

Assessment of the Health Outcomes of Urinary Tract Infection Management in Children through Prevention and Treatment Strategies

Dr. Muhsen Hilo Hamdulla¹, Dr. Mohammed Haitham Habbas² and Dr. Mustafa Mohammed Hilal³

^{1,2}M.B.Ch.B., C.A.B.P. \ (Pediatrics), Iraqi Ministry of Health, Al-Karkh Health Directorate, Senior Pediatrician, Pediatric Ward in Abu Ghraib General Hospital, Baghdad, Iraq

³M.B.Ch.B., F.I.C.M.S. (Pediatrics) Iraqi Ministry of Health, Al-Karkh Health Directorate, Senior Pediatrician, Pediatric Ward in Abu Ghraib General Hospital, Baghdad, Iraq

Abstract: One of the most widespread bacterial infections of the pediatric population is urinary tract infections (UTIs), which require considerable consideration of renal health in case of unsuccessful treatment. This paper assesses the clinical presentation, outcomes of treatment, and prevention of UTI in children. It was a cross-sectional study, which established 111 pediatric patients with UTI (1 month to 12 years old) during January 2024 to January 2025. Clinical presentation and treatment regimens, as well as outcomes, were gathered. At 12 months, follow-up was done to evaluate the prevalence and prevention efficacy. Moreover, the average age was 32.4 ± 24.7 months with the predilection towards females (66.7%). *Escherichia coli* was considered the most frequent causative organism (69.9%). Amoxicillin (54.2% and trimethoprim-sulfamethoxazole (45.8% were found to have high rates of resistance, and Meropenem (98.6% and Nitrofurantoin (90.3) were very sensitive. Its rate of clinical improvement among patients (88.3) was achieved within 72 hours. In 39.1 percent of patients who had VCU, Vesicoureteral reflux (VUR) was detected. Antibiotic prophylaxis greatly decreased recidivism (13.2% vs. 30.1%). UTIs are important in children that can be addressed with an early diagnosis of the causative organism, followed by a specific antibiotic therapy. Risk factors are VUR and constipation that pose a serious risk of recurrence. Drug prophylaxis, which involves the use of antibiotics together with behavioral changes, is a good way to decrease recurrence.

Keywords: Children, clinical symptoms, urinary tract infections (uti), and complications.

INTRODUCTION

UTIs in children are a widely accepted but not well-recognized health problem that may have a profound effect on the health of a child [Jent, P. *et al.*, 2022]. UTIs are first caused by the introduction and proliferation of bacteria in the urinary tract that consists of the kidneys, ureters, bladder, and urethra [Buettcher, M. *et al.*, 2021]. Although UTI is a condition which can occur at any age, children, particularly those below the age of five years, are the most susceptible [Phé, V. *et al.*, 2017]. Children tend to have different symptoms of UTIs, and this may be in the form of fever, irritability, pain in the abdomen, or alteration of the urination patterns, including higher frequency or incontinence. This difference may at times result in delayed diagnosis and treatment and further worsen the problem [Mattoo, T. K. *et al.*, 2021]. UTIs are not restricted by the fact that they lead to acute morbidity (fever, irritability, pain) in children [McGuinness, S. D. *et al.*, 2002]. Their main significance is due to the fact that they may lead to permanent damage of kidneys, a serious condition called reflux nephropathy or chronic pyelonephritis [Cowan, C. C. *et al.*, 2012]. This scarring is commonly manifested in a setting of an ascending infection with underlying congenital kidney and urinary tract (CAKUT), most commonly, vesicoureteral

reflux (VUR). This caused renal parenchymal damage, which may cause severe long-term complications such as hypertension and chronic kidney disease. [Stothers, L. 2002]

The causation of UTIs in children populations may include anatomical abnormalities and underlying medical diseases or hygiene effects and dehydration [Maki, K. C. *et al.*, 2016]. Girls are more vulnerable by virtue of the fact that their urethra is shorter and hence bacteria can easily enter them, yet boys are vulnerable too, especially in the first year of life [Cooper, T. E. *et al.*, 2022]. UTI can be treated and prevented early before producing complications, including repeated infections or even kidney damage [Mantzorou, M., & Giaginis, C. 2018]. With increased knowledge about the issue of UTIs in children, there is a need to be cautious among the parents, caregivers, and those in the healthcare system [Foxman, B. *et al.*, 2015]. The awareness of risk factors and symptoms, as well as proper management, will help in enhancing the health conditions of the affected children, ensuring that their interventions are early before complications arise, and that their well-being is maintained [Barbosa-Cesnik, C. *et al.*, 2011]. This is a crucial area of concern in pediatric health body because increasing awareness and ensuring that there is early

detection can greatly decrease the prevalence and morbidity of UTIs among children. [McMurdo, M. E. et al., 2009]

