Scientific Research Publishing

Journal of Biosciences and Medicines, 2024, 12, 85-93
https://www.scirp.org/journal/jbm
ISSN Online: 2327-509X
ISSN Print: 2327-5081

Urinary Tract Infection in Pediatric Emergency Department of Mohamed VI Hospital in Marrakech: Epidemiological Profile and Antibiotic Resistance

Radia Laanait[1], Soufiane Elmoussaoui[2], Widad Lahmini[1,2], Mounir Bourrous[1,3]

[1]Pediatric Emergency Department, Mother and Child Hospital, University Hospital Mohammed VI, Marrakesh, Morocco
[2]Laboratory Childhood, Health and Development, Faculty of Medicine and Pharmacy, Cadi Ayyad University, Marrakech, Morocco
[3]Laboratory for Infectious Disease Control, Faculty of Medicine and Pharmacy, Cadi Ayad University, Marrakech, Morocco
Email: radia92laanait@gmail.com

How to cite this paper: Laanait, R., Elmoussaoui, S., Lahmini, W. and Bourrous, M. (2024) Urinary Tract Infection in Pediatric Emergency Department of Mohamed VI Hospital in Marrakech: Epidemiological Profile and Antibiotic Resistance. *Journal of Biosciences and Medicines*, **12**, 85-93.
https://doi.org/10.4236/jbm.2024.126009

Received: April 29, 2024
Accepted: June 11, 2024
Published: June 14, 2024

Abstract

Background: Urinary tract infection (UTI) is one of the most frequent bacterial infections in pediatrics. The aim of our work was to establish the epidemiological and bacteriological profile of UTIs in children and then to study the sensitivity of the bacterial strains isolated to antibiotics. Materials and methods: This is a retrospective descriptive study over 3 years (2019-2022), including all cytobacteriological examination of urine (CBEU), performed in children aged 3 months to 14 years, admitted and treated for UTI, in the pediatric emergency department of Mohamed VI University Hospital. Results: A total of 239 children were included in our study. The mean age was 26 months. The sex ratio was 1.08. *Escherichia coli* was the most isolated bacterial strain in 79% of samples. The tested strains showed a high level of sensitivity to susceptibility rate toward amikacin (91%) and ciprofloxacin (100%) and whereas the level of resistance was high to the most current recommended antibiotics, mainly beta-lactams. Management was based, in severe forms of pyelonephritis, dual antibiotic therapy based on Third-generation cephalosporins combined with gentamycin. Favorable outcome was noted in 94% of children. Conclusion: Awareness-raising on the proper use of antibiotics, issuing national recommendations for the treatment of urinary tract infections in order to standardize therapeutic regimens is strongly recommended. Effective control of these infections requires a global prevention strategy that implies close collaboration between epidemiologists, clinicians, bacteriologists, hygienists and the health care team.

Keywords

Child, Urinary Tract Infection, Bacteria, Antibiotics, Resistances

1. Introduction

Urinary tract infection is one of the most common bacterial infections in pediatrics [1] [2]. Before the age of 8, 7% - 8% of girls and 2% of boys have already had a UTI [2] [3]. These are acute cystitis or pyelonephritis. The latter can lead to parenchymal renal scarring and, in the long term, to arterial hypertension, nephron reduction or proteinuria, particularly in the case of frequent recurrences [2] [3] [4]. The diagnosis of UTI is classically based on the association of suggestive clinical signs, significant bacteriuria and leukocyturia [2] [3] [5].

Urine cytobacteriological examination (CBEU) is the key element in the diagnosis of UTI, but it is often not easy to perform. What's more, in current practice, antibiogram results are only available at least forty-eight hours after the CBEU has been performed [6]. The most frequently incriminated germ is *Escherichia coli*, from the *Enterobacteriaceae* family [1] [7]. Treatment of UTIs is generally empirical, leading to frequent therapeutic failures with antibiotics prescribed as first-line treatment [5] [7]. This failure is exacerbated by the emergence and increasing frequency of germ resistance to these antibiotics [6] [7], thus reducing therapeutic possibilities.

