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Research Article

A Cross-Sectional Study of Pathogenic Bacteria Isolated from Women Infected with Urinary Tract Infections

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Abstract

Background: Urinary tract infections (UTI) are among the most common bacterial infections, affecting millions worldwide, particularly women. The urinary tract consists of the upper (kidneys and ureters) and lower (bladder and urethra) parts, and infections can occur in either region.
Objective: Using a phenotypic method, the study aims to isolate and identify pathogenic bacteria from women with urinary tract infections and β-lactamases detection.
Methodology: In this study, 155 urine samples were collected from women with UTI from June 2024 to January 2025. We used standard laboratory methods to culture urine, diagnose all bacterial isolates on laboratory media, and test antibiotic resistance using the Kirby-Bauer disc diffusion methodology.
Results: Out of the total of 155 urine samples, there were 236 positive bacterial cultures; 123 (52%) gram-negative, and 113 (48%) gram-positive. The results revealed that out of a total of 236 bacterial isolates; there were 78 *E.coli* (33%), 57 *E.faecalis* (24%), 48 *S.aureus* (20.3%), 37 *K.pneumoniae* (16%), 8 *S.heamolyticus* (3.3%), 5 *P.mirabilis* (2.1%) and 3 *P.aeruginosa* (1.3%). The results showed that all bacterial isolates from chronic infections were highly resistant to most antibiotics than those isolated from acute infections. Out of a total of 123 gram-negative bacteria, there were 40 isolates (32.5%) that were positive ESBL according to the phenotypic detection method.
Conclusion: Urinary tract infections in women are often caused by *E.coli, E.faecalis,* and *S. aureus*. Compared with bacteria isolated from acute infections, most chronic infection isolates were highly resistant to antibiotics.

1. Introduction

Urinary tract infections are a common and potentially serious health problem, affecting millions of people worldwide [1]. The urinary tract, which includes the kidneys, ureters, bladder, and urethra, is susceptible to bacterial, fungal, and viral infections, with bacterial infections being the most prevalent. Epidemiological studies have shown that urinary tract infections disproportionately affect women, with approximately one in two women experiencing at least one UTI in their lifetime, and one in four experiencing recurrence [2]. The prevalence of UTIs is also higher in certain populations, such as individuals with diabetes, those with urinary tract abnormalities, and those who have recently undergone urological procedures [3]. The most common causative agents of UTIs are *Escherichia coli* and *Staphylococcus saprophyticus*, accounting for up to 80% of community-acquired uncomplicated urinary infections in women under 50 years of age. However, in tertiary care settings, the etiological agents and their antimicrobial sensitivity patterns may differ, as these facilities often cater to patients who have been partially treated or maltreated [4].

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Urinary Tract Infections caused by Extended-Spectrum Beta-Lactamase producing bacteria have become an increasingly concerning public health issue due to their widespread emergence and the challenges they present in terms of effective treatment. The production of extended-spectrum beta-lactamases by uropathogens allows them to hydrolyze and confer resistance to a wide range of beta-lactam antibiotics, including penicillins, third-generation cephalosporins, and monobactams [5]. The epidemiology of ESBL-producing Enterobacteriaceae has been extensively studied, with reports indicating a global rise in the prevalence of these multidrug-resistant organisms. In particular, *Klebsiella pneumoniae*, a common causative agent of UTIs, has been observed to harbor genes responsible for beta-lactam resistance on plasmids, which can be readily transferred among different bacterial species, further exacerbating the problem [6].

The impact of ESBL-producing *Enterobacteriaceae* infections in critically ill patients, such as those in intensive care units, has been a subject of increasing concern. The spread of these resistant pathogens in such settings can have profound consequences, leading to poorer patient outcomes and increased reliance on last-resort carbapenem antibiotics [7].

Accurate microbiological diagnosis and appropriate antimicrobial therapy for invasive ESBL-producing infections remain challenging, as highlighted by several expert recommendations [8]. The scarcity of randomized controlled trials in this area necessitates the need for further research to guide clinical decision-making and inform effective strategies to combat the threat of ESBL-producing uropathogens [9].

2. Methodology

2.1. Isolation and Identification

155 urine samples were collected during the study period (June 2024 to January 2025) from 155 women with urinary tract infections. Cultural characteristics and biochemical tests were used to identify all growing bacterial isolates, and finally, the Vitek-2 system was used to identify all growing bacteria onto cultures media.

