Austin Journal of Microbiology

Open Access

Austin Publishing Group

Research Article

Evolution of the Antibiotic Resistance Profile of Uropathogenic *Escherichia coli* in *Laâyoune*: Comparison between Two Study Periods

Zakaria Laanibi[1]*, Yassine Ben Lahlou[2], Atmani Walid[3] and Haddou Ammar[4]

[1]Departement of Biology, Hassan II Military Teaching Hospital, Laâyoune, Morocco

[2]Departement of Biology, Mohamed V Military Teaching Hospital, Rabat, Morocco

[3]Anesthesiology and Intensive Care Unit, Hassan II Military Teaching Hospital, Laâyoune, Morocco

[4]ENT Head of Hassan II Military Teaching Hospital, Laâyoune, Morocco

***Corresponding author**: Zakaria Laanibi, Departement of Biology, Hassan II Military Teaching Hospital, Laâyoune, Morocco

Email: zakaria23690@gmail.com

Received: October 17, 2025

Accepted: November 10, 2025

Published: November 11, 2025

Abstract

Introduction: Urinary tract infections (UTIs) are a common reason for medical consultation, with *Escherichia coli* (E. coli) being the main causative agent. This study aimed to analyze the resistance profile of uropathogenic *E. coli* isolates collected at Hassan II Hospital in Laâyoune and to compare the findings with those of a previous similar study.

Materials and Methods: This was a retrospective study conducted from January 2023 to December 2024, including *E. coli* strains isolated from urine samples. Antibiotic susceptibility testing was performed using the agar diffusion method and interpreted according to the 2024 CA-SFM guidelines. Extended-spectrum beta-lactamase (ESBL) production was detected using the synergy test.

Results: Among the 4,841 urine cultures performed, 860 (17.7%) were positive, including 384 *E. coli* strains (44.6%). High resistance rates were observed for amoxicillin (89%), amoxicillin–clavulanic acid (68%), and cephalothin (83.5%). Resistance to third-generation cephalosporins remained lower: ceftriaxone (8.5%), ceftazidime (10.5%), and cefixime (19%). Resistance to ciprofloxacin was 16%, fosfomycin 11%, cotrimoxazole 39%, and imipenem 1%. ESBL-producing strains accounted for 5.4% of isolates.

Discussion and Conclusion: These results demonstrate a worsening of resistance to first-line beta-lactams (amoxicillin, amoxicillin–clavulanic acid, and cephalothin) compared with the previous period, reflecting increased selection pressure due to their empirical use. Conversely, resistance to fluoroquinolones and cotrimoxazole appears to have stabilized or slightly decreased. The moderate emergence of ESBL-producing strains underscores the need for strengthened surveillance and a rational antibiotic stewardship policy in the region.

Keywords: Urinary tract infection; Urine culture; *Escherichia coli*; Antibiotic resistance

Introduction

Urinary tract infection (UTI) is one of the most common bacterial infections and represents a major public health concern. Enterobacteriaceae are the most frequently identified pathogens in this infection [1]. *Escherichia coli* (E. coli) remains a priority organism for surveillance and antibiotic resistance studies because of its high prevalence in urinary infections and its potential severity. The emergence and spread of acquired resistance mechanisms in *E. coli* strains have significantly limited the use of many first-line antibiotics [2]. The aim of this study was, on the one hand, to analyze the resistance profile of uropathogenic *E. coli* strains isolated in the medical biology laboratory of the Hassan II Military Hospital in Laâyoune, and on the other hand, to assess the evolution of this resistance by comparing our findings with those of a previous study.

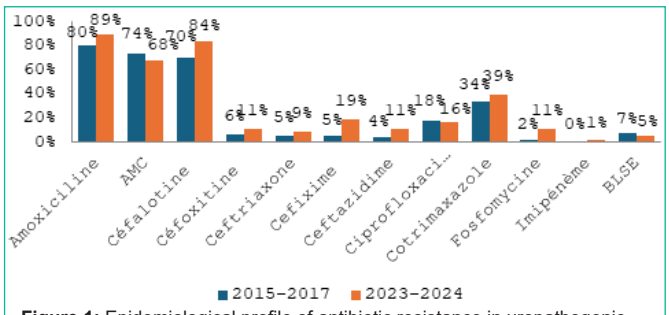

Figure 1: Epidemiological profile of antibiotic resistance in uropathogenic *Escherichia coli* isolates.