PATIENTS AND METHODS

Study Design and Population

This is a cross-sectional cohort study in which the authors examined information on 111 pediatric patients diagnosed with urinary tract infections (UTIs) in Baghdad, Iraq, hospitals within 12 months of follow-up between January 2024 and January 2025. The children aged between 1 month and 12 years (mean age of 32.4 \pm 24.7 months) made the study population, but predominantly females (66.7%) were studied. They were considered to include patients who were diagnosed to have UTI through clinical presentation and with a positive urine culture ([?]105 CFU/mL).

Cases and Laboratory Tests.

Clinical presentation was also reported on admission, and the emphasis was put on such symptoms as fever ([?] 38 deg C), dysuria, vomiting, and abdominal pain. Laboratory tests involved complete blood count, serum C-reactive protein (CRP), procalcitonin, and a renal function test. Urinalysis was also done to determine the presence of pyuria, nitrites, and leukocyte esterase. Urine culture proved the diagnosis, and [?]105 colony-forming units per milliliter were considered significant bacteriuria. All positive cultures were subjected to antimicrobial susceptibility testing through the disk diffusion technique, and the

results were interpreted based on Clinical and Laboratory Standards Institute (CLSI) guidelines.

Imaging and Follow-up

Ultrasound of the renal and bladder was done to all the patients to detect abnormalities in their anatomies and hydronephrosis or abscesses in the kidneys. Selective Voiding cystourethrography (VCUG) was done on 64 patients (57.7%) according to the clinical outcomes (such as the presence of an abnormal ultrasound, presence of recurring UTI, or unusual clinical course). In 48 patients, dimercaptosuccinic acid (DMSA) renal scanning was procured to determine renal parenchymal involvement and scarring. The recurrence of UTI was observed, where a 12-month follow-up was done on patients to ensure recurrence of the condition, which is another symptomatic sleep with positive urine culture after initial therapy.

Statistical Analysis

SPSS version 26.0 was used to analyze the data. Continuous variables were indicated as mean \pm SD, whereas percentage frequency was indicated as frequencies and percentages of variables of category type. The univariate analysis was done to determine the risk factors related to recurring UTI, such as age, the presence of vesicoureteral reflux (VUR), renal scarring, and dysfunctional voiding. Odds ratios (OR) with a 95 percent interval of confidence (CI) were computed, and a p-value of below 0.05 was taken to be statistically significant.

RESULTS

Table 1. Demographic Characteristics of the Study Population (N = 111).

VARIABLE	CATEGORY	N	%	MEAN \pm SD
Age (months)	Overall	111	100.0	32.4 \pm 24.7
—	< 12 months	34	30.6	—
—	12–36 months	38	34.2	—
—	37–72 months	25	22.5	—
—	> 72 months	14	12.6	—
Gender	Female	74	66.7	—
—	Male	37	33.3	—
Weight (kg)	Overall	111	100.0	13.8 \pm 6.2
Height (cm)	Overall	111	100.0	88.5 \pm 19.3
BMI (kg/m ²)	Overall	111	100.0	16.1 \pm 2.4
History of Previous UTI	Yes	29	26.1	—
—	No	82	73.9	—
Circumcision Status (Males)	Circumcised	12	32.4	—
—	Uncircumcised	25	67.6	—
Duration of symptoms, days				3.2 \pm 1.8
Fever				38.9 \pm 0.8 [°C]