Monitoring bacterial resistance is therefore essential for updating first-line treatment protocols. The aim of this study was to determine the epidemiology, bacterial etiology and evolution of urinary tract infections, as well as their sensitivity to antibiotics, with a view to improving the management of this pathology in children.

2. Materials and Methods

2.1. Subjects

This is a 3-year period retrospective study from January 2019 to January 2022. The study included all children aged 3 months to 14 years admitted and treated for urinary tract infection in the emergency department of the University Hospital Mohammed VI of Marrakech (Morocco).

2.2. Sample Collection and Bacterial Identification

An appropriate volume of urine sample was collected with aseptic technique, either in a sterile bag or in the middle of the stream in the majority of children. In the laboratory, as soon as urine samples were received, technicians checked their compliance with the requirements of the medical microbiology reference document (REMIC). Compliant urine was processed in accordance with medical microbiology guidelines (REMIC). We used BrillanceTM UTI Agar chromogenic culture medium (Oxoid) for culture, UF-1000iTM (Sysmex) for urinary cytolo-

gy, and BD PhoenixTM 100 (Becton Dickinson) for identification of isolated bacteria. Antibiotic susceptibility testing was carried out in accordance with the recommendations of the French Microbiology Society's Antibiotic Susceptibility Committee (CA-SFM).

The results were interpreted in accordance with the recommendations of the medical microbiology guidelines (REMIC). The positivity of a CBEU was based on the Kass criteria, defined by the presence of leukocytes with a number greater than or equal to 104 elements/ml and bacteriuria greater than 105 germs/ml with the presence of a single bacterial species. Excluded from this study are infections caused by specific germs such as mycobacteria, parasites, and fungi.

2.3. Statistical Analysis

Data were entered into Epi-data version 3.2.1 and exported to the Statistical Package for the Social Science (SPSS) version 20 statistical software.

3. Results

The number of UTI episodes recorded during our study period was 239. The average age of the children was 26 months, with extremes ranging from 3 months to 14 years. The 3 months to 2 years age group was the most affected, accounting for 45.5% of cases. Females accounted for 52% of cases, for a sex ratio of 1.08. Children from low socio-economic backgrounds accounted for 35%, those from middle socio-economic backgrounds for 45%, and only 20% had healthcare coverage (Table 1).

Urine dipstick tests were carried out in 70% of children. Culture results were dominated by Gram-negative bacilli, led by *Escherichia coli (E. coli)*, present in 79% of children. *Klebsiella* came second with 11% and *Proteus* represented 2% of germs. Gram-positive bacteria were represented by: *Enterococcus*, *Pseudomonas* and *Staphylococcus aureus* representing 6%, 2% and 0.8% of germs, respectively (Table 2).

The sensitivity of *Escherichia coli* to ampicillin was tested in only 30% of cases, all of which were resistant to this molecule. The rate of resistance to amoxicillin, amoxicillin-clavulanic acid (ACA) and sulfamethoxazole (SMX) was 77.2%, 15.8% and 35.1% respectively. No resistant strains to quinolones were observed in our study. Third-generation cephalosporins (C3G) and aminoglycosides remain the most active molecules on *E. coli* in our study, with resistance rates of 7% and 8.8% respectively (Figure 1).

Table 1. Sociodemographic characteristics of the study subjects.

Variables	n	Percentage
Sex		
Male	115	48%
Female	124	52%

Continued

Age		
3 months - 2 years	109	45.6%
3 - 5 years	64	26.8%
6 - 8 years	39	16.3%
Residence		
Urban	157	65.6%
Rural	82	34.4%
Socio-economic status		
Low	84	35%
Middle	107	45%
Healthcare coverage		
With	48	20%
Without	191	80%

Table 2. Frequency of germs found on CBEU.