Citation: Zakaria Laanibi, Yassine Ben Lahlou, Atmani Walid and Haddou Ammar. Evolution of the Antibiotic Resistance Profile of Uropathogenic *Escherichia coli* in *Laâyoune*: Comparison between Two Study Periods. Austin J Microbiol. 2025; 10(1): 1060.

Table 1: Comparative table of antibiotic resistance profiles across Morocco.

STUDIES	Laâyoune %	Rabat % [5]	Fes % [7]	Casablanca % [8]	littérature review % [9]
Sex ratio F/M	1.4				
Positif UCBE	17.7				
E.coli rate	44.6		72	75.41	
E. coli producing SBLE	5.4	6,73	4,67		
Amoxicilin	89	64	79	63.16	90
Amoxicillin + clavulanic acid	68	36	65	38.16	64
Céfalotin	83.5	26	56		
Céfoxitin	11	3	6	16.96	15,1
Ceftriaxon	8.5	12		16.9	28,7
Céfixim	19				
Ceftazidim	10.5				31,8
Norfloxacin		34		27.78	34
Ciprofloxacin	16		27	26.52	
Cotrimaxazol	39	41	39		56
Fosfomycin	11	2			
Imipenem	1	1	0		

Materials and Methods

This was a retrospective study conducted over a two-year period (from January 1, 2023, to December 31, 2024) including all *E. coli* strains isolated from urine samples received at the medical biology laboratory of Hassan II Hospital in Laâyoune. The samples were obtained from hospitalized patients in various departments, from patients admitted to the emergency department, and from outpatients.

All patients with bacteriuria ≥ 10^3 CFU/mL in men and ≥ 10^4 CFU/mL in women, with or without significant leukocyturia, were included in the study. Identification of isolates was based on morphological, cultural, and biochemical characteristics. Antibiotic susceptibility testing was performed by agar disk diffusion, and interpretation followed the guidelines of the Antibiogram Committee of the French Society for Microbiology (CA-SFM, 2024 recommendations) [3].

Extended-spectrum beta-lactamase (ESBL) production was detected by the synergy test using a central disk of amoxicillin + clavulanic acid (AMC) surrounded by disks of ceftazidime, ceftriaxone, and cefotaxime. The presence of an ESBL was indicated by the characteristic "champagne-cork" appearance of inhibition zones.

Data processing was carried out using Excel© software, and statistical analysis was performed with the Jamovi 2.3.21 software package.

Results

A total of 4,841 urine cultures were performed during the study period, of which 860 were positive (17.7%). These samples came predominantly from outpatients (92.7%, n = 229), followed by patients admitted to the emergency department (4.9%, n = 1). The female-to-male sex ratio was 1.4. Urine cytology showed leukocyturia of 10^3 and 10^4 cells/mL in 21.2% and 25.9% of cases, respectively. Bacteriuria without leukocyturia was observed in 18.4% of cases. In our series, 384 strains of *E. coli* were isolated, representing 44.6% of all identified pathogens. The antimicrobial resistance profile of the isolates revealed high resistance rates to amoxicillin (89%), amoxicillin–clavulanic acid (68%), and cephalothin (83.5%). Resistance rates were lower for cefoxitin (11%), ceftriaxone (8.5%), cefixime (19%), and ceftazidime (10.5%).

Resistance to ciprofloxacin was 16%, to fosfomycin 11%, and to cotrimoxazole 39%. ESBL-producing *E. coli* accounted for 5.4% of isolates, while 1% of strains were resistant to imipenem.

Discussion

In our study, cytological analysis of urine samples revealed bacteriuria without associated leukocyturia in 18.4% of cases. This finding highlights that the presence of pathogens without a significant leukocyte response is not uncommon, which can complicate diagnosis when leukocyturia is heavily relied upon as an inflammatory marker.

Escherichia coli accounted for 44.6% of identified pathogens. This result is consistent with numerous studies both in Morocco and internationally, where *E. coli* remains the most frequent uropathogen in community-acquired urinary tract infections. For instance, studies conducted in Marrakech and Rabat report similar proportions of *E. coli* among uropathogenic isolates [4,5].