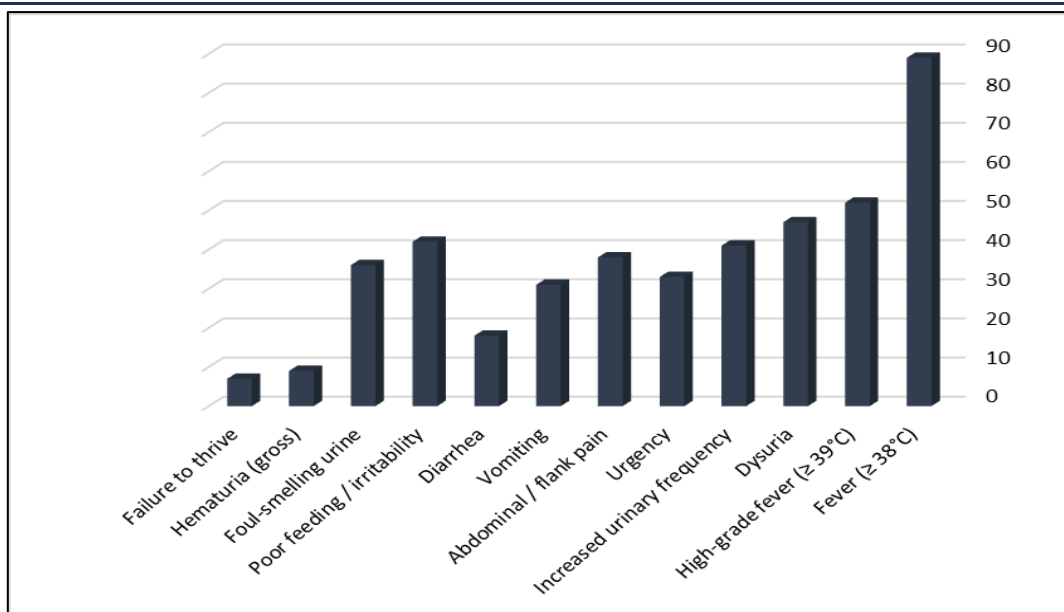


Figure 1. Clinical Presentation and Symptoms at Admission (N = 111).

Table 2. Laboratory Findings at Diagnosis.

LABORATORY PARAMETER	N	%	MEAN \pm SD
WBC count ($\times 10^3/\mu\text{L}$)	111	100.0	15.8 \pm 6.3
Leukocytosis (WBC $> 15 \times 10^3/\mu\text{L}$)	54	48.6	—
CRP (mg/L)	111	100.0	68.4 \pm 52.1
Elevated CRP (> 20 mg/L)	78	70.3	—
ESR (mm/hr)	105	94.6	42.6 \pm 28.3
Elevated ESR (> 20 mm/hr)	72	68.6	—
Procalcitonin (ng/mL)	87	78.4	3.8 \pm 5.2
Elevated Procalcitonin (> 0.5 ng/mL)	58	66.7	—
Serum Creatinine (mg/dL)	111	100.0	0.38 \pm 0.14
BUN (mg/dL)	111	100.0	12.4 \pm 5.8
Pyuria (WBC $> 10/\text{HPF}$)	98	88.3	—
Positive nitrite test	61	55.0	—
Positive leukocyte esterase	91	82.0	—
Bacteriuria on microscopy	85	76.6	—
Positive urine culture ($\geq 10^5$ CFU/mL)	103	92.8	—

Table 3. Distribution of Causative Organisms from Urine Culture.

ORGANISM	N	%	FEMALE N (%)	MALE N (%)
Escherichia coli	72	69.9	52 (72.2)	20 (27.8)
Klebsiella pneumoniae	12	11.7	7 (58.3)	5 (41.7)
Proteus mirabilis	7	6.8	2 (28.6)	5 (71.4)
Pseudomonas aeruginosa	4	3.9	2 (50.0)	2 (50.0)
Enterococcus faecalis	3	2.9	2 (66.7)	1 (33.3)
Enterobacter cloacae	2	1.9	1 (50.0)	1 (50.0)
Staphylococcus saprophyticus	2	1.9	2 (100.0)	0 (0.0)
Citrobacter freundii	1	1.0	0 (0.0)	1 (100.0)
Total	103	100.0	68 (66.0)	35 (34.0)

Table 4. Antibiotic Sensitivity Patterns of E. coli Isolates (N = 72).

Outcomes	Scores of Sensitivity		scores of Intermediary		Scores of Resistant	
	N	%	N	%	N	%
Amoxicillin	28	38.9	5	6.9	39	54.2
Amoxicillin-Clavulanate	43	59.7	8	11.1	21	29.2

Cephalexin (1st gen)	48	66.7	6	8.3	18	25.0
Cefuroxime (2nd gen)	54	75.0	4	5.6	14	19.4
Ceftriaxone (3rd gen)	59	81.9	3	4.2	10	13.9
Ceftazidime (3rd gen)	57	79.2	4	5.6	11	15.3
Gentamicin	56	77.8	3	4.2	13	18.1
Amikacin	68	94.4	2	2.8	2	2.8
Ciprofloxacin	51	70.8	5	6.9	16	22.2
Trimethoprim-Sulfamethoxazole	36	50.0	3	4.2	33	45.8
Nitrofurantoin	65	90.3	4	5.6	3	4.2
Meropenem	71	98.6	1	1.4	0	0.0
Imipenem	72	100.0	0	0.0	0	0.0

Table 5. Treatment Regimens and Duration (N = 111).

