Urinary Tract Infections in Pediatric Age: A 5-Year Hospital-Based Retrospective Study

Inês Medeiros de Carvalho[1], Carolina Simão[1], Beatriz Fraga[1], Joana Rosa[1], Marta Mendonça[1], Lucinda Pacheco[1], Augusta Arruda[1]*

1. Pediatrics Department, Hospital do Divino Espírito Santo, Ponta Delgada, Azores, Portugal

https://doi.org/10.71749/pkj.108

Abstract

Introduction: Urinary tract infections are the second most common bacterial infections in pediatric patients. Understanding local antibiotic resistance patterns is essential for appropriate therapeutic decision-making. This study aims to determine the prevalence and antibiotic susceptibility profile of microorganisms responsible for urinary tract infections in a Level II Hospital, to enhance empirical antibiotic prescription and prevent resistance.

Methods: A retrospective and descriptive study was conducted by reviewing the medical records of patients aged 0–17 years diagnosed with urinary tract infections, confirmed by urinary sediment with >5 leukocytes/field and microorganism identification in urine culture, between 2018 and 2022 in the Pediatric Department. Patients with nephro-urological malformations, positive urine cultures with inactive sediment, and asymptomatic bacteriuria were excluded. Urine samples collected using collection bags were also excluded.

Results: A total of 976 patients were included, with a predominance of females observed across all age groups, except during the first year of life, in which males exhibited a higher prevalence. *Escherichia coli* was the most frequently isolated microorganism across all age groups, with a sensitivity of 97.7% to cefuroxime-axetil and a resistance rate of 28.1% to amoxicillin-clavulanic acid. In the adolescent population, *Staphylococcus saprophyticus* demonstrated a prevalence similar to that of *Escherichia coli. Staphylococcus saprophyticus* exhibited nearly 94% sensitivity to amoxicillin-clavulanic acid and intrinsic resistance to fosfomycin.

Conclusion: *Escherichia coli* remains the primary etiological agent of urinary tract infections, with a prevalence nearly equivalent to that of *Staphylococcus saprophyticus* in adolescence, findings consistent with the literature. Considering the antimicrobial resistance pattern observed in our institution, empirical therapy should involve cefuroxime axetil until 12 years of age, followed by amoxicillin-clavulanic acid in older patients. Our findings highlight the importance of continuous monitoring of antibiotic susceptibility patterns to optimize empirical urinary tract infections management and reduce future resistance rates.

Keywords: Anti-Bacterial Agents; Child; Drug Resistance, Microbial; Microbial Sensitivity Tests; Urinary Tract Infections/drug therapy

INTRODUCTION

Urinary tract infection (UTI) is the second most common cause of bacterial infections in pediatric patients, often leading parents to seek emergency care. Its incidence is higher in males during the first year of life, after which it becomes more prevalent in females.[1-4]

The most common etiological agents of pediatric UTIs are Gram-negative bacteria, with *Escherichia coli (E. coli)* being the most prevalent microorganism, responsible for approximately 53%–83% of cases. Other pathogens include *Klebsiella* spp., *Proteus* spp., and *Enterococcus* spp.[5-9]

Despite variations in antibiotic susceptibility, a considerable resistance rate to commonly prescribed antibiotics remains a significant concern. *E. coli* exhibits significant resistance to ampicillin (69.8%–87%) and first-generation cephalosporins such as cefazolin (15%–62%). Resistance to trimethoprim-sulfamethoxazole is also high, ranging from 24% to 44%.[5-9]

Early empirical treatment should be initiated promptly to prevent renal parenchymal damage and potential long-term sequelae. The decision regarding empirical antibiotic therapy should consider the antibiotic susceptibility patterns of the most commonly isolated local bacteria and be adjusted based on urine culture and antimicrobial susceptibility test

Received: 25/08/2025 **Accepted:** 28/01/2026 **Published Online:** 05/02/2026 **Published:**-

* **Corresponding Author:** Inês Carvalho | ines95carvalho@gmail.com | Av. D. Manuel I, 9500-370 Ponta Delgada, Portugal

results.[1-4,10,11] The findings of this study may contribute to mitigating antimicrobial resistance and promoting a more evidence-based empirical prescription approach.