2.2. Antibiotics Sensitivity Test

The susceptibility to antibiotics was tested using the Kirby-Bauer disc diffusion technique [10]. After being adjusted appropriately, five new bacterial colonies were suspended in nutritional broth (0.5 McFerland standard tubes with $1.5\text{x}10^8$ CFU per ml). Mueller Hinton agar was streaked with suspension, coated with all antibiotic discs, and incubated aerobically for 24 hours at 37°C. Twelve antibiotics were utilised in this study: 25g of amoxicillin, 25/10g of amoxicillin+clavulanic acid, 30g of cefotaxime, 30g of ceftriaxone, 30g of ceftazidime, 5g of levofloxacinxacin, 15g of gentamicin, 30UI of tetracycline, 30g of imipenem, 10g of tobramycin, and 10g of imipenem [11]. The Clinical and Laboratory Standards Institute establishes standards for antibiotic sensitivity and resistance based on the width of the bacterial growth [12].

2.3. Phenotypic detection of Extended Spectrum Beta lactamases- producing bacteria

In accordance with the 0.5 McFerland standard tube (1.5×10^8 CFUs/ml), the bacterial suspension was adjusted. In the middle of the Mueller Hinton agar plate, surrounded by three sides of 30 μg of ceftriaxone, were 10 μg of amoxicillin and 20 μg of clavulanic acid [13]. The plates were incubated at 37°C for 24 hours after cefotaxime (30 μg) and ceftazidime (30 μg) were positioned 15 mm from the centre of amoxicillin (10 μg) with clavulanic acid (20 μg). Any increase in the inhibition zone towards AMC disc 30μg was considered as positive for the extended spectrum beta-lactamase.

2.4. Statically analysis

Data has been compared using percentages using the Graph-Pad Prism program version 8.

3. Results

3.1. Total Urine Samples and Total Bacterial Isolates

In this study, 155 urine samples were collected from 155 women infected with UTI. The results of the current study showed that out of total 155 urine samples, there were 236 positive bacterial cultures. Out of total 236 bacterial isolates, there were 123 (52%) were Gram-negative and 113 (48%) were Gram-positive bacteria. 56 (23.7%) isolated from acute urinary tract infection and 180 (76.3%) isolated from chronic urinary tract infection Table 1.

Table 1: Total bacterial isolates from women infected with acute and chronic urinary tract infections.

Bacterial isolates	Acute infection	Chronic infection	Total (%)
Gram-negative	33 (27%)	90 (73%)	123 (52%)
Gram-positive	23 (20%)	90 (80%)	113 (48%)
Total (%)	56 (23.7%)	180 (76.3%)	**236 (100%)**

On the other hand, the results documented that out of total of 236 bacterial isolates, there were 171(72.5%) isolated from married women infected with urinary tract infection and there were 65(27.5%) isolated from not married women, 136 isolated from pregnant women and 35 isolated from not pregnant women Table 2.

Table 2: Total bacterial isolates from married and not married women infected with urinary tract infection.

Bacterial isolates	Married		Not married	Total (%)
	Pregnant	Not Pregnant		
Gram-negative	70	20	33	**123(52%)**
Gram-positive	66	15	32	113(48%)
Total	136	35		
Total (%)	**171(72.5%)**		**65(27.5%)**	**236 (100)**

3.2. Total Bacterial Isolates from Women According to Age Group

According to the results of Gram stain Table 3, 85 isolates (36%) from women with age group 21-30 years old followed by age group 31-40 years old with 49 bacterial isolates (21%). The third highest number of age group that isolated was 10-20 years old with 39 bacterial isolates (16.5%), while, 36 bacterial isolates (15%) belong to age group 51-60 years, the lowest age group was 41-50 with 27 bacterial isolates.

Table 3: Total bacterial isolates from women infected with acute and chronic urinary tract infections.

Bacterial isolates	Age/Year					Total (%)
	10-20	21-30	31-40	41-50	51-60	
Gram-negative	23	42	28	11	19	123 (52%)
Gram-positive	16	43	21	16	17	113(48%)
Total (%)	**39(16.5)**	**85(36)**	**49(21)**	**27(11.5)**	**36(15)**	**236(100)**

3.3. Total Gram- Negative Bacteria

The results showed that there were 33 Gram-negative bacteria isolated from women infected with acute urinary tract infection. Five bacterial isolates from age group 10-20 years old, followed by age group 21-30 years with 14 isolates and 10 isolates from age group 31-40 years, while, the age group 41-50 and 51-60 years was the lowest with 2 bacterial isolates from each group.