Germe	n	Percentage
Escherichia coli	189	79%
Klebsiella pneumoniae	26	11%
Proteus mirabilis	5	2%
Enterococcus	14	6%
Pseudomonas	5	2%
Staphylococcus aureus	2	0.8%

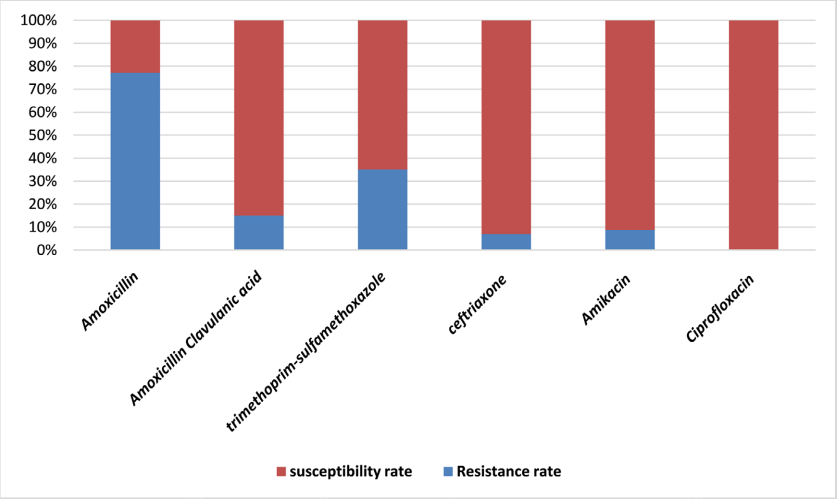

Figure 1. Resistance rates of *Escherichia coli* to the main antibiotics recommended for the treatment of urinary tract infections in children (n = 189).

Half of *Klebsiella* strains were resistant to ACA and sulfamethoxazole, 20% to C3G and gentamicin, and 10% to quinolones. For *Proteus*, 80% of strains were resistant to amoxicillin, and the remaining 20% had intermediate sensitivity. The rate of *Enterococcus* resistance in our study was around 50% for ampicillin, third-generation cephalosporin and TMP/SMX. No strains resistant to amoxicillin, ACA or aminoglycosides were observed.

Multidrug resistance (MDR) to two or more drugs was observed for 73.3% of Gram-negative bacteria and 82.5% Gram-positive bacteria. Overall, MDR in both groups was 79.8%.

Renal ultrasound performed in 85% of cases was normal in 50%; abnormalities detected were dominated by uretero-hydronephrosis. The main abnormalities revealed on cystography were vesicoureteral reflux, posterior urethral valve and ureterocele.

In our series, 203 children (85%) had acute pyelonephritis. Children with a severe form of the disease received a dual antibiotic therapy based on injectable C3G (Ceftriaxone in 30% and Cefotaxime in 3% of children) combined with gentamycin for 2 to 5 days, followed by oral cefixime in 26% of children. The remainder had germs resistant to ECBU, so treatment was based on the results of the antibiogram.

Immediate evolution was favorable in 94% of children. In 4.5%, the germ persisted at the follow-up CBEU, necessitating a change in treatment.

4. Discussion

Urinary tract infection is the most common non-epidemic infectious disease. In Morocco, urinary tract infections are still frequent and rank first among hospital-acquired infections [1]. They occur 2 to 3 times more frequently in girls, except in the first months of life, when they generally reflect urinary tract malformations, which are more common in boys [5].

At pre-school age, girls are more often infected than boys. By the age of six, 7% of girls and 2% of boys have suffered at least one episode of UTI [2] [8]. Between the ages of 6 and 16, the frequency is 2% in girls versus 0.1% in boys [9] [10]. The frequency and distribution of UTIs in relation to the age and sex of the children in our study are in line with the literature [5].

In the present study, Gram-negative bacteria were pre-dominantly isolated with a rate of 92% which is in agreement with many studies reported from Mekelle [11], 83% India [12], 92% and South Africa [13] which is 87.5%. In most studies conducted elsewhere in the world, the commonest uropathogens were Gram-negative bacteria. The frequency of isolation of uropathogens varies with different geographical locations.

Among the overall bacterial isolates, *E. coli* (79%) was the most frequently isolated uropathogens in our study. Our study agrees with other studies conducted in Iran [14], India [12], Germany [15] and Tanzania [16]. But other studies [17] [18] reported *Enterococcus spp., S. aureus and Klebsiella spp*. To be the

dominant pathogens isolated, respectively.