According to the European Centre for Disease Prevention and Control, Portugal is among the European countries with the highest antibiotic resistance rates.[12] The National Program for the Prevention of Antimicrobial Resistance, established in November 2009, aims to reduce antimicrobial resistance rates nationwide.[13]

The objective of this study was to assess the prevalence of etiological agents responsible for pediatric UTIs at Hospital do Divino Espírito Santo Ponta Delgada (HDES) in Azores, as well as their antibiotic susceptibility profiles, in order to reduce broad-spectrum antibiotic prescriptions and, consequently, minimize antimicrobial resistance.

MATERIAL AND METHODS

This study is a retrospective analysis of pediatric patients diagnosed with urinary tract infections between 2018 and 2022 at the Pediatrics Department of HDES. The Ethical Committee authorized this study in accordance to institutional guidelines. Informed consent was waived, due to the retrospective and non-interventional nature of the study.

Participants

All patients aged 0 to 17 years with UTI, confirmed by urinary sediment (US) with >5 leukocytes/field and a positive urine culture (UC). Cases with nephro-urological malformations, positive UC with inactive sediment, and asymptomatic bacteriuria were excluded. Urine samples collected using collection bags were also excluded.

Variables and Outcomes

Data were collected from patients' medical records (Glint®) and the microbiology department of HDES. The analyzed variables included demographic data (age, gender), clinical data (personal nephro-urological history and symptomatology), laboratory data (urinalysis type II, urine culture, and antibiotic susceptibility testing), and therapeutic data (empirical antibiotic therapy). The primary outcome was antibiotic sensitivity.

Definitions

Nephro-urological malformations included vesicoureteral reflux, neurogenic bladder, chronic catheterization, junction syndrome, pyelocaliceal duplication, nephrectomy, chronic renal failure, single kidney and ectopic kidneys.

Inactive sediment is a sediment with < 5 leukocytes/field.

Asymptomatic bacteriuria is the absence of signs or symptoms of a UTI in a patient whose urine culture meets the criteria for a UTI.[11]

Statistical Methods

Categorical variables were summarized as absolute counts and corresponding percentages. Data analysis and the generation of tables and figures were conducted using Microsoft Excel and Word 2010.

RESULTS

Of the initial 1626 cases identified, 368 were excluded due to nephro-urological pathology and 282 due to normal urinary sediment or absence of urinary sediment analysis, resulting in a final cohort of 976 patients.

Females predominated overall (80.5%) across all age groups, except during the first three months of life, when UTIs were more frequent in males (79% *vs* 21%) (Table 1). Most cases were diagnosed in the emergency department (95%), followed by outpatient consultations (3.5%), while the remaining 1.5% originated from inpatient wards, the neonatal unit, the neonatal intensive care unit, and other services (Table 1).

Table 1. Baseline patient characteristics

Characteristics	Total
Absolute number – n (%)	976 (100)
2018	225 (23)
2019	256 (26)
2020	180 (18)
2021	194 (20)
2022	121 (13)
Age (median in years)	6,8
Age groups	n (%)
< 3 months	38 (3.9)
3- <12 months	84 (8.6)
12- 24 months	135 (13.8)
>24 months- 5 years	200 (20.5)
6-12 years	211 (21.6)
>12 years	308 (31.6)
Female gender – n (%)	786 (80.5)
Female gender by age groups	n (%)
< 3 months	8 (21)
3- <12 months	45 (53)
12- 24 months	104 (77)
>24 months- 5 years	168 (84)
6-12 years	180 (85)
>12 years	281 (91)
Origin of cases	n (%)
Emergency department	927 (95)
Outpatient consultation	34 (3.5)
Inpatient care	6 (0.6)
Neonatal unit	2 (0.2)
Neonatal intensive care unit	2 (0.2)
Others	5 (0.5)

Analysis of uropathogen distribution according to age and sex (Table 2) showed that *Escherichia coli* was the most frequently isolated microorganism, accounting for 59% of all cases, followed by *Proteus mirabilis* (15.9%) and *Staphylococcus saprophyticus* (13.5%). During the first three months of life, UTIs were more common in males, with *E. coli* predominating in boys (75%) compared with girls (25%). Between 3 and 12 months of age*, E. coli* remained the leading pathogen in both sexes, although it was proportionally more frequent in females (70%) than in males (30%).