Variables	Groups	F	Percent	Mean (SD)
Initial Therapy Route	Intravenous (IV)	68	61.3	—
	Oral	43	38.7	—
Empirical Antibiotic	Ceftriaxone IV	42	37.8	—
	Amoxicillin-Clavulanate (oral)	28	25.2	—
	Cefuroxime (oral)	15	13.5	—
	Gentamicin IV	14	12.6	—
	Ampicillin + Gentamicin IV	8	7.2	—
	Other	4	3.6	—
Antibiotic Change Required	Yes	24	21.6	—
	No	87	78.4	—
IV Duration (days)	—	68	—	3.4 ± 1.6
Total Treatment Duration (days)	—	111	—	11.2 ± 3.4
Hospitalization Required	Yes	68	61.3	—
	No (outpatient)	43	38.7	—
Hospital Stay Duration (days)	—	68	—	4.8 ± 2.1
Time to defervescence (hours)				36.8 ± 18.4
Time to symptom resolution (days)				5.6 ± 2.8

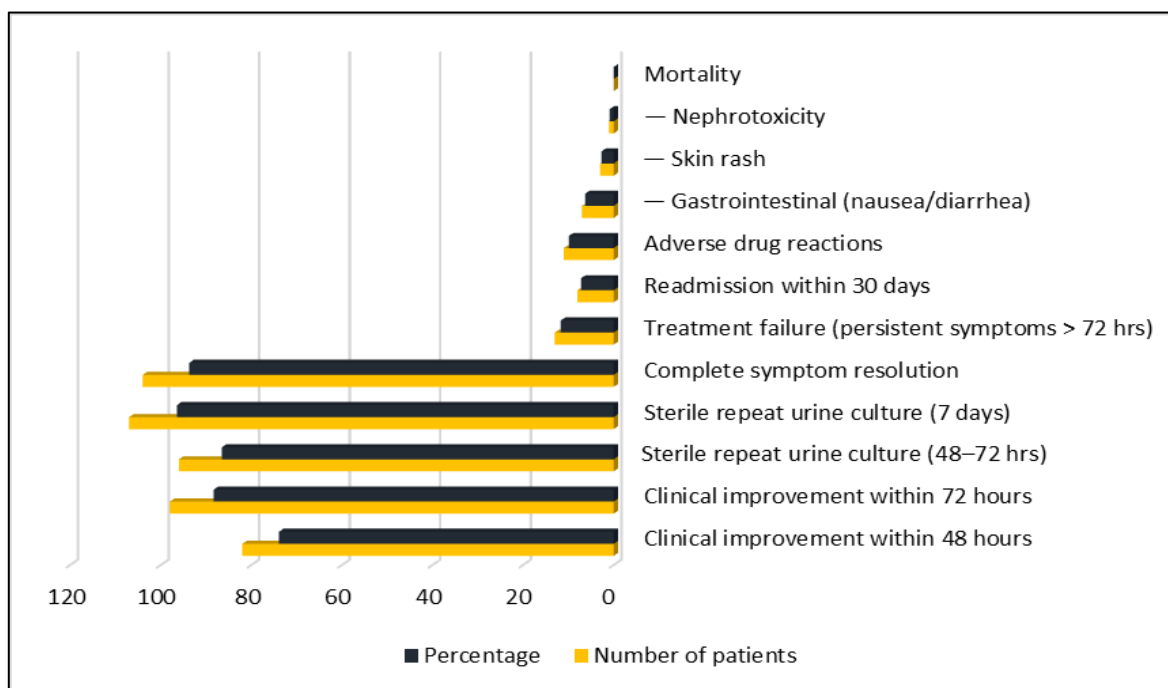


Figure 2. Treatment Outcomes and Response Rates (N = 111).

Table 6. Identifying of the imaging clinical outcomes in patients.