Generally, in the present study and in most other studies conducted elsewhere, *E. coli* was the most frequently isolated uropathogens. It is the most common cause of UTI and accounts for 75% - 90% of UTIs in children. However, its relative frequency varies in different areas [4] [15] [18]. *E. coli* is the commonest flora of the gastrointestinal tract and bowel from which it ascends to urinary tract and it has well characterized virulence factors to colonize the urinary tracts.

The second leading bacterial isolate in our study was *Klebsiella pneumoniae* (11%) followed by *Enterococcus* (6%), which is in line with other studies reported in Iran [14] and Germany [15].

In the present study, sensitivity of Gram-negative bacteria was relatively high for ciprofloxacin, amikacin and ceftriaxone. A study in Ethiopia [17] is in agreement with our study which showed that ciprofloxacin controlled 75% of Gram-negative bacteria. In other studies, ciprofloxacin is a widely used fluoroquinolone with high bacterial activity against uropathogens and well-established clinical efficacy in the treatment of UTIs [2] [4] [15] [16].

A high level of resistance of Gram-negative bacteria was also observed for ampicillin, amoxicillin-clavulanic acid and sulfamethoxazole in the present study. This is in agreement with the studies in India [12] and Ethiopia [17] which showed a high level of resistance to ampicillin.

E. coli, the first frequently isolated bacterium, was (100%) resistant to ampicillin. Our study is comparable with Tanzania [16] [17] [18]. The high resistance of Gram-negative bacteria to ampicillin might be due to ease of availability, its frequently prescribed drug and its low cost.

In the present study, the overall percentage of sensitivity for Gram-positive isolates was high for amoxicillin, amoxicillin-clavulanic acid and aminoglycosides. Our study is almost comparable with Madagascar [9], whereas Gram-positive isolates were resistant to ampicillin and cotrimoxazole.

Multidrug resistance (MDR) to two or more drugs was observed in 73.3% and 82.5% of Gram-negative and Gram-positive isolates, respectively. Overall, MDR in both groups was 79.8%. Similar results have been reported in several studies [2] [4] [17] [19]. This high MDR in the present study might be due to the widespread overuse of antibiotics, inappropriate prescription of drugs and lack of knowledge about drug resistance in the study area.

The presence of numerous co-resistances limits probabilistic therapeutic options in cases of UTI caused by extended-spectrum beta-lactamase (ESBL)-producing enterobacteria [20]. Indeed, 50%, 30% and 60% of ESBL-producing strains are resistant to fluoroquinolones, aminoglycosides and trimethoprim-sulfamethoxazole respectively [20] [21]. As a result, the therapeutic arsenal for these multi-resistant strains is often restricted to carbapenems, colistin, fosfomycin, nitrofurantoin and tigecycline [21].

In this context, failure to control the phenomenon of resistance exposes us to

an increased risk of therapeutic inadequacy, which is at the root of resistance amplification on a collective basis in the event of excessive use of reserve molecules (carbapenems...), but also of an individual risk of death [19] [22].

A return to the pre-antibiotic era then becomes a likely scenario. This should lead us to change the paradigm for a considerable number of attitudes anchored in our medical practices:

- Improve the way we diagnose urinary tract infections, to avoid unnecessary treatment

- Apply current ITU management recommendations, bearing in mind the particularities of our local bacterial ecology and the antibiotic resistance data generated by our study

- Choose active antibiotics with minimal impact on gut microbiota to prevent the selection of resistant mutants.

- Rigorously apply hygiene measures (standard and complementary contact type) to patients infected or carrying bacteria that are multi-resistant to antibiotics.

Limitation of the Study

Furthermore, two issues may compromise the rigorous procedure and the reproducibility of this type of research. First, as this is a retrospective study, cause-effect relation could not be analyzed and it could be also subjected to study design-related bias. And, second, due to heavy rush in the pediatric emergency department, paper charts may not be complete for some of the cases.