Out of total 33 bacterial isolates, there were 24 isolated from married women and 9 isolated from not married women. While, the results showed that there were 90 Gram-negative bacterial isolates from women infected with chronic urinary tract infection, 18 bacterial isolates from age group 10-20 years old, followed by age group 21-30 years with 28 isolates and 18 isolates from age group 31-40 years, while, the age group 41-50 with 9 bacterial isolates and there were 17 isolates from age group 51-60, 66 isolates from urine of married women and 24 were isolated from urine of not married women Table 4.

Table 4: Distribution of Gram-Negative bacteria isolated from women's urine infected with urinary tract infection according to type of infection.

Total 123 Gram-Positive bacterial isolates			Age / year					Total (%)
			10-20	21-30	31-40	41-50	51-60	
Acute infection (33)	Married 24	Pregnant 18	0	10	7	1	0	18
		Not pregnant 6	0	2	3	1	0	6
	Not married 9		5	2	0	0	2	9
Total 33			**5**	**14**	**10**	**2**	**2**	**33(27%)**
			10-20	20-30	31-40	41-50	51-60	Total
Chronic infection (90)	Married 66	Pregnant 52	0	19	9	7	17	52
		Not pregnant 14	0	9	5	0	0	14
	Not married 24		18	0	4	2	0	24
Total 90			**18**	**28**	**18**	**9**	**17**	**90(73%)**
Total 123 (100%)			**23**	**42**	**28**	**11**	**19**	**123(100%)**

3.4. Total Gram-Positive Bacteria

The results showed Table 5 that out of total 113 gram positive bacterial isolates; there were 23 (20%) Gram-positive bacterial isolated from women infected with acute urinary tract infection and 90 (80%) bacterial isolated from women infected with chronic urinary tract infection. Six bacterial isolates from age group 10-20 years old, followed by age group 21-30 and 31-40 years with 3 isolates and 4 isolates from age group 41-50 years, while, the age group 51-60 was 7 bacterial isolates.

Out of total 23 bacterial isolates, there were 11 isolated from married women and 12 isolated from not married women. While, the results showed that there were 90 Gram-positive bacterial isolates from women infected with chronic urinary tract infection, 16 bacterial isolates from age group 10-20 years old, followed by age group 21-30 years with 43 isolates and 21 isolates from age group 31-40 years, while, the age group 41-50 was 16 bacterial isolates and there were 17 isolates from age group 51-60. There were 47 isolated from urine of married women and 43 were isolated from urine of not married women.

Table 5: Distribution of Gram-Positive bacteria isolated from women's urine infected with urinary tract infection according to type of infection.

Total 113 Gram-Positive bacterial isolates			Age / year					Total (%)
			10-20	21-30	31-40	41-50	51-60	
Acute infection (23)	Married 11	Pregnant 6	0	0	2	4	0	6
		Not pregnant 5	1	0	0	0	4	5
	Not married 12		5	3	1	0	3	12
Total 23			**6**	**3**	**3**	**4**	**7**	**23(20%)**
			10-20	20-30	31-40	41-50	41-50	Total
Chronic infection (90)	Married 47	Pregnant 21	0	10	10	1	0	21
		Not pregnant 26	1	10	4	6	5	26
	Not married 43		9	20	4	5	5	43
Total 90			**10**	**40**	**18**	**12**	**10**	**90(80%)**
Total 113 (100%)			**16**	**43**	**21**	**16**	**17**	**113(100%)**

3.5. Numbers and Percentages of Total Bacterial Isolates

The results revealed that out of total 236 bacterial isolates; there were 78 *E.coli* isolates (33%) from women's urine infected with UTI, 57 *E.faecalis* (24%), 48 *S.aureus* (20.3%), 37 *K.pneumoniae* (16%), 8 *S.heamolyticus* (3.3%), 5 *P.mirabilis* (2.1%) and 3 *P.aeruginosa* (1.3%) Figure 1 and 2.

