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Distribution of Microorganisms and Antimicrobial Susceptibility Patterns Among Urine Culture Isolates in Tajoura, Libya: A Retrospective Study

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توزيع الكائنات الدقيقة وأنماط الحساسية لمضادات الميكروبات في العينات المستزرعة من البول في تاجوراء، ليبيا: دراسة استعادية

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Abstract:
Urinary tract infection (UTIs) are common infections, and antimicrobial resistance presents a major challenge to their effective treatment. Understanding the distribution of uropathogens and their antimicrobial susceptibility patterns is important for guiding appropriate antimicrobial therapy.

This study aimed to describe the distribution of microorganisms isolated from urine cultures and assess their recorded antimicrobial susceptibility patterns in Tajoura, Libya.

A retrospective observational study was conducted using existing laboratory records from tow private medical laboratories in Tajoura, Libya, between 1 January 2025 and 4 February 2026. A total of 291 microbial isolates recovered from urine culture were included. Microorganism distribution and antimicrobial susceptibility results were summarized descriptively. Susceptibility percentages were calculated using the number of isolates tested for each antimicrobial agent.

Of the 291 microbial isolates, Staphylococcus spp. accounted for 106 (36.4%), followed Klebsiella spp. with 80 (27.5%) and Escherichia coli with 74 (25.4%). Other isolates included Pseudomonas spp. (3.8%), Proteus spp. (2.0%), Candida glabrata (1.3%), and several less frequently isolated microorganisms. Among the tested isolates, Imipenem showed susceptibility rates of 100% for E. coli, 97.3% for Staphylococcus spp., and 88.1% for Klebsiella spp. All tested Pseudomonas spp. isolates were susceptible to Imipenem 100%. The number of isolates tested varied across antimicrobial agents, and findings for less frequently isolated microorganisms were limited by small sample sizes.

The findings describe the distribution of microorganisms and their recorded antimicrobial susceptibility patterns in urine culture records from the study setting. Continued local surveillance and standardized antimicrobial susceptibility testing are important for monitoring resistance patterns and supporting evidence-based antimicrobial use.

Keywords: Urinary Tract Infections; Uropathogens; Antimicrobial Susceptibility; Antimicrobial Resistance; Urine Culture; Retrospective Study.

الملخص
تُعد عدوى المسالك البولية من أنواع العدوى الشائعة، وتُمثّل مقاومة مضادات الميكروبات تحدياً كبيراً أمام فعاليتها في العلاج. لذا، فإن فهم توزيع مسببات الأمراض البولية وأنماط حساسيتها تجاه مضادات الميكروبات يُعد أمراً بالغ الأهمية لتوجيه اختيار العلاج المناسب.
هدفت هذه الدراسة إلى وصف توزيع الكائنات الدقيقة المعزولة من مزارع البول، وتقييم أنماط حساسيتها المسجلة تجاه مضادات الميكروبات في منطقة تاجوراء بليبيا.
أُجريت دراسة رصدية بأثر رجعي (بناءً على سجلات مخبرية قائمة) في مختبرين طبيين خاصين في تاجوراء، ليبيا، خلال الفترة من 1 يناير 2025 إلى 4 فبراير 2026. شملت الدراسة ما مجموعه 291 عزلة ميكروبية تم الحصول عليها من مزارع البول. تم تلخيص توزيع الكائنات الدقيقة ونتائج الحساسية تجاه مضادات الميكروبات وصفياً، وحُسبت نسب الحساسية بناءً على عدد العزلات التي خضعت للاختبار لكل مضاد ميكروبي.
من بين العزلات الميكروبية البالغ عددها 291، مثّلت أنواع المكورات العنقودية (Staphylococcus spp.) نسبة 36.4% (106 عزلة)، تلتها أنواع الكلبسيلة (Klebsiella spp.) بنسبة 27.5% (80 عزلة)، ثم بكتيريا الإشريكية القولونية (Escherichia coli)بنسبة 25.4% (74 عزلة). كما تضمنت العزلات الأخرى أنواع الزائفة (Pseudomonas spp.) بنسبة 3.8%، وأنواع المتقلبة (Proteus spp.) بنسبة 2.0%، وفطر المبيضات الجلابراتية (Candida glabrata) بنسبة 1.3%، بالإضافة إلى كائنات دقيقة أخرى ظهرت بنسب أقل. وفيما يخص نتائج الحساسية، أظهر عقار "إيميبينيم " (Imipenem)معدلات حساسية بلغت 100% لبكتيريا الإشريكية القولونية، و97.3% للمكورات العنقودية، و88.1% لأنواع الكلبسيلة. كما كانت جميع عزلات الزائفة (Pseudomonas spp.) التي خضعت للاختبار حساسة لعقار "إيميبينيم" بنسبة 100%. تجدر الإشارة إلى أن عدد العزلات التي خضعت للاختبار تباين باختلاف المضادات الميكروبية، كما أن النتائج المتعلقة بالكائنات الدقيقة الأقل شيوعاً كانت محدودة بسبب صغر حجم العينات.
تُقدم هذه النتائج وصفاً لتوزيع الكائنات الدقيقة وأنماط حساسيتها تجاه مضادات الميكروبات بناءً على سجلات مزارع البول في موقع الدراسة. وتؤكد النتائج على أهمية استمرار الرصد المحلي وتوحيد معايير اختبارات الحساسية لمضادات الميكروبات، وذلك لمتابعة أنماط المقاومة ودعم الاستخدام الرشيد لمضادات الميكروبات استناداً إلى الأدلة العلمية..