A particularly concerning aspect of our series is the high resistance rates observed for commonly used antibiotics. Specifically, 89% of isolates were resistant to amoxicillin, and 68% were resistant to amoxicillin–clavulanic acid (AMC). These figures indicate that these antibiotics are largely ineffective when used empirically for urinary tract infections in this context. Resistance to first-generation cephalosporins, such as cephalothin, was also very high (83.5%), whereas agents like cefoxitin (11%) and ceftriaxone (8.5%) maintained better activity. Resistance rates to ciprofloxacin (16%) and cotrimoxazole (39%) remain moderate to high, further limiting therapeutic options. In contrast, fosfomycin demonstrated a more favorable profile, with only 11% resistance, making it particularly attractive for uncomplicated lower urinary tract infections.

We detected a prevalence of ESBL-producing strains of 5.4%, with only 1% of isolates resistant to imipenem. Although these rates are relatively low, their presence is clinically significant, signaling the emergence of potentially multidrug-resistant organisms.

Comparison of our results with those from a previous study conducted in the same laboratory in 2015 reveals a notable increase in resistance among uropathogenic *E. coli* to major antibiotics used for urinary infections [6]. Resistance to amoxicillin increased from 80% in 2015 to 89% in 2024, reflecting a marked deterioration. Similarly,

AMC showed high resistance but slightly decreased from 74% to 68%, indicating that its efficacy remains limited. For cephalosporins, a general increase in resistance was observed: cephalothin rose from 70% to 83.5%, cefoxitin from 6% to 11%, ceftriaxone from 5% to 8.5%, cefixime from 5% to 19%, and ceftazidime from 4% to 10.5%. These trends reflect a progressive loss of effectiveness of this therapeutic class.

Fluoroquinolones showed relative stability or slight improvement: resistance to norfloxacin remained stable at 20%, while ciprofloxacin slightly decreased from 18% in 2015 to 16% in 2024. Conversely, cotrimoxazole experienced a moderate increase from 34% to 39%. Fosfomycin, previously well preserved, showed an increase in resistance from 2% in 2015 to 11% in 2024. Although this rate remains relatively low, it indicates a concerning trend. The prevalence of ESBL-producing strains slightly decreased from 7% to 5.4%, suggesting better management or changes in antibiotic pressure. Carbapenems, represented by imipenem, remain highly effective, with resistance rates remaining very low (0% to 1%).

The overall proportion of positive urine cultures remained stable (17.5% versus 17.7%). However, the proportion of *E. coli* isolates decreased from 52% to 44.6%, which could reflect the emergence of other uropathogens in the population [6].

In comparison with data published from other Moroccan cities (Rabat [5], Fès [7], Casablanca [8]) as well as a national literature review covering 2011–2021 [9], our results are consistent in several respects. Amoxicillin showed a very high resistance rate in our study (89%), close to that reported in the national review (90%) and higher than the rates reported in Rabat (64%) and Fès (79%). This confirms that amoxicillin remains largely ineffective as monotherapy for *E. coli* urinary tract infections.

For amoxicillin–clavulanic acid (AMC), resistance observed in Laâyoune (68%) was higher than that reported in Rabat (36%) and Casablanca (38.16%), but close to the national review (64%). These findings suggest a gradual loss of efficacy for this combination.

Cephalothin demonstrated a particularly high resistance rate in Laâyoune (83.5%), substantially higher than that reported in Rabat (26%) and Fès (56%). Resistance to third-generation cephalosporins remained relatively low in Laâyoune (ceftriaxone 8.5%, ceftazidime 10.5%, cefixime 19%) compared with national data (ceftriaxone 28.7%, ceftazidime 31.8%). These results indicate a relative preservation of third-generation cephalosporin efficacy in our context.

