Antimicrobial Resistance Patterns in Pediatric Urinary Tract Infections: Insights from Hospitalized Children in Sudan

Abstract

Introduction: Urinary tract infections (UTIs) are among the most common bacterial diseases in children, affecting 3–5% of girls and 1% of boys, and leading to significant antibiotic exposure in this population. Initial UTI treatment is often empirical, based on symptomatology without microbiological confirmation.

Objective: This study aimed to identify the causative agents of UTIs in children, evaluate antimicrobial resistance rates, and recommend appropriate antibiotics.

Materials and Methods: A cross-sectional study was conducted on 67 urine samples collected from hospitalized children at Gaafar Bin Ouf Children's Hospital in Khartoum, Sudan. Samples were processed for bacterial isolation, identification, and antimicrobial susceptibility testing using the Kirby-Bauer method.

Results: Among the isolates, 24 (35.8%) were Staphylococcus aureus, 20 (29.9%) Klebsiella spp., 14 (20.9%) Escherichia coli, 8 (11.9%) Pseudomonas spp., and 1 (1.5%) Proteus spp. The highest resistance rates were observed for Amoxyclav (68.7%) and Erythromycin (61.2%), while Gentamicin (40.3%), Ciprofloxacin (43.3%), and Penicillin (46.3%) showed lower resistance rates.

Conclusion: Staphylococcus aureus was the most common UTI pathogen in hospitalized children, with high resistance rates to Amoxyclav and Erythromycin. These findings highlight the need for regular resistance monitoring and revising empirical antibiotic protocols to improve treatment outcomes.

Keywords: Urinary tract infections (UTIs), Staphylococcus aureus, antimicrobial susceptibility testing, Amoxyclav, Erythromycin

1.Introduction:

“Urinary tract infection (UTI) is one of the most common bacterial disease in children; it is acquired by an estimated 3–5% of girls and 1% of boys and represent a significant source of exposure to antibiotics in the pediatric population” (1–3) “The initial treatment of acute UTI is based on patient symptomatology and urinalysis without microbiological confirmations” (1– 3). “Early diagnosis and prompt antimicrobial treatment are required to minimize mortality including renal abscess formation, septicemia, renal scarring, and even renal failures” (4). “Moreover, they constitute a serious economic cost for countries. The economic impact may, however, be substantial because of the large number of acutely unwell children who present to primary care, additional diagnostic tests for structural abnormalities of the urinary tract, rare but serious complications of UTI, and the wider impact of antibiotic prescribing on bacterial resistance. Loss of time in school for children and loss of parental workforce loss are indirect costs" (5, 6). "The initial choice of antibacterial therapy is based on knowledge of the predominant pathogen in the patient's age group, antibacterial sensitivity patterns in the practice area, the clinical status of the patient, and the opportunity for close follow-up" (2, 4). "The initial choice of antibacterial therapy is based on knowledge of the predominant pathogen in the patient's age group, antibacterial sensitivity patterns in the practice area, the clinical status of the patient, and the opportunity for close follow up" (2, 4). "The current American Academy of Pediatrics guideline for management of UTIs in febrile infants and young children suggests giving oral or parenteral (then changed to oral) antibiotics for 7–14 days. Ceftriaxone, cefotaxime, ceftazidime, gentamicin, tobramycin, and pi, peracillin are drugs of choice for parenteral therapy. By contrast, amoxicillin clavulanate, sulfonamide (trimethoprimsulfamethoxazole or sulfisoxazole), or cephalosporin (cefixime, cefpodoxime, cefprozil, cefuroxime axetil, or cephalexin) are recommended as oral agents for treating UTI" (7, 8) Studies of pediatric uropathogens indicate that resistance to common antibiotics is on the rise (9) and treatment of UTIs is becoming more difficult with time. Moreover, there are considerable geographic variations in bacterial patterns and resistance properties depending on local antimicrobial prescription practices (2, 8, 10, 11,17) However, because of the evolving and continuing antibiotic resistance phenomenon, regular monitoring of resistance patterns is necessary to improve guidelines for empirical antibiotic therapy.