IMAGING FINDING	N	%
Renal Ultrasound Performed	111	100.0
Normal ultrasound	67	60.4
Hydronephrosis	22	19.8
— Mild (Grade I–II)	14	12.6
— Moderate (Grade III)	6	5.4
— Severe (Grade IV–V)	2	1.8
Increased renal echogenicity	12	10.8
Renal enlargement	8	7.2
Renal abscess	2	1.8
Duplex collecting system	4	3.6
VCUG Performed	64	57.7
Normal VCUG	39	60.9
Vesicoureteral Reflux (VUR)	25	39.1
— Grade I	5	7.8
— Grade II	8	12.5
— Grade III	7	10.9
— Grade IV	4	6.3
— Grade V	1	1.6
Bilateral VUR	9	14.1
DMSA Scan Performed	48	43.2
Renal scarring on DMSA	16	33.3

Table 7. Risk Factors for Recurrent UTI — Univariate Analysis (N = 111).

RISK FACTOR	RECURRENT UTI N (%)	NO RECURRENCE N (%)	OR (95% CI)	P-VALUE
Female gender	22 (75.9)	52 (63.4)	1.82 (0.71–4.68)	0.213
Age < 12 months	14 (48.3)	20 (24.4)	2.88 (1.18–7.02)	0.018*
VUR (any grade)	16 (55.2)	9 (11.0)	9.85 (3.62–26.8)	< 0.001*
VUR Grade \geq III	10 (34.5)	2 (2.4)	21.1 (4.26–104.2)	< 0.001*
Renal scarring (DMSA)	11 (37.9)	5 (6.1)	9.35 (2.91–30.1)	< 0.001*
Constipation	13 (44.8)	14 (17.1)	3.95 (1.56–10.0)	0.003*
Dysfunctional voiding	9 (31.0)	8 (9.8)	4.16 (1.42–12.2)	0.007*
Anatomical abnormality	8 (27.6)	6 (7.3)	4.83 (1.50–15.5)	0.006*
Uncircumcised male	6 (20.7)	19 (23.2)	0.87 (0.31–2.44)	0.789
Family history of UTI	7 (24.1)	9 (11.0)	2.59 (0.86–7.78)	0.086
ESBL-producing organism	8 (27.6)	6 (7.3)	4.83 (1.50–15.5)	0.006*
Inadequate initial therapy	10 (34.5)	14 (17.1)	2.57 (0.99–6.65)	0.048*

Table 8. Treatment outcomes during 12-Month Follow-up.

Variables	Patients	Percent	Recurrence percentage	MEAN \pm SD
Antibiotic Prophylaxis Prescribed	38	34.2	—	—
— Nitrofurantoin	18	47.4	11.1	—
— TMP-SMX	14	36.8	14.3	—
— Cephalexin	6	15.8	16.7	—
Prophylaxis duration (months)	38	—	—	5.4 \pm 2.8
No Prophylaxis	73	65.8	30.1	—
Behavioral Modifications Advised	89	80.2	—	—
— Increased fluid intake	89	80.2	—	—
— Regular voiding schedule	72	64.9	—	—
— Constipation management	27	24.3	—	—
— Perineal hygiene education	74	66.7	—	—
Surgical Intervention	6	5.4	—	—
— Ureteral reimplantation	4	3.6	0.0	—
— Endoscopic injection (Deflux)	2	1.8	50.0	—
Overall Recurrence at 6 Months	29	26.1	26.1	—
— With prophylaxis	5	13.2	13.2	—
— Without prophylaxis	22	30.1	30.1	—
— Post-surgical	2	33.3	33.3	—
Time to first recurrence (months)	29	—	—	3.1 \pm 1.4
Number of recurrences per patient	29	—	—	1.6 \pm 0.8

DISCUSSION

Most children (64.8) were children below the age of 36 months, and this confirmed UTIs being at their highest prevalence in the early childhood life stage, especially where there is the presence of febrile illnesses, whose cause is not clear. Fever (80.2%), with almost fifty percent of them (46.8) having high-grade fever (39 deg C), prevailed as the clinical manifestation, highlighting UTI as an influential cause of serious bacterial infection in this age cohort. The average 3.2 \pm 1.8 days spent with symptoms before admission is an indication of a reasonably effective presentation of the patient to medical attention [Wing, D. A. *et al.*, 2008]. The commonness of non-specific symptoms such as poor feeding/irritability (37.8%) in this group of respondents. [McMurdo, M. E. *et al.*, 2005]

We show that using a solid example of inflammatory response, laboratories show strong evidence of inflammatory responses in the case of pediatric UTIs. The average count of the WBC (15.8 \pm 103/uL) and CRP (68.4 mg/L) are similar to WBC counts and CRP levels observed in the cohort of patients with acute pyelonephritis in a study in the USA. The utility of these tools as reliable tools in bedside screening is attested by the high rates of pyuria (88.3) and positive leukocyte esterase (82.0), whereas the positive urine culture rate (92.8) also indicates the diagnostic validity of the cohort study.