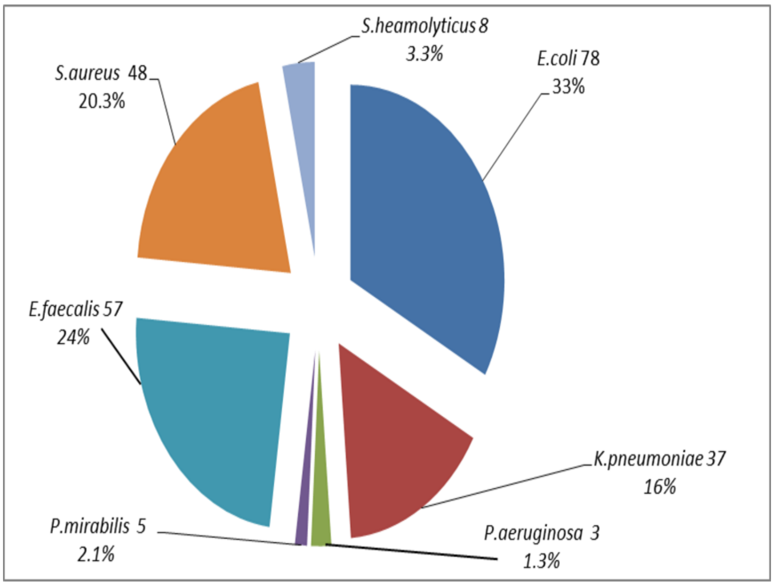

Figure 1: Numbers and percentages of total bacterial isolates from women's urine infected with urinary tract infection in this study

3.6. Antibiotics Resistance

Gram Negative Bacteria that were Sensitive and Resistance to Antibiotics

The results showed that all bacterial isolates from chronic infections were highly resistance to the most antibiotics than isolates that were isolated from acute infections. *E.coli*, *K.pneumoniae* and *P. aeruginosa* were highly resistance to amoxicillin while *P. mirabilis* was resistance with moderate percentages.

On the other hand, the results showed that there were out of total 78 E.coli isolates, there were 2 isolates (2.5%) that were resistance to Imipenem isolated from chronic infection. Also, out of total 37 *K.pneumoniae* isolates, there were 2 isolates (5%) that were resistance to Imipenem isolated from chronic infection, while out of total 3 *P.aeruginosa* isolates, there was 1 isolates (33%) that were resistance to Imipenem isolated from chronic infection. The findings revealed that *E.faecalis* isolates from chronic infections had moderate resistance to most antibiotics. While *S.aureus* isolates from chronic infections was highly resistance to most antibiotics. On the other hand, *S.heamolyticus* isolates was low resistance to the antibiotic Table 7.

3.7. Extended Spectrum Beta Lactamase Producing Bacteria

The results of the current study demonstrated that out of total 123 gram negative bacteria, there were 40 isolates (32.5%) were ESBL-producing gram negative bacteria according to phenotypic detection method Table 8. Of the 78 *E.coli* isolates, there were 16(20.5%) were ESBL-Producing bacteria (Table 4.11) and out of total 37 *K.pneumoniae* isolates, there were 21(56.7%) were ESBL-Producing bacteria. Out of total 5 *P.mirabilis* isolates, there were 2(40%) ESBL-Producing bacteria, while, of the 3 *P.aeruginosa* isolates, only 1(33.3%) were ESBL-Producing bacteria Table 8 Figures 3 and 4).

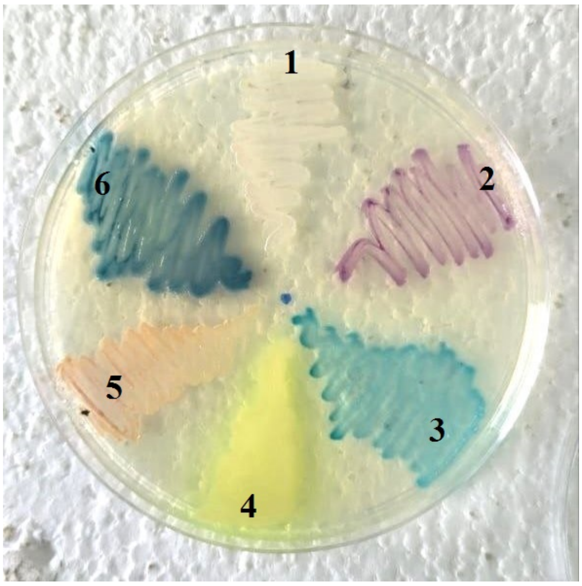

Figure 2: Bacterial growth onto CHROMagar agar medium at 37°C for 24 h. 1: *S.aureus*, 2: *E.coli*, 3: *E.faecalis,* 4: *P.aeruginosa*, 5: *P.mirabilis*, 6: *K.pneumoniae*