UTI mostly occurs during the first year of life in boys, much more commonly in uncircumcised boys. The prevalence of UTI varies with the age. During the first year of life, the male to female ratio range is 2.8–5.4. Beyond 1–2 years, there is a striking female preponderance with a 1:10 male to female ratio.

Escherichia coli spp corresponds with 75%–90% of all UTIs, followed by *Klebsiella* spp and *Proteus* spp species in females, but previous reports have showed that *Proteus* spp is as common as *E. coli* in UTIs of males aged >1 year. Others report a preponderance of Gram-positive organisms in UTIs of males. *Staphylococcus saprophyticus* and *Enterococcus* spp are UTI causative pathogens in both sexes.

2. Materials and methods:

2.1. Study design

A cross-sectional study was carried out during the period from August to December 2021 at Children admitted to Gaafar Bin Ouf Children's Hospital. The study includes patients clinically diagnosed by having one or more of the following symptoms: dysuria, frequency, urgency, suprapubic discomfort, or flank pain. Children suffering from other diseases than UTIs were excluded from the study. A total of 67 patients (24 males and 43 females) has been presented during this period of time. All patients were informed of the purpose of the study and their consent, or that of their care provider, was obtained before urine samples were collected.

2.2. Sample collection and Processing

Each patient was asked to collect approximately 10-20 ml of midstream urine into a sterile urine container. After giving proper instructions to avoid contamination and samples were processed in the laboratory within 2 hours of collection. None of the patients admitted to consuming antibiotics during the 2 weeks prior to urine sample collection.

2.3. Data collection

A structured questionnaire and referring to the patient clinical sheet were being used to collect demographic information and other data (clinical symptoms, previous antibiotic, duration of antibiotic used). verbal consent was obtained from each patient enrolled in this study.

2.4. Isolation and identification of Escherichia Coli using biochemical tests and selective medium

Urine cultures were performed using a semi-quantitative technique whereby urine samples were inoculated on cysteine-Lactose electrolyte deficient (CLED) medium plates with a calibrated loop (0.001ml) and incubated at 37°C for 18-24 hours.

Urine culture reports that exhibited colony forming units (CFUs) more than 105/ ml of voided urine were considered significant [12].

Isolated colonies from significant plates were identified and differentiated from related organisms using standard conventional biochemical tests (Kligler Iron agar:; Motility test; Indole, Urease; Citrate).

2.5. Antimicrobial susceptibility testing

Antimicrobial sensitivity testing of all isolates was performed on diagnostic sensitivity test plates according to the Kirby-Bauer method [13] following the definition of the Committee of Clinical Laboratory International Standards [14]. Bacterial inoculums were prepared by suspending the freshly grown bacteria in 5mL sterile saline. A sterile cotton swab was used to streak the surface of Mueller Hinton agar plates. Filter paper disks containing a designated concentration of the antimicrobial drugs were obtained from Hi-Media Laboratories in the following:, Gentamicin, Amoxyclin, ciprofloxacin, Erythromycin and Penicilin. The diameters of the zone of inhibition were interpreted according to CLSI standards.

3.Results

A total of 67 isolated organisms of urine sample were identified, of which 24(35.8%) were from male and 43 (64.2%)were female as shown in table (1). Their mean age was 7-16 years old, as shown in table (2). Distribution of ages in the study group as shown in tables (3) the most causative agent was *Staphylococcus aureus* 24 (35.8% of cases) followed by*Klebsiella pneumoniae* 20 (29.9%), E. coli 14 (20.9%), pseudomonas 8 (11.9%) and proteus 1(1. 5%) has showed table (4).The lowest antimicrobial resistance rate among all microorganism where to GENTAMICIN (40.3%),CIPROFLOXACIN (43.3%) andPENICILLIN (46.3%), while the highest were to AMOXYCLAV (68.7%) and ERYTHROMYCIN (61.2%) as shown in tables (5/6/7/8/9)