Table 2. Distribution of the pathogens by age groups

	PATHOGENS - n (%)									
	E. coli	P. mirabilis	S. saprophyticus	K. pneumoniae	P. aeruginosa	M. morganii	S. marcescens	Others	Total	
AGE GR		28 (2.9)	1 (0.1)	0	2 (0.2)	0	3 (0.3)	2 (0.2)	2 (0.2)	38 (3.9)
	3-12 m	99 (10.1)	18 (1.8)	0	4 (0.4)	0	3 (0.3)	1 (0.1)	15 (1.5)	140 (14.3)
	>12- 24 m	37 (3.8)	36 (3.7)	0	1 (0.1)	3 (0.3)	0	0	2 (0.2)	79 (8.1)
	>24 m- 5 A	121 (12.4)	56 (5.7)	4 (0.4)	6 (0.6)	6 (0.6)	0	0	7 (0.7)	200 (20.5)
	6-12 A	149 (15.3)	20 (2.1)	19 (1.9)	8 (0.8)	0	0	0	15 (1.5)	211 (21.6)
	>12 A	142 (14.5)	25 (2.6)	109 (11.2)	11 (1.1)	1 (0.1)	0	1 (0.1)	19 (1.9)	308 (31.6)
	Total	576 (59)	156 (15.9)	132 (13.6)	32 (3.3)	10 (1)	6 (0.6)	4 (0.4)	60 (6.1)	976 (100)

Between 12 and 24 months, a clear sex-related difference emerged: *E. coli* remained the most frequent pathogen in females (55.9%), whereas *Proteus mirabilis* predominated in males (80.0%), exceeding *E. coli* (20.0%). This pattern persisted between 24 months and 5 years of age. In females, *E. coli* accounted for 66.7% of isolates and *P. mirabilis* for 22.0%; conversely, in males, *P. mirabilis* was the most common isolate (59.4%), followed by *E. coli* (28.1%). Thus, while *E. coli* remained dominant in girls between 12 months and 5 years, *P. mirabilis* was comparatively more prevalent in boys throughout the same period.

In adolescence (>12 years), a marked sex-related difference was observed, with *Staphylococcus saprophyticus* becoming a prominent uropathogen, representing approximately 35% of isolates and occurring almost exclusively in females. *E. coli* remained prevalent in adolescents of both sexes but was proportionally less dominant in females due to the increased contribution of *S. saprophyticus*. Other microorganisms, including *Klebsiella pneumoniae, Pseudomonas aeruginosa, Morganella morganii*, and *Serratia marcescens,* were infrequently isolated and showed no consistent sex-related distribution pattern.

Regarding antimicrobial susceptibility, *E. coli* exhibited high sensitivity to cefuroxime-axetil (97.7%) and a resistance rate of 28.1% to amoxicillin-clavulanic acid. Cefuroxime-axetil demonstrated the highest overall sensitivity across most studied microorganisms (90%) (Table 3). In adolescents, *Staphylococcus saprophyticus* showed sensitivity to amoxicillin-clavulanic acid of nearly 94% and intrinsic resistance to fosfomycin (Table 4). Over the five-year study period, a significant increase in antimicrobial resistance was observed, with resistance to fosfomycin rising from 21.8% to 49.6% and resistance to ceftriaxone increasing from 0.4% to 10.7% (Table 5).

Table 3. Distribution of pathogens by antibiotic sensitivity

		Antibiotic - n (%)													
		Amoxicillin + clavulanic acid		Cefuroxime		Cefuroxime axetil		Fosfomycin		Nitrofurantoin		Ceftriaxone		Cefotaxime	
		R	S	R	S	R	S	R	S	R	S	R	S	R	S
PATHOGENS	E. coli	162 (28)	414 (72)	13 (2.3)	563 (97.7)	13 (2.3)	563 (97.7)	4 (1)	572 (99)	0	576 (100)	6 (1.1)	570 (98.9)	1 (0.2)	575 (99.8)
	P. mirabilis	11 (7.1)	145 (92.9)	1 (0.7)	155 (99.3)	1 (0.7)	155 (99.3)	24 (15.4)	132 (84.6)	118 (75.6)	38 (24.4)	0	156 (100)	1 (0.7)	155 (99.3)
	S. saprophyticus	7 (5.3)	125 (94.7)	3 (2.3)	129 (97.7)	1 (0.8)	131 (99.2)	132 (100)	0	0	132 (100)	3 (2.3)	129 (97.7)	3 (2.3)	129 (97.7)
	K. pneumoniae	13 (40.6)	19 (59.4)	1 (3.2)	31 (96.8)	1 (3.2)	31 (96.8)	4 (12.5)	28 (87.5)	1 (3.2)	31 (96.8)	1 (3.2)	31 (96.8)	1 (3.2)	31 (96.8)
	P. aeruginosa	N/A		N/A		N/A		2 (20)	-	N/A		N/A		N/A	
	M. morganii	6 (100)	0	N/A		4 (66.7)	-	4 (66.7)	-	4 (66.7)	-	-	2 (33.3)	0	6 (100)
	S. marcescens	4 (100)	0	N/A		2 (50)	-	-	2 (50)	2 (50)	-	-	2 (50)	2 (50)	2 (50)