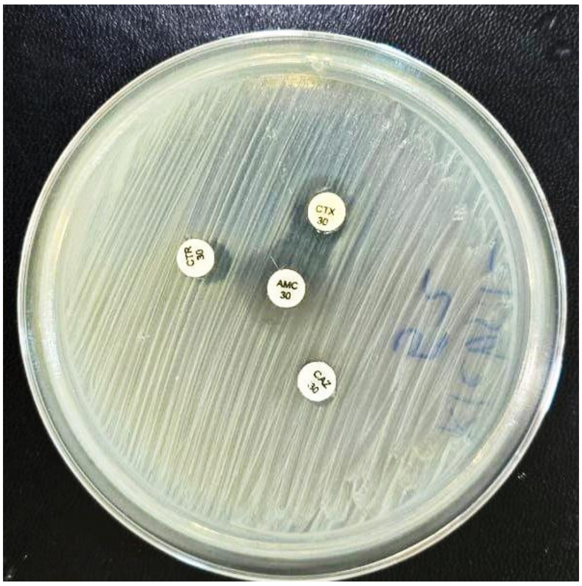

Figure 3: Positive result of ESBL-Producing *E.coli* isolated from women infected with chronic UTI

4. Discussion

Urinary tract infections are a common healthcare concern, affecting millions of individuals worldwide. These infections can range from acute, uncomplicated cases to more chronic and complicated forms, with varying etiologies and management strategies [14]. The initial diagnosis of acute uncomplicated cystitis is typically based on the patient's medical history and presenting symptoms, such as urinary urgency, frequency, pain upon voiding, lower abdominal discomfort, and changes in urine appearance [15]. Urinalysis can provide supporting evidence, with the presence of red blood cells, high nitrite levels, and leukocyte esterase being indicative of an active infection. However, the gold standard for diagnosis remains the bacteriological urine culture, which allows for the identification of the causative agent and antimicrobial susceptibility testing [16]. Urinary tract infections are a common health issue for women, affecting millions of individuals worldwide. *Escherichia coli* and *Staphylococcus saprophyticus* are the most prevalent causative agents, accounting for around 80% of community-acquired uncomplicated urinary infections in women under 50. Additionally, gram-negative bacteria like *Klebsiella* species, Proteus mirabilis, *Pseudomonas aeruginosa*, *Acinetobacter*, and *Serratia* are also frequently isolated from pediatric patients with UTIs, though they only account for 10% of cases [17]. The high prevalence of UTIs in women is likely due to several factors, including anatomical differences, hormonal effects, and behavioral patterns.

Several studies have investigated the prevalence and antibiotic resistance patterns of bacteria causing urinary tract infections. These studies have generally found that Escherichia coli is the most common uropathogen, but the frequency of other gram-negative bacteria such as Klebsiella and the emergence of extended-spectrum beta-lactamase-producing and carbapenem-resistant Enterobacteri-aceae are also on the rise [18]. The reported data on antimicrobial susceptibility patterns have been conflicting, highlighting the need for local surveillance to guide empirical treatment decisions [19]. Infection rates tend to increase with age, and the resistance of urinary tract pathogens to commonly prescribed antibiotics has increased worldwide over the last decade, leading to serious therapeutic challenges. Since the distribution of these

Table 6: Total gram negative bacteria isolated from women infected with urinary tract infection that were sensitive and resistance to antibiotics.