Table (1): Distribution of gender in the study group

		Frequency	Percent
N	Male	24	35.8
	Female	43	64.2
	Total	67	100.0

Table (2): Mean and median of Ages in the study group

Age: Statistics	
N	67
Mean	12.49
Median	12.00

Table (3): Distribution of ages in the study group

		Frequency	Percent

N	7-11 yrs	18	26.9
	12-16 yrs	49	73.1
	Total	67	100.0

Table (4): Distribution of Isolated bacteria in the study group

Bacteria	frequency	percentage
S.aureus	24	35.8
E.coli	14	20.9
Klebsiella	20	29.9
Pseudomonas	8	11.9
Proteus	1	1.5
Total	67	100.0

Table (5): Frequencies of antibiotic's sensitivity

PENICILLIN			
		Frequency	Percent
N	sensitive	36	53.7
	resistant	31	46.3
	Total	67	100.0

Table (6):Frequencies of Gentamycin antibiotics sensitivity

GENTAMYCIN			
		Frequency	Percent
N	sensitive	40	59.7
	resistant	27	40.3
	Total	67	100.0

Table (7): Frequencies of Amoxyclav antibiotics sensitivity

AMOXYCLAV			
		Frequency	Percent
N	sensitive	21	31.3
	resistant	46	68.7
	Total	67	100.0

Table (8): Frequencies of Erythromycin antibiotics sensitivity

ERYTHROMYCIN			
		Frequency	Percent
N	Sensitive	26	38.8
	resistant	41	61.2
	Total	67	100.0

Table(9):Frequencies of Ciprofloxacin antibiotics sensitivity

CIPROFLOXACIN			
		Frequency	Percent
N	sensitive	38	56.7

	resistant	29	43.3
	Total	67	100.0

4.Discussion

Urinary tract infection (UTI) is of major clinical importance owing to considerably high morbidity and mortality rates among children. In this study,67 isolated organisms of urine samples were identified.

In this study, the most causative agent was *staphylococcus aureus* 24 (35.8% of cases) followed by *Klebsiella pneumoniae* 20 (29.9%), E. coli 14 (20.9%), pseudomonas 8 (11.9%) and proteus 1(1. 5%), it disagrees with the result of a study Gunduz in that they reach a result that the most causative agent is *Escherichia coli* was detected in (58.9%) of the patients, Klebsiella (17.9%) and Proteus (15.8%).

Susceptibility results showed the highest resistance were to Amoxyclav (68.7%) and ERYTHROMYCIN (61.2%), which disagrees with the result of study. Vazouras K *et al* (15)among 459 prescriptions identified high reported resistance rates to ampicillin (42.0%), Trimethoprim/Sulfamethoxazole (26.5%) and Amoxicillin/Clavulanic acid (12.2%); lower resistance rates were identified for third-generation Cephalosporins (1.7%), Nitrofurantoin (2.3%), Ciprofloxacin (1.4%) and Amikacin (0.9%).

It also agrees with the result of a study of Ahmed *et al*, (16) they reach a result that of 273 urine samples, drug resistance was found in 92% (n = 82/89) of samples, with most (80%) being resistant to at least two drugs. Antibiotic resistance was commonly observed in Ampicillin (88.3%), Piperacillin (72.7%), Clindamycin (66.7%), Amoxicillin/Clavulanic acid (66.2%), and Trimethoprim/Sulfamethoxazole (50%).

The result showed the lowest resistance rate for Gentamicin (40.3%), Ciprofloxacin (43.3%) and Penicillin (46.3%), it disagrees with the result of Gunduz S they reach the result that the lowest resistance to nitrofurantoin (21.4%), Piperacillin/Tazobactam (19.1), Imipenem (8.6%), Meropenem (8.8%), Amikacin (6.2%) and Cefoperazone/Sulbactam (CSL) (4.7%).

5.Conclusion:

Staphylococcus aureus was the most common UTI pathogen in hospitalized children, with high resistance rates to Amoxyclav and Erythromycin. These findings highlight the need for regular resistance monitoring and revising empirical antibiotic protocols to improve treatment outcomes.

Consent:

All patients were informed of the purpose of the study and their written informed consent, or that of their care provider, was obtained before urine samples were collected.

6.Disclaimer (Artificial intelligence)

Author S hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

7.References:

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