الكلمات المفتاحية: عدوى المسالك البولية؛ مسببات الأمراض البولية؛ الحساسية تجاه مضادات الميكروبات؛ مقاومة مضادات الميكروبات؛ مزرعة البول؛ دراسة بأثر رجعي.

Introduction

Urinary tract infections (UTIs) are among the most common bacterial infections encountered in clinical practice and represent an important cause of morbidity worldwide. They may affect different parts of the urinary system, and their clinical severity ranges from uncomplicated lower urinary tract infection to more serious infections that may require specialized medical care. The microorganisms responsible for UTIs vary according to geographical location, patient characteristic, and healthcare setting. Therefore, identifying the microorganisms isolated from urine cultures and understanding their antimicrobial susceptibility patterns are important for supporting appropriate treatment decisions [1,2].

Antimicrobial resistance (AMR) is a major public health concern because it can reduce the effectiveness of commonly used antibiotics and complicate the management of infectious diseases. In UTIs, resistance to frequently prescribed antimicrobial agents may limit empirical treatment options and increase the importance of microbiological diagnosis and susceptibility-guided therapy. The world Health Organization has emphasized the importance of antimicrobial resistance surveillance to improve understanding of resistance trends and support evidence-based public health responses [3]. Routine analysis of laboratory culture and susceptibility data can contribute to local surveillance by identifying commonly isolated microorganisms and describing their recorded responses to tested antimicrobial agents.

Studies conducted in Libya have reported variation in the distribution of urinary pathogens and their antimicrobial susceptibility patterns across healthcare setting. A study at Tripoli medical center identified *Escherichia coli* as the most frequently isolated bacterial pathogen, followed by *Klebsiella pneumoniae*, while also reporting resistance to several tested antibiotics [1]. More recently, a study in zawia reported that *E. coli* and *Klebsiella* were among the predominant uropathogens and documented substantial resistance to several commonly used antimicrobial agents [2]. These findings highlight the importance of continued local investigation, while also indicating that results from individual facilities should be interpreted within the context of their study population and laboratory practices.

Retrospective analysis of existing laboratory records provides an opportunity to describe the microorganisms identified in routine urine cultures and summarize their recorded antimicrobial susceptibility patterns. However, the interpretation of these findings depends on the completeness and quality of laboratory records, the methods used for susceptibility testing, and the number of isolates tested for each antimicrobial agent. Results based on

small numbers of isolates should be interpreted cautiously and should not be generalized beyond the available data.

The present study aimed to describe the distribution of microorganisms recovered from urine cultures and assess their recorded antimicrobial susceptibility patterns using laboratory data from two private medical laboratories in Tajoura, Libya. By summarizing the available results and accounting for differences in the number of isolates tested for individual antimicrobial resistance surveillance and inform future investigations.

1.2. Problem statement

The research problem concerns the need to describe the uropathogens recorded in urine culture data and characterize their antimicrobial susceptibility and resistance patterns. This is particularly important given the continuing change in antimicrobial resistance and the potential variation in susceptibility profiles across microbial species and healthcare settings.

According, this study retrospectively analyzes available laboratory to identify the most frequently recorded isolates and describe their antimicrobial susceptibility and resistance patterns, taking into account the number of isolates tested against each antimicrobial agent.

1.3. Significance of the study

The significant of this study lies in its contribution to the local understanding of microorganisms isolated from urine cultures and their documented antimicrobial susceptibility patterns. Specifically, the study:

1. Provides a local data on the description of microorganisms recorded in urine culture from two private medical laboratories in Tajoura, Libya.
2. Describes the recorded antimicrobial susceptibility and resistance patterns among the tested isolates.
3. Contributes to the local evidence base for antimicrobial resistance surveillance.
4. Provides findings that can be compared with previously published studies from Libya and other relevant regions.
5. Highlights areas where further laboratory surveillance and research may be needed, while recognizing that the findings should be interpreted within the limitations of the available data.