Fluoroquinolones showed moderate resistance, with ciprofloxacin at 16% in Laâyoune compared with 27% in Fès and 26.5% in Casablanca. Resistance to cotrimoxazole remained stable across Laâyoune (39%), Fès (39%), and Casablanca (41%), and aligns with the national review data (56%). Fosfomycin appears to remain an effective option, with a low resistance rate in Laâyoune (11%), although slightly higher than in Rabat (2%). ESBL-producing strains represented 5.4% of isolates in Laâyoune, close to the rates reported in Rabat (6.73%) and Fès (4.67%). While this prevalence remains lower than some international reports, it indicates a limited but concerning emergence of potentially multidrug-resistant strains. Imipenem retained remarkable activity, with only 1% resistance in Laâyoune, consistent with data from other cities where its efficacy remains nearly complete.

From a clinical perspective, these results necessitate an urgent reassessment of empirical management protocols for urinary tract infections in our institution. Amoxicillin no longer appears suitable as a first-line treatment in this context. Although the amoxicillin–clavulanic acid (AMC) combination is somewhat more effective, it still exhibits high resistance levels. Third-generation cephalosporins and fosfomycin, as well as other potent agents, remain viable options, but their use should be reserved and guided by antibiotic susceptibility testing. Furthermore, the presence of ESBL-producing strains, even at moderate prevalence, justifies the implementation of systematic microbiological surveillance, optimization of empirical therapy, and a strict antibiotic stewardship policy. However, this study has certain limitations. Data on patients' prior antibiotic use were not available, which could significantly influence observed resistance profiles. Additionally, the lack of a clear distinction between community-acquired and nosocomial infections limits the interpretation of the results, particularly for the most severe cases.

Conclusion

Our data reveal a general worsening of resistance among uropathogenic *E. coli* isolates in our laboratory, particularly against beta-lactams and cotrimoxazole, while certain antibiotics such as fluoroquinolones and carbapenems retain relative efficacy. The observed resistance profile aligns with national trends, showing high resistance to amoxicillin and cephalothin, with preserved effectiveness of third-generation cephalosporins, fosfomycin, and imipenem. Interregional comparison highlights some disparities, notably higher resistance to AMC and cephalothin in Laâyoune. These findings underscore the need for continuous surveillance and adaptation of therapeutic protocols according to local resistance profiles.

References

1. CMIT. Infections urinaires. In E. Pilly: Alinea Plus Ed 20164/227-237.
2. Sabir S. anjum AA, Ijaz T, Ali MA, Khan MR, MR, Nawaz M. Isolation and antibiotic suceptibility of E.coli from urinary tract infections. In a tertiary care hospital. Prak J Med Sci. 2014; 30: 389-392.
3. Communiqué du comité de l'antibiogramme de lasociété française de microbiologie. Recommandations 2017.
4. MOUAMIN M, Ait Said L, ZAHLANE K, Antibiorésistance des souches d'Echerichia coli et de Proteus mirabilis au cours des infections urinaires communautaires de l'adulte à Marrakech et implications thérapeutiques Laboratoire de microbiologie. Hôpital Ibn Tofail CHU de Marrakech.
5. Elmostafa Benaissa Nadia Elmrimar El-Mehdi Mostafa Elouennass. M. Update on the resistance of Escherichia coli isolated from urine specimens in a Moroccan hospital: a review of a 7-year period June 2021GERMS. 2021; 11: 189-198.
6. Yassine Ben Lahlou1,2 , Elmostapha Benaissa1,2 , Adil Maleb3, Mariama Chadli2, Mostafa Elouennass1,21 Equipe de recherche en épidémiologie et résistance bactérienne/Centre BIO-INOVA, 2 Service de.
7. Bactériologie, CHU Mohammed V, Faculté de Médecine et de Pharmacie, Rabat, 3 Laboratoire de Microbiologie, CHU Mohammed VI Oujda, Maroc. M. Mahmoud, N. Benseddik, G. Yahyaoui.v Profil de résistance des entérobactéries dans les infections urinaires. 2010; 32.
8. Antibiotic resistance profiling of Uropathogenic Enterobacteriaceae, Casablanca, Morocco Aniba Rafik, Barguigua Abouddihaj, Dihmane Asmaa, Nayme Kaotar and Timinouni Mohammed E3S Web Conf. 2021; 319: 01002.
9. Nejjari, C., El Achhab, Y., Benaouda, A. et al. Résistance aux antimicrobiens chez les pathogènes GLASS au Maroc : revue épidémiologique. BMC Infect Dis. 2022; 22: 438.