Legend: R- resistance / S- sensitivity / N/A- not tested /- no results

Table 4. Distribution of most frequent pathogens by antibiotic sensitivity and age groups

			ANTIBIOTIC - n (%)													
			Amoxicillin + clavulanic acid		Cefuroxime		Cefuroxime axetil		Fosfomycin		Nitrofurantoin		Ceftriaxone		Cefotaxime	
			R	S	R	S	R	S	R	S	R	S	R	S	R	S
PATHOGENS	E. coli	< 3 m	11 (39.3)	17 (60.7)	0	28 (100)	0	28 (100)	0	28 (100)	0	28 (100)	0	28 (100)	0	28 (100)
		3-12 m	27 (27.3)	72 (72.7)	1 (1)	98 (99)	1 (1)	98 (99)	0	99 (100)	0	99 (100)	1 (1)	98 (99)	0	99 (100)
			12 (32.4)	25 (67.6)	2 (5.4)	35 (94.6)	2 (5.4)	35 (94.6)	1 (2.7)	36 (97.3)	0	37 (100)	0	37 (100)	1 (2.7)	36 (97.3)
		>24 m- 5A	32 (26.4)	89 (73.6)	0	121 (100)	0	121 (100)	1 (0.8)	120 (99.2)	0	121 (100)	0	121 (100)	0	121 (100)
			48 (32.2)	101 (67.8)	5 (3.4)	144 (96.6)	5 (3.4)	144 (96.6)	1 (0.7)	148 (99.3)	0	149 (100)	3 (2)	146 (98)	0	149 (100)
		>12 A	32 (22.5)	110 (77.5)	5 (3.5)	137 (96.5)	5 (3.5)	137 (96.5)	1 (0.7)	141 (99.3)	0	142 (100)	2 (1.4)	140 (98.6)	0	142 (100)
	P. mirabilis	< 3 m	0	1 (100)	0	1 (100)	0	1 (100)	-	-	-	-	0	1 (100)	0	1 (100)
			1 (5.6)	17 (94.4)	0	18 (100)	0	18 (100)	5 (27.8)	13 (72.2)	15 (83.3)	3 (16.7)	0	18 (100)	0	18 (100)
		>12- 24 m	3 (8.3)	33 (91.7)	0	36 (100)	0	36 (100)	3 (8.3)	33 (91.7)	26 (72.2)	10 (27.8)	0	36 (100)	0	36 (100)
		>24 m- 5A	3 (5.4)	53 (94.6)	0	56 (100)	0	56 (100)	11 (19.6)	45 (80.4)	45 (80.4)	11 (19.6)	0	56 (100)	0	56 (100)
			1 (5)	19 (95)	1 (5)	19 (95)	1 (5)	19 (95)	4 (20)	16 (80)	15 (75)	5 (25)	0	20 (100)	1 (5)	19 (95)
		>12 A	3 (12)	22 (88)	0	25 (100)	0	25 (100)	1 (4)	24 (96)	17 (68)	8 (32)	0	25 (100)	0	25 (100)
	S. saprophyticus	< 3 m	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		3-12 m	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		>12- 24 m	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		>24 m- 5A	0	4 (100)	0	4 (100)	0	4 (100)	4 (100)	0	0	4 (100)	0	4 (100)	0	4 (100)
		6-12 A	0	19 (100)	0	19 (100)	-	-	19 (100)	0	0	19 (100)	0	19 (100)	0	19 (100)
		>12 A	7 (6.4)	102 (93.6)	3 (2.8)	106 (97.2)	1 (0.9)	108 (99.1)	109 (100)	0	0	109 (100)	3 (2.8)	106 (97.2)	3 (2.8)	106 (97.2)