5. Conclusion

Urinary tract infection is a real health problem. The bacterial ecology of urinary tract infections is dominated by *Enterobacteriaceae*, led by *E. coli*. The development of resistance to certain antibiotics prolongs hospital stays and makes treatment more costly. In order to improve management, we need to monitor the bacterial ecosystem, and introduce and adhere to appropriate therapeutic protocols during first-line treatment.

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Bonacorsi, S., *et al.* (2016) Examen cytobactériologique des urines (ECBU). In: Denis, F., *et al.*, Eds., *Bactériologie Médicale*, 3e Édition, Elsevier Masson, Issy-les-Moulineaux, 163-170.

[2] Iacobelli, S., Bonsante, F. and Guignard, J.P. (2009) Infections urinaires en pédiatrie. *Archives de Pédiatrie*, **16**, 1073-1079. https://doi.org/10.1016/j.arcped.2009.03.001

[3] Janvier, F., Mbongo-Kama, E., Mérens, A. and Cavallo, J. (2008) Les difficultés d'interprétation de l'examen cytobactériologique des urines. *Revue Francophone des Laboratoires*, **2008**, 51-59. https://doi.org/10.1016/s1773-035x(08)74525-8

[4] Bissan, A.T., Razine, R., Doumbia, M. and Benouda, A. (2016) L'infection urinaire communautaire: Bactériologie et résistance chez une population de nourrissons marocains. *Revue d'Épidémiologie et de Santé Publique*, **64**, S139-S140. https://doi.org/10.1016/j.respe.2016.03.063

[5] Bouskraoui, M., *et al.* (2010) Epidemiology of Urinary Tract Infection in Children in Marrakech. *Archives de Pédiatrie*, **17**, S177-S178.

[6] Maleb, A., Lahrache, K., Lamrabat, S., Rifai, S., Rahmani, N., Bensalah, M., *et al.* (2019) Les infections urinaires infantiles au centre hospitalier universitaire Mohammed VI d'Oujda (Maroc). *Journal de Pédiatrie et de Puériculture*, **32**, 322-329. https://doi.org/10.1016/j.jpp.2019.07.001

[7] Rakotovao-Ravahatra, Z.D., Randriatsarafara, F.M., Rasoanandrasana, S., Raverohanta, L. and Rakotovao, A.L. (2017) Phénotypes de résistance des souches d'*Escherichia coli* responsables d'infection urinaire au laboratoire du Centre Hospitalo-Universitaire de Befelatanana Antananarivo. *Pan African Medical Journal*, **26**, Article 166. https://doi.org/10.11604/pamj.2017.26.166.11828

[8] Lagree, M., Bontemps, S., Dessein, R., Angoulvant, F., Madhi, F., Martinot, A., *et al.* (2018) Extended-Spectrum β-Lactamase-Producing Enterobacteriaceae, National Study of Antimicrobial Treatment for Pediatric Urinary Tract Infection. *Médecine et Maladies Infectieuses*, **48**, 193-201. https://doi.org/10.1016/j.medmal.2018.01.007

[9] Rasamiravaka, T., Shaista Sheila, H.S.L., Rakotomavojaona, T., Rakoto-Alson, A.O. and Rasamindrakotroka, A. (2015) Changing Profile and Increasing Antimicrobial Resistance of Uropathogenic Bacteria in Madagascar. *Médecine et Maladies Infectieuses*, **45**, 173-176. https://doi.org/10.1016/j.medmal.2015.03.006

[10] Basmaci, R. and Cohen, R. (2018) Que doit savoir le pédiatre sur *Escherichia coli* producteur de β-lactamase à spectre étendu? *Perfectionnement en Pédiatrie*, **1**, 62-67. https://doi.org/10.1016/j.perped.2018.01.009

[11] Tesfahunegn, Z., Asrat, D., Woldeamanuel, Y. and Estifanos, K. (2009) Bacteriology of Surgical Site and Catheter Related Urinary Tract Infections Amongpatients Admitted in Mekelle Hospital, Mekelle, Tigray, Ethiopia. *Ethiopian Medical Journal*, **47**, 117-127.