1.4. Aim and objectives

General aim: To describe the distribution of microorganisms isolated from urine cultures and assess their recorded antimicrobial susceptibility patterns using laboratory data from two private medical laboratories in Tajoura, Libya, during the study period.

Specific objective:

The specific objectives of this study were:

1. To identify the microbial isolates recorded in the urine culture dataset and describe their distribution.
2. To describe the recorded antimicrobial susceptibility and resistance patterns among the different microbial group.
3. To summarize the observed susceptibility and resistance proportions for each tested antimicrobial agent, using the appropriate number of tested isolates as the denominator.
4. To compare the study finding with those of previously published studies from Libya and other relevant settings.

2. Materials and Methods

2.1. Study Design and Setting

This retrospective observational study was based on laboratory records from two private medical laboratories, Al-Baylsan laboratory and Tajoura Al-Wasat laboratory in Tajoura, Tripoli, Libya. The study covered the period from 1 January 2025 to 4 February 2026. A total of 291 microbial isolates recovered from urine specimens and subjected to antimicrobial susceptibility testing were included in the analysis. The study aimed to describe the distribution of the recorded microorganisms and their documented antimicrobial susceptibility patterns.

2.2 Microbial Identification

Microbial identification results were obtained from the laboratory records. At Al-Baylsan laboratory, urine specimens were cultured using routine laboratory procedures, followed by microbial identification using the

Render MA120 system. At Tajoura AL-Wasat Laboratory, urine specimens were cultured media, and microbial identification was performed using routine laboratory methods.

2.3 Antimicrobial and Antifungal Susceptibility testing

At Al-Baylsan laboratory, antimicrobial susceptibility testing of bacterial isolates was performed using the Render MA120 system following routine culture procedures. The four Candida glabrata isolates were also processed using this system for identification and antifungal to the information provided by the laboratory.

At Tajoura AL-Wasat laboratory, antimicrobial susceptibility testing of bacterial isolates was performed using the disk diffusion method following routine culture and identification procedures.

2.4. Date Analysis

Data were extracted from the laboratory records of the two participating laboratories. The dataset comprised 291 microbial isolates obtained from urine specimens during the study period. The recorded variable included microorganism identification and the available antimicrobial or antifungal susceptibility results.

Descriptive analysis was performed by manually calculating frequencies and percentages using a calculator. Microorganism distribution was summarized using frequencies and percentages. susceptibility results were classified as susceptible (S), intermediate (I), resistant (R), according to the categories recorded in the laboratory data. For each antimicrobial agent, percentages were calculated using the number of isolates tested for that agent as the denominator. Isolates without a recorded result for a specific agent were excluded from the corresponding calculation. Results were presented in tables and interpreted descriptively, with caution applied to findings for microorganisms represented by small number of isolates.

3.Results:

3.1- Distribution of Microbial Isolates:

A total of 291 microbial isolates were recovered from urine cultures during the study period.

Table 1 presents the distribution of the isolated microorganisms according to bacterial and fungal species. microbial isolates (n = 291)

Species	n	%
Staphylococcus spp.	106	36.4
Escherichia coli	74	25.4
Klebsiella spp.	80	27.5
Pseudomonas spp.	11	3.8
Proteus spp.	6	2.1
Candida glabrata.	4	1.4
Streptococcus pnemoniae	3	1.0
Enterobacter spp.	2	0.7
Citrobacter spp	2	0.7
Acinetobacter baumannii	1	0.3
Micrococcus luteus	1	0.3
Kluyvera ascorbata	1	0.3
Total	291	100

A total of 291microbial isolates were recovered from urine cultures during the study period. *Staphylococcus* spp. were the most frequently isolated microorganisms, accounting for 106 isolates (36.4%), followed by *Klebsiella* spp. with 80 isolates (27.5%). and *Escherichia coli* with 74 isolates (25.4%). *Pseudomonas* spp. accounted for 11 isolates (3.8%), while *Proteus* spp. accounted for 6 isolates (2.1%). Less frequently recorded organisms included *Candida glabrata* (1.4%), *Streptococcus pnemoniae* (1.0%), *Enterobacter* spp. (0.7%), *Citrobacter* spp. (0.7%), *Acinetobacter baumannii* (0.3%), *Micrococcus* spp. (0.3%) and *Kluyvera ascorbate* (0.3%).