Legend: R- resistance / S- sensitivity / N/A- not tested /- no results

Table 5. Distribution of antibiotic sensitivity by years

		ANTIBIOTIC - n (%)													
		Amoxicillin + clavulanic acid		Cefuroxime		Cefuroxime axetil		Fosfomycin		Nitrofurantoin		Ceftriaxone		Cefotaxime	
		R	S	R	S	R	S	R	S	R	S	R	S	R	S
YEARS	2018	49 (21.8)	176 (78.2)	5 (2.2)	220 (97.8)	10 (4.4)	215 (95.6)	49 (21.8)	176 (78.2)	37 (16.4)	188 (83.6)	1 (0.4)	224 (99.6)	1 (0.4)	224 (99.6)
	2019	66 (25.8)	190 (74.2)	5 (2)	251 (98)	7 (2.7)	249 (97.3)	56 (21.9)	200 (78.1)	65 (25.4)	191 (74.6)	7 (2.7)	249 (97.3)	1 (0.4)	255 (99.6)
	2020	41 (22.8)	139 (77.2)	5 (2.8)	175 (97.2)	5 (2.8)	175 (97.2)	46 (25.6)	134 (74.4)	35 (19.4)	145 (80.6)	7 (3.9)	173 (96.1)	3 (1.7)	177 (98.3)
	2021	46 (23.7)	148 (76.3)	4 (2)	190 (98)	7 (3.6)	187 (96.4)	66 (34)	128 (66)	51 (26.3)	143 (73.7)	6 (3)	188 (97)	2 (1)	192 (99)
	2022	26 (21.5)	95 (78.5)	3 (2.5)	118 (97.5)	5 (4.1)	116 (95.9)	60 (49.6)	61 (50.4)	42 (34.7)	79 (65.3)	13 (10.7)	108 (89.3)	3 (2.5)	118 (97.5)

Legend: R- resistance / S- sensitivity / N/A- not tested /- no results

DISCUSSION

Urinary tract infections (UTIs) remain a significant concern in pediatric patients, representing the second most common bacterial infection in this age group.[14] Our study confirms the predominance of *E. coli* (59%) as the leading causative microorganism, followed by *Proteus mirabilis* (15.9%) and *Staphylococcus saprophyticus* (13.6%). These findings are consistent with previous reports identifying *E. coli* as the most frequent etiological agent in pediatric UTIs, with prevalence rates ranging from 53% to 83%.[14-15]

A distinct sex-related distribution was observed. Although females predominated overall (80.5%), a higher prevalence of UTIs was found in males during the first year of life. This pattern supports existing evidence suggesting an increased susceptibility in male infants, likely related to anatomical and physiological factors.[16] After the first year of life, the prevalence shifted towards females, which may be explained by anatomical differences and greater vulnerability to ascending infections.[15-17]

A particularly relevant finding was the age- and sex-related variation in pathogen distribution between 12 months and 5 years of age. In this period, *Proteus mirabilis* became comparatively more prevalent than *E. coli* in males, accounting for a substantial proportion of isolates. In contrast, among females in the same age range, *E. coli* remained the predominant pathogen, with *P. mirabilis* contributing to a smaller proportion of infections. In adolescence, *Staphylococcus saprophyticus* showed a marked increase in prevalence (35%), nearly equaling *E. coli* in frequency. These findings underscore the importance of age- and sex-specific considerations when selecting empirical antibiotic therapy, as the distribution of causative pathogens varies across pediatric age groups.[18]

Antimicrobial resistance remains a major concern in pediatric UTIs. In our cohort, *E. coli* demonstrated high sensitivity to cefuroxime-axetil (97.7%) but showed a considerable resistance rate to amoxicillin-clavulanic acid (28.1%). These results align with global trends reporting increasing resistance of *E. coli* to commonly used antibiotics, particularly beta-lactams.[18,19] Additionally, *Staphylococcus saprophyticus* isolates in adolescents exhibited high sensitivity to amoxicillin-clavulanic acid (approximately 95%) but intrinsic resistance to fosfomycin, highlighting the need for careful antibiotic selection in this population.[19]