AB	*E.coli 78*				*K.pneumoniae 37*				*P.mirabilis 5*		*P.aeruginosa 3*	
	Acute 21 No. (%)		Chronic 57 No. (%)		Acute 12 No. (%)		Chronic 25 No. (%)		Chronic 5 No. (%)		Chronic 3 No. (%)	
	S	R	S	R	S	R	S	R	S	R	S	R
AX	10 (13)	11(14)	22(28)	35(45)	8(22)	4(11)	5(13)	20(54)	3(60)	2(40)	0(0)	3(100)
AMC	15(19)	6(8)	24(31)	33(42)	9(25)	3(8)	5(13)	20(54)	3(60)	2(40)	0(0)	3(100)
CTX	15(19)	6(8)	24(31)	33(42)	8(22)	4(11)	7(18)	18(49)	3(60)	2(40)	0(0)	3(100)
CRO	14(18)	7(9)	23(29.5)	34(43)	8(22)	4(11)	7(18)	18(49)	2(40)	3(60)	0(0)	3(100)
CAZ	16(20.5)	5 (6.5)	5(6.5)	30(38)	7(19)	5(14)	10(27)	15(40)	2(40)	3(60)	0(0)	3(100)
LIV	19(24.5)	2(2.5)	29(37)	28(36)	5(13)	7(18)	9(23)	16(43)	3(60)	2(40)	0(0)	3(100)
CN	19(24.5)	2(2.5)	37(47)	20(26)	7(18)	5(14)	5(14)	20(54)	2(40)	3(60)	0(0)	3(100)
CIP	20(26)	1(1)	37(47)	20(26)	7(18)	5(14)	7(18)	18 (49)	2(40)	3(60)	0(0)	3(100)
TE	18(23)	3(4)	27(35)	30(38)	5(14)	7(18)	11(30)	14(38)	3(60)	2(40)	0(0)	3(100)
AK	20(26)	1(1)	37(47)	20(26)	10(27)	2(5)	15(41)	10(27)	2(40)	3(60)	0(0)	3(100)
TM	13(17)	8(10)	37(47)	20(26)	10(27)	2(5)	15(41)	10(27)	2(40)	3(60)	0(0)	3(100)
IMP	21(27)	0(0)	55(70.5)	2(2.5)	12(33)	0(0)	23(62)	2(5)	5(100)	0(0)	2 (67)	1(33)

AB: Antibiotics, S: Sensitive, R: Resistance, AX: Amoxicillin 25μg,
AMC:Amoxicillin+clavulanic acid 325/10μg, CTX: Cefotaxime 30μg,
CRO: Ceftriaxone 30μg, CAZ: Ceftazidime 30μg,
LIV: Levofloxacin 5μg, CN: Gentamicin 15μg, CIP: Ciprofloxacin 5μg,
TE: Tetracycline 30 UI, AK: Amikacin 30μg, TM: Tobramycin 10μg, IMP: Imipenem 10μg.

Table 7: Total gram positive bacteria isolated from women infected with urinary tract infection that were sensitive and resistance to antibiotics.

AB	*E.faecalis 57*				*S.aureus 48*				*S.heamolyticus 8*	
	Acute 18 No. (%)		Chronic 39 No. (%)		Acute 5 No. (%)		Chronic 43 No. (%)		Chronic 8 No. (%)	
	S	R	S	R	S	R	S	R	S	R
AX	10(18)	8(14)	20(35)	19(33)	2(4)	3(6)	18(37)	25(52)	8(100)	0(0)
AMP	10(18)	8(14)	20(35)	19(33)	2(4)	3(6)	23(48)	20(41)	6(75)	2(25)
AMC	12(21)	6(11)	24(42)	15(26)	2(4)	3(6)	23(48)	20(41)	7(87)	1(13)
AZM	12(21)	6(11)	30(53)	9(16)	3(6)	2(4)	25(52)	18(37)	7(87)	1(13)
CIP	13(23)	5(8)	30(53)	9(16)	3(6)	2(4)	28(85)	15(31)	6(75)	2(25)
CLI	13(23)	5(9)	27(47)	12(21)	2(4)	3(6)	28(58)	15(31)	5(63)	3(37)
RIF	18(32)	0(0)	27(47)	12(21)	2(4)	3(6)	31(64)	12(25)	5(62)	3(38)
VAN	18(32)	0(0)	27(47)	12(21)	3(6)	2(4)	28(58)	15(31)	7(87)	1(3)
TET	18(32)	0(0)	24(42)	15(26)	3(6)	2(4)	23(48)	20(41)	4(50)	4(50)
E	18(32)	0(0)	24(42)	15(26)	2(4)	3(6)	23(48)	20(41)	4(50)	4(50)