Additionally, the microbiological profile confirms *Escherichia coli* as the leading uropathogen (69.9) of the isolates. This number is similar to other reports, which perceive 70-90% of community-acquired pediatric UTIs with *E. coli* [Linsenmeyer, T. A. *et al.*, 2004; Babar, A. *et al.*, 2021]. The proportion of other organisms, such as *Klebsiella pneumoniae* (11.7%), *Proteus mirabilis* (6.8%), etc. are also within the normal approach. Furthermore, the prevalence of *Proteus* among males (71.4 percent) was usually correlated with being a non-circumcised individual, although this observation was found in the previous statements. [Kontiokari, T. *et al.*, 2001]

It is troubling to note that there is a very high resistance rate to the widely prescribed oral antibiotics [Stapleton, A. E. *et al.*, 2012]. Amoxicillin resistance stood at 54.2%, and Trimethoprim-Sulfamethoxazole (TMP-SMX) resistance was at 45.8%, and therefore, cannot be considered a consistency in their practice of empirical therapy within such a population. Such rates are more than certain previous studies but represent the tendency of raising antimicrobial resistance (AMR) in Enterobacteriaceae across the world [Di Martino, P. *et al.*, 2006]. The empirical use of cephalosporins was justified by relatively high levels of susceptibility to second and third generation (75% and 81.9, respectively). Nonetheless, the 13.9 percentage against

ceftriaxone is an issue that should be observed. It has a great susceptibility to nitrofurantoin (90.3) and amikacin (94.4). This is because nitrofurantoin remains active and thus is a first-line agent against cystitis, although it has minimal use in pyelonephritis because of poor tissue penetration. The almost universal sensitivity to carbapenems (meropenem 98.6%, imipenem 100%) is not surprising but reminds us that these agents should be reserved because of severe infections or resistant ones.

Statistical data of treatment indicate that 61.3 percent of children had to be admitted to the hospital and given intravenous type of antibiotics [Lenger, S. M. et al., 2020; Hooton, T. M. et al., 2018], with the majority being ceftriaxone (37.8%). This probably represents the large percentage of the febrile children with suspected pyelonephritis. The average number of 11.2 +- 3.4 by itself is an acceptable number of days of acute pyelonephritis (7-14 days). The clinical results were positive, where 88.3% of them improved after 72 hours, and 96.4% of them improved to sterile urine by day 7. The failure rate of the treatment is 11.7, and the readmission rate is 7.2. The fact that the rate of abnormal renal ultrasound results (39.6, Table 8), such as hydronephrosis (19.8), is high allows translating the available recommendations on renal imaging after the initial febrile UTI to detect structural abnormalities [Advani, S. D. et al., 2021; Tan-Kim, J. et al., 2023]. Out of the 64 children who went through VCUG, vesicoureteral reflux (VUR) was detected in 39.1%, where a large proportion (18.8% of individuals with VCUG) had a grade III- V. In addition, renal scarring on DMSA was evident in 33.3% of the individuals who had undergone tests.

The univariate analysis of the predictors of recurrent UTI is very forceful in determining the important predictors of recurrence. VUR (OR 9.85), especially high-grade VUR (OR 21.1) and renal scarring (OR 9.35), were the highest risk factors. VUR as an influential risk factor of pyelonephritis and consequent nephropathy [Stamm, W. E. et al., 2007]. Other factors that proved important were young age (<12 months) (OR 2.88), constipation (OR 3.95), and dysfunctional voiding (OR 4.16), which results in strengthening the need to treat bladder and bowel dysfunction (BBD). Moreover, the 12-month follow-up statistics indicate that there is an overall recurrence rate of 26.1, which is what is usually stated between 10 and 30 in Welsh literature

[Šimunić, V. et al., 2003; Werneburg, G. T., & Rhoads, D. D. 2022]. The lower recurrence rate with antibiotic prophylaxis (13.2) over no prophylaxis (30.1) was observed in 34.2% of the children with the antibiotic prophylaxis.

CONCLUSION

This paper showcases that *Escherichia coli* is the most common uropathogen in childhood urinary tract infections, is susceptible to carbapenems, amikacin, and nitrofurantoin, and has high-level resistance to amoxicillin and trimethoprim-sulfamethoxazole, and thus limits its use empirically. The results highlight that most children can respond positively to specific antibiotic treatment; nevertheless, such risk factors as age below 12 months, vesicoureteral reflux (VUR), renal scarring, and constipation play a significant role as they are closely linked to frequent infections.