The consistently high sensitivity of cefuroxime-axetil (90%) across most isolated microorganisms supports its use as a first-line empirical treatment for pediatric UTIs up to 12 years of age. Conversely, given the increased prevalence of *Staphylococcus saprophyticus* in adolescents and its favorable susceptibility profile to amoxicillin-clavulanic acid, this agent may represent a more appropriate empirical option in older patients. These findings reinforce the importance of continuous surveillance of local resistance patterns to guide empirical antibiotic choices and reduce the risk of treatment failure and further resistance development.[20]

Finally, our study highlights that the majority of pediatric UTI cases were managed in the emergency department (95%), with fewer cases addressed in outpatient clinics (3.5%) or inpatient settings (1.5%). This distribution raises important considerations regarding access to and adequacy of primary care services for pediatric UTI management. Strengthening outpatient diagnostic pathways and early treatment strategies may help reduce emergency department utilization while ensuring timely and effective care.[16]

Limitations

Although this study provides important insights into the epidemiological profile and antibiotic resistance patterns of pediatric urinary tract infections, certain limitations warrant consideration. The retrospective nature of the study may introduce selection bias, and data collection from electronic records may lead to missing information. Additionally, we did not evaluate the clinical outcomes of different antibiotic regimens, which could provide further evidence on the effectiveness of specific treatments.

Future research should focus on longitudinal analyses to assess trends in antibiotic resistance over time and the impact of recurrent UTIs on resistance patterns. Investigating factors such as previous antibiotic exposure, underlying conditions, and treatment adherence could help refine empirical antibiotic prescribing and strengthen strategies for preventing antimicrobial resistance.[21]

CONCLUSION

This study reinforces the predominance of *E. coli* as the main causative agent of pediatric UTIs, with a notable increase in *Staphylococcus saprophyticus* prevalence in adolescence. The observed resistance patterns highlight the importance of tailoring empirical antibiotic therapy based on local epidemiological data. Cefuroxime-axetil remains the preferred choice for children up to 12 years, while amoxicillin-clavulanic acid may be more suitable for adolescents. Continuous surveillance and adherence to antimicrobial stewardship programs are essential to optimize treatment and mitigate antibiotic resistance in pediatric UTIs.[13] Furthermore, given the intrinsic resistance of *Staphylococcus saprophyticus* to fosfomycin, future studies are warranted to assess the appropriateness of its use in empirical treatment, particularly in adolescents where this pathogen is more prevalent.

LEARNING POINTS

Escherichia coli remains the leading cause of pediatric UTIs, but *Staphylococcus saprophyticus* shows increasing prevalence in adolescents.

Local resistance patterns should guide empirical therapy: cefuroxime-axetil is most effective in children up to 12 years, while amoxicillin-clavulanic acid is suitable for adolescents.

Rising resistance to fosfomycin highlights the need for cautious antibiotic use.

Continuous surveillance and adherence to antimicrobial stewardship programs are essential to optimize treatment, reduce broad-spectrum antibiotic use, and mitigate resistance in pediatric urinary tract infections.

Ethical Disclosures

Conflicts of Interest: The authors have no conflicts of interest to declare.
Financing Support: This work has not received any contribution, grant or scholarship
Confidentiality of Data: The authors declare that they have followed the protocols of their work center on the publication of patient data.
Protection of Human and Animal Subjects: The authors declare that the procedures followed were in accordance with the regulations of the relevant clinical research ethics committee and those of the Code of Ethics of the World Medical Association (Declaration of Helsinki as revised in 2024).
Provenance and Peer Review: Not commissioned; externally peer-reviewed.

Contributorship Statement

IC and CS: Performed data collection, data analysis and interpretation, and wrote the manuscript.
AA: Assisted in data elaboration.
AA, BF, JR, MM and LP: Revised the manuscript.
All authors approved the final version to be published.