3.2- Antimicrobial susceptibility patterns of *Klebsiella* spp.

Table 2. Antimicrobial susceptibility patterns of *Klebsiella* spp. isolates (n = 80).

Antibiotic	No. tested	Sensitive n (%)	Intermediate n(%)	Resistance rate n(%)
Amikacin	32	(71.8%) 23	(21.8%) 7	(6.2%) 2

Gentamicin	31	(41.9%) 13	(38.7%) 12	(19.3%) 6
Tobramycin	54	(31.4%) 17	(42.5%) 23	(25.9%) 14
Ciprofloxacin	55	(65.4%) 36	(23.6%) 13	(10.9%) 6
Norfloxacin	55	(60.0%) 33	(18.1%) 10	(21.8%) 12
Nalidixic acid	51	(45.0%) 23	(25.4%) 13	(29.4%) 15
Ceftriaxone	37	(59.4%) 22	(13.5%) 5	(27.0%) 10
Imipenem	59	(88.1%) 52	(10.1%) 6	(1.6.0%) 1
Sulfamethoxazole	24	(29.1%) 7	(20.8%) 5	(50.0%) 12

Imipenem demonstrated the highest susceptibility rate (88. 1%), followed by Amikacin (71.9%) and Ciprofloxacin (65.4%).

The highest resistance rate was observed for Sulfamethoxazole (50%), followed by Nalidixic acid (29.4%), Ceftriaxone (27.0%).

Intermediate susceptibility was most frequently observed with Tobramycin and Gentamicin.

3.3- Antimicrobial susceptibility patterns of *Staphylococcus* spp.

Table 3. Antimicrobial susceptibility patterns of *Staphylococcus* spp. isolates (n = 106).

Antibiotic	No. tested	Sensitive n (%)	Intermediate n(%)	Resistance rate n(%)
Amikacin	92	(87.0%) 80	(10.8%) 10	(2.17%) 2
Tobramycin	45	(53.3%) 24	(37.7%) 17	(8.9%) 4
Streptomycin	40	(50.0%) 20	(37.5%) 15	(12.5%) 5
Ciprofloxacin	93	(72.0%) 67	(23.6%) 22	(4.3%) 4
Norfloxacin	57	(57.9%) 33	(26.3%) 15	(15.8%) 9
Ceftriaxone	43	(67.4%) 29	(27.9%) 12	(4.7%) 2
Cefuroxime	27	(77.8%) 21	(7.4%) 2	(14.8%) 4
Imipenem	75	(97.3%) 73	(1.3%) 1	(1.3%) 1
Nitrofurantoin	56	(25.0%) 14	(26.7%) 15	(48.2%) 27

Among *Staphylococcus* spp. isolates, Imipenem showed the highest susceptibility rate (97.3%), followed by Amikacin (87.0%) and Cefuroxime (77.8%). Nitrofurantoin showed the highest resistance rate (48.2%), followed by Norfloxacin (15.8%) and Cefuroxime (14.8%). Intermediate susceptibility was also observed among the tested antimicrobial agents, with varying proportions.

3.4- Antimicrobial susceptibility patterns of *Escherichia coli*

Table 4. Antimicrobial susceptibility patterns of *Escherichia coli* isolates (n = 74).

Antibiotic	No. tested	Sensitive n (%)	Intermediate n(%)	Resistance rate n(%)
Amikacin	44	(70.4%) 31	(29.5%) 13	(0%) 0
Tobramycin	37	(35.1%) 13	(54.1%) 20	(10.8%) 4
Gentamicin	38	(42.1%) 16	(42.1%) 16	(15.8%) 6
Ciprofloxacin	56	(73.2%) 41	(16.1%) 9	(10.7%) 6
Norfloxacin	47	(83.0%) 39	(8.5%) 4	(8.5%) 4
Nalidixic acid	39	(23.1%) 9	(33.3%) 13	(43.6%) 17
Cefotaxime	19	(84.2%) 16	(5.3%) 1	(10.5%) 2
Ceftriaxone	22	(68.2%) 15	(9.1%) 2	(22.7%) 5
Cefuroxime	27	(77.8%) 21	(3.7%) 1	(18.5%) 5
Imipenem	64	(100%) 64	(0%) 0	(0%) 0
Sulfamethoxazole	21	(47.6%) 10	(9.5%) 2	(42.9%) 9

Imipenem demonstrated complete in vitro activity agents all tested *Escherichia coli* isolates, with a susceptibility rate of 100%. High susceptibility rates were also observed for Cefotaxime (84.2%), Norfloxacin (83.0%), and Cefuroxime (77.8%). the highest resistance rates were recorded for Nalidixic acid (43.6%) and Sulfamethoxazole

(42.9%). Resistance to other tested antimicrobial agents varied, with different numbers of isolated tested for each agent.