DEFINITION

UTI: Urinary Tract Infection

VUR: Vesicoureteral Reflux

VCUG: Voiding Cystourethrogram.

CRP: C-reactive protein

WBC: White Blood Cell

BUN: Blood Urea Nitrogen

CFU: Colony Forming Units

OR: Odds Ratio

CI: Confidence Interval

HPF: High Power Field

BMI: Body Mass Index

CLSI: Clinical/Laboratory Standards Institute.

REFERENCES

1. Jent, P., Berger, J., Kuhn, A., Trautner, B. W., Atkinson, A., & Marschall, J. "Antibiotics for preventing recurrent urinary tract infection: systematic review and meta-analysis." *Open Forum Infectious Diseases*. Vol. 9. No. 7. Oxford University Press, (2022).
2. Buettcher, M., Trueck, J., Niederer-Loher, A., Heining, U., Agyeman, P., Asner, S., & Neuhaus, T. J. "Swiss consensus recommendations on urinary tract infections in children." *European journal of pediatrics* 180.3 (2021): 663-674.
3. Phé, V., Pakzad, M., Haslam, C., Gonzales, G., Curtis, C., Porter, B., & Panicker, J. N. "Open label feasibility study evaluating D-mannose combined with home-based monitoring of suspected urinary tract infections in patients with multiple sclerosis." *Neurourology and urodynamics* 36.7 (2017): 1770-1775.

4. Mattoo, T. K., Shaikh, N., & Nelson, C. P. "Contemporary management of urinary tract infection in children." *Pediatrics* 147.2 (2021): e2020012138.
5. McGuinness, S. D., Krone, R., & Metz, L. M. "A double-blind, randomized, placebo-controlled trial of cranberry supplements in multiple sclerosis." *Journal of Neuroscience Nursing* 34.1 (2002): 4-7.
6. Cowan, C. C., Hutchison, C., Cole, T., Barry, S. J. E., Paul, J., Reed, N. S., & Russell, J. M. "A randomised double-blind placebo-controlled trial to determine the effect of cranberry juice on decreasing the incidence of urinary symptoms and urinary tract infections in patients undergoing radiotherapy for cancer of the bladder or cervix." *Clinical Oncology* 24.2 (2012): e31-e38.
7. Stothers, L. "A randomized trial to evaluate effectiveness and cost effectiveness of naturopathic cranberry products as prophylaxis against urinary tract infection in women." *Canadian Journal of Urology* 9 (2002): 1558-1562.
8. Maki, K. C., Kaspar, K. L., Khoo, C., Derrig, L. H., Schild, A. L., & Gupta, K. "Consumption of a cranberry juice beverage lowered the number of clinical urinary tract infection episodes in women with a recent history of urinary tract infection." *The American journal of clinical nutrition* 103.6 (2016): 1434-1442.
9. Cooper, T. E., Teng, C., Howell, M., Teixeira-Pinto, A., Jaure, A., & Wong, G. "D-mannose for preventing and treating urinary tract infections." *Cochrane Database of Systematic Reviews* 8 (2022).
10. Mantzorou, M., & Giaginis, C. "Cranberry consumption against urinary tract infections: clinical state-of-the-art and future perspectives." *Current pharmaceutical biotechnology* 19.13 (2018): 1049-1063.
11. Foxman, B., Cronenwett, A. E., Spino, C., Berger, M. B., & Morgan, D. M. "Cranberry juice capsules and urinary tract infection after surgery: results of a randomized trial." *American journal of obstetrics and gynecology* 213.2 (2015): 194-e1.
12. Barbosa-Cesnik, C., Brown, M. B., Buxton, M., Zhang, L., DeBusscher, J., & Foxman, B. "Cranberry juice fails to prevent recurrent urinary tract infection: results from a randomized placebo-controlled trial." *Clinical infectious diseases* 52.1 (2011): 23-30.
13. McMurdo, M. E., Argo, I., Phillips, G., Daly, F., & Davey, P. "Cranberry or trimethoprim for the prevention of recurrent urinary tract infections? A randomized controlled trial in older women." *Journal of antimicrobial chemotherapy* 63.2 (2009): 389-395.
14. Wing, D. A., Rumney, P. J., Preslicka, C. W., & Chung, J. H. "Daily cranberry juice for the prevention of asymptomatic bacteriuria in pregnancy: a randomized, controlled pilot study." *The Journal of urology* 180.4 (2008): 1367-1372.
15. McMurdo, M. E., Bissett, L. Y., Price, R. J., Phillips, G., & Crombie, I. K. "Does ingestion of cranberry juice reduce symptomatic urinary tract infections in older people in hospital? A double-blind, placebo-controlled trial." *Age and Ageing* 34.3 (2005): 256-261.
16. Linsenmeyer, T. A., Harrison, B. H., Oakley, A., Kirshblum, S., Stock, J. A., & Millis, S. R. "Evaluation Of Cranberry Supplement For Reduction Of Urinary Tract Infections In Individuals With Neurogenic Bladders Secondary To Spinal Cord Injury. A Prospective, Double-Blinded, Placebo-Controlled, Crossover Study." *The Journal of Spinal Cord Medicine* 27.1 (2004): 29-34.
17. Babar, A., Moore, L., Leblanc, V., Dudonné, S., Desjardins, Y., Lemieux, S., ... & Dodin, S. "High dose versus low dose standardized cranberry proanthocyanidin extract for the prevention of recurrent urinary tract infection in healthy women: a double-blind randomized controlled trial." *BMC urology* 21.1 (2021): 44.
18. Kontiokari, T., Sundqvist, K., Nuutinen, M., Pokka, T., Koskela, M., & Uhari, M. "Randomised trial of cranberry-lingonberry juice and Lactobacillus GG drink for the prevention of urinary tract infections in women." *Bmj* 322.7302 (2001): 1571.
19. Stapleton, A. E., Dziura, J., Hooton, T. M., Cox, M. E., Yarova-Yarovaya, Y., Chen, S., & Gupta, K. "Recurrent urinary tract infection and urinary Escherichia coli in women ingesting cranberry juice daily: a randomized controlled trial." *Mayo Clinic Proceedings*. Vol. 87. No. 2. Elsevier, 2012.
20. Di Martino, P., Agniel, R., David, K., Templer, C., Gaillard, J. L., Denys, P., & Botto, H. "Reduction of Escherichia coli adherence to uroepithelial bladder cells after consumption of cranberry juice: a double-blind randomized placebo-controlled cross-over