REFERENCES

1. Shaikh N, Hoberman A. Acute management, imaging, and prognosis of urinary tract infections in children. [accessed Dec 2024] Available at: http://www.uptodate.com.
2. National Institute for Health and Care Excellence. Urinary tract infection in under 16s: diagnosis and management. [accessed Dec 2024] Available at: https://www.nice.org.uk/guidance/ng224/chapter/Recommendations
3. C. Ochoa Sangrador, S. Málaga Guerrero, Recomendaciones de la Conferencia de Consenso "Manejo Diagnóstico y Terapéutico de las Infecciones del Tracto Urinario en la Infancia. An Pediatr. 2007;67:517-25. doi: 10.1016/S1695-4033(07)70718-X.
4. Cincinati Children's Hospital Medical Center. First urinary tract infection in children 12 years of age or less: UTI Guideline Team. [accessed Dec 2024] Available at: https://www.cincinnatichildrens.org/health/u/uti-prevention
5. Samanci S, Pınarbaşı AS. Microbial etiology and antibiotic resistance in urinary tract infections in children; view from an area where antibiotics are overused. Eur Rev Med Pharmacol Sci. 2023;27:7680-7. doi: 10.26355/eurrev_202308_33421.
6. Shrestha LB, Baral R, Poudel P, Khanal B. Clinical, etiological and antimicrobial susceptibility profile of pediatric urinary tract infections in a tertiary care hospital of Nepal. BMC Pediatr. 2019;19:36. doi: 10.1186/s12887-019-1410-1.
7. Edlin RS, Shapiro DJ, Hersh AL, Copp HL. Antibiotic resistance patterns of outpatient pediatric urinary tract infections. J Urol. 2013;190:222-7. doi: 10.1016/j.juro.2013.01.069.
8. Pouladfar G, Basiratnia M, Anvarinejad M, Abbasi P, Amirmoezi F, Zare S. The antibiotic susceptibility patterns of uropathogens among children with urinary tract infection in Shiraz. Medicine. 2017;96:e7834. doi: 10.1097/MD.0000000000007834.
9. Kurt-Şükür ED, Özçakar ZB, Doğan Ö, Öztürk M, Karaman M, Çakar N, Güriz H, Yalçınkaya F. The changing resistance patterns of bacterial uropathogens in children. Pediatr Int. 2020;62:1058-63. doi: 10.1111/ped.14270.
10. Teixeira A, Jardim H. Infeção urinária na criança ou sobre o conhecimento tácito e a medicina baseada na evidência. Acta Pediatr Port 2009:40:LXXXI-IV.
11. Direção-Geral da Saúde. Diagnóstico e Tratamento da Infeção do Trato Urinário em Idade Pediátrica. Lisboa: DGS;2012.
12. European Antimicrobial Resistance Surveillance Network. Antimicrobial resistance surveillance in Europe: Annual report of the European Antimicrobial Resistance Surveillance Network (EARS-Net). [accessed Dec 2024] Available at: https://www.ecdc.europa.eu/en/about-us/networks/disease-networks-and-laboratory-networks/ears-net-data
13. Direção-Geral da Saúde. Programa Nacional de Prevenção das Resistências aos Antimicrobianos (PNPRA) 2019–2023. Lisboa: DGS; 2019.
14. Shaikh N, Morone NE, Bost JE, Farrell MH. Prevalence of urinary tract infection in childhood: a meta-analysis. Pediatr Infect Dis J. 2008;27:302–8. doi: 10.1097/INF.0b013e31815e4122.
15. Zorc JJ, Kiddoo DA, Shaw KN. Diagnosis and management of pediatric urinary tract infections. Clin Microbiol Rev. 2005;18:417–22. doi: 10.1128/CMR.18.2.417-422.2005.
16. Freedman AL. Urologic diseases in North America Project: trends in resource utilization for urinary tract infections in children. J Urol. 2005;173:949–54. doi: 10.1097/01.ju.0000152092.03931.9a.
17. Montini G, Tullus K, Hewitt I. Febrile urinary tract infections in children. N Engl J Med. 2011;364:239–50. doi: 10.1056/NEJMra1007755.
18. Bryce A, Hay AD, Lane IF, Thornton HV, Wootton M, Costelloe C. Global prevalence of antibiotic resistance in paediatric urinary tract infections caused by Escherichia coli and association with routine use of antibiotics in primary care: systematic review and meta-analysis. BMJ. 2016;352:i939. doi: 10.1136/bmj.i939.
19. Dulek DE, Mueller EL. Antibiotic Resistance and Its Clinical Impact in Pediatric Infections. Curr Opin Pediatr. 2019;31:115–23.
20. Linhares I, Raposo T, Rodrigues A, Almeida A. Frequency and antimicrobial resistance patterns of bacteria implicated in community urinary tract infections: a ten-year surveillance study (2000–2009). BMC Infect Dis. 2013;13:19. doi: 10.1186/1471-2334-13-19.
21. European Centre for Disease Prevention and Control (ECDC). Surveillance of antimicrobial resistance in Europe 2022 – 2020 data. Stockholm: ECDC; 2022.