3.5- Antimicrobial susceptibility patterns of *Pseudomonas* spp.

Table 5. Antimicrobial susceptibility patterns of *Pseudomonas* spp. isolates (n = 11).

Antibiotic	No. tested	Sensitive n (%)	Intermediate n(%)	Resistance rate n(%)
Amikacin	4	(50.0%) 2	(50.0%) 2	(0%) 0
Tobramycin	7	(28.6%) 2	28.6(%) 2	(42.9%) 3
Gentamicin	4	(25.0%) 1	(50.0%) 2	(25.0%) 1
Ciprofloxacin	11	(54.5%) 6	(36.4%) 4	(9.1%) 1
Norfloxacin	10	(80.0%) 8	(20.0%) 2	(0%) 0
Imipenem	11	(100%) 11	(0%) 0	(0%) 0

The results showed that Imipenem exhibited complete in vitro activity against activity against all tested *Pseudomonas* spp. isolates (100%), followed by Norfloxacin (80.0%) and ciprofloxacin (54.5%). The highest resistance rates was observed for Tobramycin (42.9%). However, several antimicrobial agents were tested in a limited number of isolates; therefore, these findings should be interpreted with caution.

3.6- Antimicrobial susceptibility patterns of less frequently Isolated microorganisms.

Table 6. Antimicrobial susceptibility profiles of less isolated uropathogens.

Microorganism	No. of isolates (n)	Most susceptible antibiotics	Antibiotics showing resistance	Comments
Proteus spp.	5 6 6 2 3	Norfloxacin (80%)4 Ciprofloxacin (66.7%)4 Imipenem (50%)3 Ceftriaxone (50%)1	Cefuroxime (60%)3 Ciprofloxacin (33.3%)2 Imipenem (16.6%)1 Gentamicin (33. 3%) 1	Low number of isolates; results should be interpreted with caution
Streptococcus pnemoniae	3	Amoxicillin, Cefuroxime, Ceftriaxone, Cefepime, levofloxacin	Limited resistance	Small sample size
Enterobacter spp.	2	Ciprofloxacin, Gentamicin, Amikacin	Resistance observed to some B- lactams	Very few isolates
Citrobacter spp.	2	Tigecycline	Variable resistance	Very few isolates
Micrococcus luteus	1	Penicillin, Vancomycin	None	Single isolate
Acinetobacter baumannii	1	Amikacin, Cefotaxime	Penicillin, Minocycline	Single isolate
Kluyvera ascorbata	1	Most tested antibiotic	Minimal resistance	Single isolate

Note: Owing to the small number of isolates for these species, antimicrobial susceptibility results should be interpreted with caution.

Table 6. summarizes the antimicrobial susceptibility patterns of less frequently isolated microorganisms. Among Proteus spp. isolates, the highest recorded susceptibility was observed for Norfloxacin (80.0%), followed by ciprofloxacin (66.6%). Resistance was recorded against cefuroxime (60.0%), Gentamicin (33.3%), Ciprofloxacin (33.3%), other microorganisms, including *Streptococcus pnemoniae*, *Enterobacter* spp., *Citrobacter* spp., *Micrococcus luteus*, *Acinetobacter baumannii*, and *Kluyvera ascorbata*, were represented by small numbers of isolates. Therefore, their susceptibility finding are presented descriptively and should be interpreted with caution.

3.7 Antifungal susceptibility patterns of *Candida glabrata* isolates.

Table 7. Antifungal susceptibility pattern of *Candida glabrata* isolates (n = 4).

Antifungal	No. tested	Sensitive n (%)	Intermediate n(%)	Resistance rate n(%)
Flucytosine	4	(0%) 0	(0%) 0	(100%) 4
Amphotericin B	4	(0%) 0	(0%) 0	(100%) 4
Caspofungin	4	(0%) 0	(0%) 0	(100%) 4
Fluconazole	4	(0%) 0	(0%) 0	(100%) 4
Itraconazole	4	(0%) 0	(0%) 0	(100%) 4
Voriconazole	4	(0%) 0	(0%) 0	(100%) 4

All four candida glabrata isolates (n = 4) were recorded as resistant to all six tested antifungal agents: Flucytosine, amphotericin B, Caspofungin, Fluconazole, Itraconazole, and Voriconazole. No susceptible or intermediate results were recorded among the tested isolates.

