghanistan. The results demonstrated a high incidence of UTIs in children under five, with a predominance of female patients and infants under one year of age. The most commonly isolated pathogens were *Escherichia coli* (65%), followed by *Klebsiella spp*. and *Candida spp*. The presence of pyuria, hematuria, and nitrite positivity were highly suggestive of UTIs, aligning with clinical guidelines that recommend urine dipstick testing for all febrile children. Antimicrobial resistance was notably prevalent, with a significant proportion of *Enterobacteriaceae* isolates exhibiting extended-spectrum beta-lactamase (ESBL) production, especially among *Proteus* (90%) and *Klebsiella* (78%). Furthermore, *E. coli* demonstrated a high resistance rate to third-generation cephalosporins, particularly *ceftazidime* (98%) and *ceftriaxone* (82%). However, *E. coli* and *Klebsiella* exhibited good sensitivity to nitrofurantoin, fosfomycin, and imipenem, suggesting these agents may remain effective treatment options.

Interestingly, Candida species were also frequently isolated (12.5%), especially *Candida albicans*, which may reflect the increasing use of antibiotics in immunocompromised pediatric patients. This highlights the potential for opportunistic fungal infections, which need to be considered in the management of pediatric UTIs.

Overall, this study underscores the concerning rise in multidrug-resistant organisms (MDR) in pediatric UTIs, which could complicate treatment options and necessitate careful, targeted antibiotic use. The findings point to the need for regular surveillance of antimicrobial resistance patterns, the judicious use of antibiotics, and the development of guidelines for empirical treatment, with particular attention to age, sex, and local resistance trends. In conclusion, managing pediatric UTIs requires a balanced approach, including accurate diagnostic tools like urine dipstick tests, culture-based identification of pathogens, and close monitoring of antimicrobial resistance trends. The high rate of resistance to common antibiotics emphasizes the need for more effective stewardship and the development of alternative therapeutic strategies to combat the growing challenge of multidrug-resistant pathogens.

Abbreviations

Acronym, Descriptions; UTI, Urinary tract infection; CFU, Colony forming units; ESBL, Extended Spectrum Beta Lactamase; FMIC, French Medical Institute for Mother and Children; MDR, Multi Drug Resistance; CLED, Cystine-Lactose-Electrolyte-Deficient Agar; API, Analytical Profile Index; IlMS, Integrated Laboratory Management System; SPSS, Statistical Package for the Social Sciences; IHC, Immunohistochemical; MH2, Muller-Henton agar; LE, Leukocyte esterase; WBC, White Blood Cells; UTI, Urinary tract infection; AMC, Augmentin; AMP, Ampicillin; AK, Amikacin; ATM, Aztreonam; CAZ, Ceftazidime; TZP, Piperacillin/tazobactam; CN, Gentamicin; CRO, Ceftriaxone; NIT, Nitrofurantoin; FOS, Fosfomycin; CIP, Ciprofloxacin; SXT, Sulfamethoxazole/trimethoprim; CFM, Cefixime; IMP, Imipenem; RD, Rifampicin; DA, Clindamycin; E, Erythromycin; FD, Fusidic acid; P, Penicillin; TEC, Teicoplanin; VA, Vancomycin; AB, Amphotericin B; NY, Nystatin; MCZ, Miconazole; KET, Ketoconazole; CTR, Clotrimazole; PB, Polymyxin B; FCA, Fluconazole.

Data Sharing Statement

All data generated or analyzed during this study are included in this published article.

Ethical Approval and Informed Consent

Our study complies with the declaration of Helsinki. Permission was obtained from FMIC's Ethical Research Committee on August 27, 2023, to conduct this research (no. 075-FMIC-ER-23). The guidelines laid down by the research committee and ethical review committee of the FMIC were followed while conducting the current research. Informed consent was obtained from all the parents/legal guardians.

Patient or Public Involvement

No patients or members of the public were involved in the design, conduct, reporting, and dissemination plans of our research.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that they have no competing interests.

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