AB: Antibiotics, S: Sensitive, R: Resistance, AX: Amoxicillin 25μg,
AB: Antibiotics, S: Sensitive, R: Resistance, AX: Amoxicillin 25μg,
AMP: Ampicillin 10 μg, AMC:Amoxicillin+clavulanic acid 25/10μg,
AZM: Azithromycin 30 μg, CIP: Ciprofloxacin 5μg, CLI: Clindamycin 2 μg RIF: Rifampicin 30 μg,
VAN: Vancomycin 30 μg, TET: Tetracycline 30 μg, E: Erythromycin 30 μg.

pathogens and their susceptibility to antibiotics varies regionally, the local epidemiological characteristics and antibiotic resistance patterns must be adequately known to achieve good therapeutic outcomes and prevent the emergence of drug-resistant bacterial strains [20].

The incidence of extended-spectrum beta-lactamase-producing Enterobacteriaceae has been steadily increasing worldwide, posing a significant threat to public health. These multidrug-resistant organisms are capable of hydrolyzing a wide range of beta-lactam antibiotics, including cephalosporins and monobactams, rendering many common treatment options ineffective [21]. Escherichia coli and Klebsiella species are the most prevalent ESBL-producing pathogens, frequently responsible for urinary tract infections and other serious infections. Strains expressing these enzymes present unique challenges, as the detection of ESBLs can be complex, and treatment options are often limited. Proper infection control practices, such as hand hygiene and the judicious use of antibiotics, are essential to prevent the spread and outbreaks of ESBL-producing bacteria [22]. Clinicians must be vigilant in identifying these resistant organisms, as they are associated with poorer clinical outcomes and increased mortality compared to infections caused by non-ESBL-producing strains. Timely and accurate diagnosis of ESBL-producing uropathogens is crucial for guiding appropriate antibiotic therapy. Carbapenems are often considered the drugs of choice for the treatment of severe ESBL-producing Enterobacteriaceae infections, although comparative clinical trials are limited [23]. Alternative antimicrobial agents, such as tigecycline and fosfomycin, have shown promising activity against these multidrug-resistant pathogens and merit further evaluation

Table 8: Total bacterial isolates from women infected with acute and chronic urinary tract infections.

ESBL-Producing bacteria	Single growth 3 isolates		Mix growth 37 isolates		Total (%)
	Acute	Chronic	Acute	Chronic	
E.coli 78	1	1	3	11	16(20.5%)
K.pneumoniae 37	0	1	7	13	21(56.7%)
P.mirabilis 5	0	0	1	1	2(40%)
P.aeruginosa 3	0	0	0	1	1(33.3%)
Total 123	1	2	11	26	40 (32.5%)

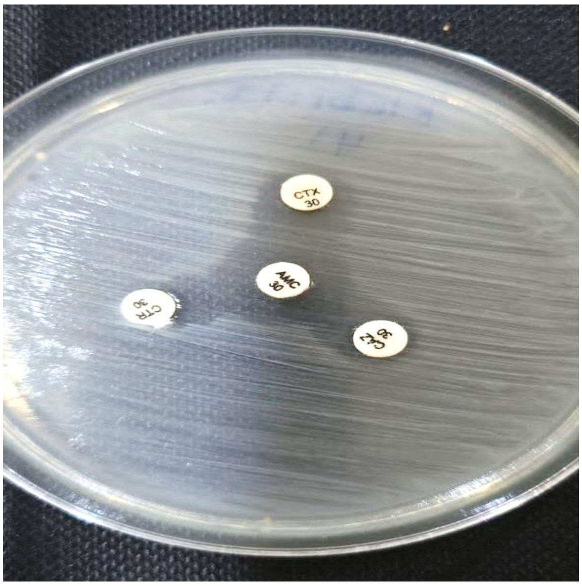

Figure 4: Positive result of ESBL-Producing *K.pneumoniae* isolated from women infected with chronic UTI

5. Conclusion

According to this study, urinary tract infections in women are often caused by *E.coli, E.faecalis,* and *S.aureus*. Compared with bacteria isolated from acute infections, most chronic infection isolates were highly resistant to antibiotics.

Article Information

Availability of data and material: Data are available upon request.
Competing interests: Regarding the research, authorship, and/or publishing of this paper, the author(s) state that they have no possible conflicts of interest. This work has never been published before, and it isn't being considered by any other journals.
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