4. Discussion

This study investigated the distribution of uropathogens isolated from urine cultures and evaluated their antimicrobial susceptibility patterns. A diverse range of microorganisms was identified, with *Staphylococcus* spp., *Escherichia coli*, and *Klebsiella* spp. representing the major groups, while *pseudomonas* spp., *Proteus* spp., *Candida glabrata*, and several less frequently isolated organisms occurred at lower frequencies.

4.1. Distribution of microorganisms isolated from urine cultures

A total of 291 isolates were included in the study. *Staphylococcus* spp. represented the most frequently isolated group (36.4%), followed by *Klebsiella* spp. (27.5%) and *E. coli* (25.4%). Other bacterial organisms and *Candida glabrata* were identified at lower frequencies.

This distribution differs from several previous Libyan studies in which Gram-negative organisms, particularly *E. coli*, predominated. A study conducted at Tripoli Medical Center reported *E. coli* as the most common isolate (55.68%), followed by *K. pneumoniae* (20.46%), *P. aeruginosa* (10.23%), and *p. mirabilis* (9.09%). [1]

Similarly, a study from Messalate Central Hospital reported *E. coli* in 55.6% of isolates and *K. Pneumoniae* in 16.3%. [4]

More recently, a study conducted in Zawia during 2022-2024 identified *E. coli* as the predominant pathogen (38.7%), followed by *Klebsiella* spp. (24.0%), *Proteus mirabilis* (8.0%), and *Staphylococcus aureus* (7.3%). [2]

Differences between studies may reflect variations in patient characteristics, healthcare settings, geographic location, specimen collection methods, microbiological identification procedures, and the criteria used to define clinically significant bacteriuria.

4.2. Antimicrobial susceptibility patterns

The present study demonstrated considerable variation in antimicrobial susceptibility among the different bacterial species. Importantly, the number of isolates tested was not identical for all antimicrobial agents. Therefore, susceptibility and resistance percentages were interpreted according to the number of isolates actually tested against each antimicrobial rather than the total number of isolates of a given species.

This methodological consideration is particularly important when interpreting results obtained from a small number of isolates. Such results should be regarded as descriptive observations rather than representative estimates of antimicrobial resistance.

The overall findings are consistent with recent Libya reports documenting increasing antimicrobial resistance among urinary pathogens. A recent study from Zawia reported high resistance to amoxicillin and ampicillin, while Imipenem showed relatively low resistance. The same study reported an ESBL phenotype among 43.3% of combined *E. coli* and *Klebsiella* isolates. [2]

Similarly, a 2025 study from Tripoli reported substantial resistance among Enterobacteriaceae to amoxicillin-clavulanate and third-generation cephalosporins, whereas resistance to carbapenems and fosfomycin was comparatively lower. [5]

4.3. *Staphylococcus* spp.

Staphylococcus spp. were the most frequently isolated organisms in the present study, with 106 isolates.

Although the *Staphylococcus* isolates included different species, the majority were identified as *Staphylococcus aureus*, with a smaller proportion belonging to other *Staphylococcus* species.

Among the tested antimicrobial agents, Imipenem demonstrated high in-vitro activity, with 73 of 75 tested isolates susceptible (97.3%). Amikacin also demonstrated relatively high activity, with 80 of 92 tested isolates susceptible (87.0%).

In contrast, considerable resistance was observed against several other antimicrobial agents. These findings differ partly from the results reported by the Tripoli Medical Center study, in which *S. aureus* showed substantial resistance to sulfamethoxazole, ciprofloxacin, nitrofurantoin, and other agents. [1]

Such differences may be related to variation in bacterial species, patient populations, antimicrobial exposure, and geographical or temporal factors.

4.4. *Escherichia coli*

Seventy-four *Escherichia coli* isolates were identified in the present study. Although E. coli was not the predominant organism in this dataset, it remains one of the most important uropathogens worldwide.

Imipenem showed the highest observed activity, with 64/64 isolates susceptible (100%). Norfloxacin also showed relatively high susceptibility (83.0%), while ciprofloxacin showed 73.2% susceptibility the isolates tested.

Trimethoprim-sulfamethoxazole showed 42.9% resistance among the 21 tested isolates. Although this finding is clinically relevant, the relatively limited number tested should be considered when interpreting the result.

Previous Libya studies have similarly documented important resistance among urinary E. coli. In Northwestern Libya, resistance to ampicillin reached 69.2%, while ciprofloxacin resistance was 23.1%; MDR was identified in 33.2% of E. coli isolates. [6]

The Tripoli Medical Center study reported even higher resistance to several commonly used agents, including nitrofurantoin and ciprofloxacin. [1]

A recent study from Zawia also reported that more than 40% of *E. coli* isolates were resistant to fluoroquinolones. [2]

The nitrofurantoin finding in the present study should not be strongly emphasized, because only a small number of *E. coli* isolates were tested against this antimicrobial.