[12] Akram, M., Shahid, M. and Khan, A.U. (2007) Etiology and Antibiotic Resistance Patterns of Community-acquired Urinary Tract Infections in J N M C Hospital Aligarh, India. *Annals of Clinical Microbiology and Antimicrobials*, **6**, Article No. 4. https://doi.org/10.1186/1476-0711-6-4

[13] Jeena, P.M., Coovadia, H.M. and Adhikari, M.A. (1996) Bacteriuria in Children Attending a Primary Health Care Clinic: A Prospective Study of Catheter Stream Urine Samples. *Annals of Tropical Paediatrics*, **16**, 293-298. https://doi.org/10.1080/02724936.1996.11747841

[14] Navidinia, M. (2012) Study Prevalence of Verotoxigenic *E. coli* Isolated from Urinary Tract Infections (UTIs) in an Iranian Children Hospital. *The Open Microbiology Journal*, **6**, 1-4. https://doi.org/10.2174/1874285801206010001

[15] Pape, L., Gunzer, F., Ziesing, S., Pape, A., Offner, G. and Ehrich, J.H. (2004) [Bacterialpathogens, Resistance Patterns and Treatment Options in Community Acquired Pediatric Urinary Tract Infection]. *Klinische Pädiatrie*, **216**, 83-86.

[16] Msaki, B.P., Mshana, S.E., Hokororo, A., Mazigo, H.D. and Morona, D. (2012) Prevalence and Predictors of Urinary Tract Infection and Severe Malaria among Febrile Children Attending Makongoro Health Centre in Mwanza City, North-Western Tanzania. *Archives of Public Health*, **70**, Article No. 4. https://doi.org/10.1186/0778-7367-70-4

[17] Belete, Y., Asrat, D., Woldeamanuel, Y., Yihenew, G. and Gize, A. (2019) Bacterial Profile and Antibiotic Susceptibility Pattern of Urinary Tract Infection among Children Attending Felege Hiwot Referral Hospital, Bahir Dar, Northwest Ethiopia. *Infection and Drug Resistance*, **12**, 3575-3583. https://doi.org/10.2147/idr.s217574

[18] Singh, S. and Madhup, S. (2015) Clinical Profile and Antibiotics Sensitivity in Childhood Urinary Tract Infection at Dhulikhel Hospital. *Kathmandu University Medical Journal*, **11**, 319-324. https://doi.org/10.3126/kumj.v11i4.12541

[19] Duong, H.P., Mong Hiep, T.T., Hoang, D.T., Janssen, F., Lepage, P., De Mol, P., *et al.* (2015) Difficultés de prise en charge des infections urinaires fébriles chez l'enfant vietnamien. *Archives de Pédiatrie*, **22**, 848-852. https://doi.org/10.1016/j.arcped.2015.05.010

[20] Dantas Palmeira, J. and Ferreira, H.M.N. (2020) Extended-Spectrum β-Lactamase (ESBL)-Producing Enterobacteriaceae in Cattle Production—A Threat around the World. *Heliyon*, **6**, e03206. https://doi.org/10.1016/j.heliyon.2020.e03206

[21] Adler, A., Sturlesi, N., Fallach, N., Zilberman-Barzilai, D., Hussein, O., Blum, S.E., *et al.* (2015) Prevalence, Risk Factors, and Transmission Dynamics of Extended-Spectrum-β-Lactamase-Producing Enterobacteriaceae: A National Survey of Cattle Farms in Israel in 2013. *Journal of Clinical Microbiology*, **53**, 3515-3521. https://doi.org/10.1128/jcm.01915-15

[22] Cohen, R., Raymond, J., Faye, A., Gillet, Y. and Grimprel, E. (2015) Prise en charge des infections urinaires de l'enfant. Recommandations du groupe de pathologie infectieuse pédiatrique de la Société française de pédiatrie et de la Société de pathologie infectieuse de langue française. *Archives de Pédiatrie*, **22**, 665-671. https://doi.org/10.1016/j.arcped.2015.03.016