- trial." *World Journal of urology* 24.1 (2006): 21-27.
21. Lenger, S. M., Bradley, M. S., Thomas, D. A., Bertolet, M. H., Lowder, J. L., & Sutcliffe, S. "D-mannose vs other agents for recurrent urinary tract infection prevention in adult women: a systematic review and meta-analysis." *American journal of obstetrics and gynecology* 223.2 (2020): 265-e1.
22. Hooton, T. M., Vecchio, M., Iroz, A., Tack, I., Dornic, Q., Seksek, I., & Lotan, Y. "Effect of increased daily water intake in premenopausal women with recurrent urinary tract infections: a randomized clinical trial." *JAMA internal medicine* 178.11 (2018): 1509-1515.
23. Advani, S. D., Polage, C. R., & Fakh, M. G. "Deconstructing the urinalysis: a novel approach to diagnostic and antimicrobial stewardship." *Antimicrobial Stewardship & Healthcare Epidemiology* 1.1 (2021): e6.
24. Tan-Kim, J., Shah, N. M., Do, D., & Menefee, S. A. "Efficacy of vaginal estrogen for recurrent urinary tract infection prevention in hypoestrogenic women." *American journal of obstetrics and gynecology* 229.2 (2023): 143-e1.
25. Stamm, W. E. "Estrogens and urinary-tract infection." *The Journal of infectious diseases* 195.5 (2007): 623-624.
26. Šimunić, V., Banović, I., Ciglar, S., Jeren, L., Baldani, D. P., & Šprem, M. "Local estrogen treatment in patients with urogenital symptoms." *International Journal of Gynecology & Obstetrics* 82.2 (2003): 187-197.
27. Werneburg, G. T., & Rhoads, D. D. "Diagnostic stewardship for urinary tract infection: a snapshot of the expert guidance." *Cleve Clin J Med* 89.10 (2022): 581-587.

Source of support: Nil; **Conflict of interest:** Nil.

Cite this article as:

Hamdulla, M. H., Habbas, M. H. & Hilal, M. M. "Assessment of the Health Outcomes of Urinary Tract Infection Management in Children through Prevention and Treatment Strategies" *Sarcouncil Journal of Medical Series* 5.3 (2026): pp 1-9.