4.5. *Klebsiella* spp.

Klebsiella spp. demonstrated an important resistance profile in the present study. Imipenem showed relatively high activity, with 52/59 isolates susceptible (88.1%).

Resistance to cefuroxime and trimethoprim-sulfamethoxazole was 50% among the isolates tested, while ciprofloxacin resistance was approximately 34.5% and tobramycin resistance was 25.9%.

These findings are broadly consistent with previous Libyan studies reporting substantial antimicrobial resistance among *Klebsiella* isolates. In Northwestern Libya, *Klebsiella* showed 100% resistance to ampicillin,33.3% resistance to ceftriaxone, and 17.4% resistance to ciprofloxacin, while MDR was identified in 42% of isolates. [6]

However, the present study did not specifically establish ESBL production by phenotypic or molecular testing. Therefore, resistance patterns alone should not be used to classify isolates as ESBL-producing organisms.

4.6. *Pseudomonas* spp.

Only 11 *Pseudomonas* isolates were identified in the present study; therefore, the results should be interpreted cautiously.

All 11 isolates were susceptible to Imipenem (100%). Norfloxacin also demonstrated relatively high activity, with 8 of 10 tested isolates susceptible (80.0%), While Ciprofloxacin showed 54.5% susceptibility (6/11).

Although these findings indicate retained in-vitro activity of some antimicrobial agents against the tested isolates, the small sample size limits the generalizability of these observations.

Recent studies involving Pseudomonas aeruginosa isolates from Libyan hospitals have documented multidrug resistance and carbapenemase-associated mechanisms, highlighting the importance of continuous antimicrobial resistance surveillance. [7]

4.7. *Proteus* spp.

0nly six Proteus isolates were recovered in the present study. Norfloxacin showed 80.0% susceptibility among five tested isolates, while ciprofloxacin showed 66.7% susceptibility among six tested isolates.

Cefuroxime showed 60.0% resistance among five tested isolates. These findings should be interpreted cautiously because of the small number of isolates tested for each antimicrobial agent.

4.8. Less frequently isolated organisms

The study also identified *Streptococcus pneumoniae* (n=3), *Enterobacter* spp. (n=2), *Citrobacter* spp. (n=2), *Acinetobacter baumannii* (n=1), *Micrococcus luteus* (n=1), and *Kluyvera ascorbata* (n=1).

Because of the very small number of isolates, these findings should be considered descriptive only. Previous studies have reported variations in antimicrobial resistance patterns among different bacterial species and healthcare settings.

Although these findings demonstrate microbial diversity, the small number of isolates prevents reliable estimation of antimicrobial resistance rates. Accordingly, these organisms should be presented descriptively rather than used to establish general susceptibility patterns.

4.9. *Candida glabrata*

Four isolates of *Candida glabrata* were identified in the present study. All four isolates were reported as resistant to the six tested antifungal agents.

Although this finding is noteworthy, it should not be interpreted as a population-level resistance rate because of the very small sample size.

A recent study conducted in Alexandria, Egypt, reported fluconazole resistance in 76.5% of 34 urinary *Candida* isolates, with higher resistance among non-albicans *candida* species. [8]

These findings provide a relevant comparison; however, differences in species distribution, sample size, and susceptibility testing methods should be considered when interpreting the results.

Furthermore, candiduria does not necessarily indicate symptomatic urinary tract infection, as candida recovered from urine may represent colonization or contamination in some clinical situations. These finding should be interpreted together with the patient's clinical condition.

4.10. Overall interpretation

Overall, the present study demonstrates considerable diversity among microbial isolates recovered urine cultures and substantial variation in antimicrobial susceptibility patterns. The findings are generally consistent with previous Libyan studies reporting antimicrobial resistance among urinary pathogens.

An important observation is that some antimicrobial agents, particularly Imipenem and amikacin, retained relatively high in-vitro activity against several of the tested bacterial groups, whereas other commonly used antimicrobial agents showed considerable resistance. However, these findings should not be interpreted as direct treatment recommendations. Antimicrobial selection should be based on the patient's clinical condition, the identified organism, validated CLSI\EUCAST susceptibility criteria, local antibiograms, and antimicrobial stewardship principles.

The study therefore emphasizes the need for continuous surveillance of antimicrobial resistance, periodic updating of local antibiograms, rational antimicrobial use, and further investigation of multidrug-resistant and ESBL-producing urinary pathogens in Libya.

5. Conclusions and Recommendations

This retrospective study, based on laboratory records from two private laboratories in Tajoura, Libya, demonstrated diversity in the microbial isolates obtained from urine specimens that underwent antimicrobial susceptibility testing. *Staphylococcus* spp. were among the most frequently recorded isolates, followed by *Klebsiella* spp. and *Escherichia coli*, while other microorganisms, including *candida glabrata*, were recorded at lower frequencies.

The antimicrobial susceptibility findings varied among the microbial groups and the antimicrobial agents tested. High recorded susceptibility to Imipenem was observed among the tested isolates of the principal bacterial groups,

reaching 100% for *E. coli* and 97.3% for *Staphylococcus* spp., and 88.1% for *Klebsiella* spp. These findings indicate substantial in-vitro activity of Imipenem against the tested isolates. However, they should be interpreted in relation to the number of isolates tested for each agent and the interpretive criteria applied by the laboratories.

The findings also highlight the importance of analyzing antimicrobial susceptibility results separately for each antimicrobial agent, using the number of isolates tested for that agent as the denominator rather than assuming that all isolates underwent testing against every antimicrobial agent.

The study supports the importance of strengthening local surveillance of antimicrobial susceptibility and resistance patterns. Nevertheless, because the analysis relied on retrospective laboratory records and some microbial groups were represented by small numbers of isolates, the findings should not be generalized directly to all patients or all urinary tract infections in Tajoura or Libya.

Overall, this study provides a local description of the microbial isolates recorded and their documented antimicrobial susceptibility patterns in the two participating laboratories. It may serve as a basis for further studies using standardized testing procedures and clearly documented interpretive criteria.

5.2. Recommendations

Based on the study findings and limitations, the following recommendations are proposed:

1. Strengthen local antimicrobial resistance surveillance.
2. Standardize and document antimicrobial susceptibility testing procedures and interpretive criteria.
3. Improve laboratory data recording, particularly the number of isolates tested for each antimicrobial agent.
4. Promote the rational use of antibiotics and antimicrobial stewardship.
5. Conduct larger studies involving multiple healthcare facilities.
6. Improve the documentation of antifungal susceptibility testing, particularly for Candida glabrata.
7. Investigate important resistance mechanisms, such as extended-spectrum beta-lactamase (ESBL) production, where feasible.

6.References:

[1] Ben Ashur A, El Magrahi H, Elkammoshi A, Alsharif H. prevalence and antibiotics susceptibility pattern of urine bacterial isolates from Tripoli Medical Center (TMC), Tripoli, Libya. Iberoam J Med. 2021;3(3):221-226.

[2] Eswaey IO, Alghoj MA, Abu Sneana M, Izeit H, Jwely JM. Antimicrobial resistance patterns among uropathogens isolated from positive urine cultures: a cross-sectional study. University of Zawia journal of Medical Sciences. 2025;1(2):64-69.

[3] World Health Organization. Global Antimicrobial Resistance and Use Surveillance System(GLASS). Geneva: World Health Organization. Available from: https://WWW.Who.int/initiatives/glass/

[4] Mohammed MA, Alnour TMS, Shakurfo OM, Aburass M. Prevalence and antimicrobial resistance pattern of bacterial strains isolated from patients with urinary tract infection in Messalata Center Hospital, Libya. Asian pac J Trop Med. 2016;9(8):771-776.

[5] Tamer A, Mansour M,Farag S. Prevalence and antibiotic resistance of Enterobacteriaceae in urinary tract infections: A retrospective study at Secondary Healthcare Center-Tripoli, Libya. Tripolitana Medical Journal. 2025; 14(1).

[6] Abujnah AA, Zorgani A, Sabri MAM, El-Mohammady H, Khalek RA, Ghenghesh KS. Multidrug resistance and extended-spectrum B-lactamases genes among Escherichia coli from patients with urinary tract infections in Northwestern Libya. Libyan J Med.2015; 10(1):26412.

[7] Gadaime NK, Haddadin RN, Shehabi AA, Omran IN. Antimicrobial resistance and carbapenemase dissemination in Pseudomonas aeruginosa isolates from Libyan hospitals: a call for surveillance and intervention. Libyan J Med. 2024; 19(1):2344320.

[8] Zeitoun H, Salem RA, EL-Guink NM, Tolba NS, Mohamed NM. Elucidation of the mechanisms of fluconazole resistance and repurposing treatment options against urinary Candida spp. isolated from hospitalized patients in Alxandria, Egypt. BMC Microbial. 2024;24:383.

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