Journal of Advanced Zoology

ISSN: 0253-7214

*Volume **45 Special** Issue **02 Year 2023** Page **1406:1420***

Antibiotic resistance patterns in individuals with urinary tract infections: Bacterial profile

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Article History
Received: 11 March 2023
Revised: 21 August 2023
Accepted: 03 October 2023

ABSTRACT

Urinary tract infections (UTIs) are one of the most significant problems in medical science. Were also common bacterial infections that impact 150 million individuals each year globally. Serious consequences include frequent recurrences, pyelonephritis, kidney damage, premature delivery, and difficulties from repeated antibiotic treatment. The current study aims to identify the bacterial profile and antibiotic resistance trend among urinary tract infection patients. From October 2021 to April 2022, 185 patients with urinary tract infections were admitted to Rizgary Teaching Hospital in the Erbil-Kurdistan area. A systematic questionnaire was used to collect cultural and clinical information. Standard microbiological practices were used for culture and antibiotic resistance testing. According to the location of the infection, clinical specimens from the investigated patients showed a bacterial infection rate of 51.3%. Enterococcus faecalis (56.8%), Staphylococcus spp. (21%), Klebsiella pneumoniae (11.57%), Pseudomonas aeruginosa, and Streptococcus spp. (5.2%) were among the most common bacteria isolated. These bacterial isolates were antibiotic-resistant to various degrees. Many antibiotics, such as Cefotaxime, Nalidixic acid, and Amikacin, were resistant to Gram-negative bacteria, whereas Imipenem and Cefixime were sensitive. While Cefotaxime and Nalidixic Acid are resistant to Gram-positive bacteria, Imipenem, Ciprofloxacin, and Norfloxacin are highly sensitive. In conclusion, the significant prevalence of organisms and their resistance to widely used antibiotics raises questions about potential future treatments for these ailments.

Keywords: Bacterial Profile, Antibiotic Resistance Pattern, Urinary tract infections

1. INTRODUCTION

One of the most widespread infections in humans, urinary tract infections (UTI), is mainly brought on by bacterial pathogens globally (Otajevwo, 2013). It has a variety of clinical symptoms that impact the lower and upper urinary tracts, such as fever, dysuria, urgency, burning, and transient suprapubic discomfort (Adugna et al., 2021). It is second in frequency after respiratory tract infections and contributes significantly to antibiotic prescriptions. The majority of instances of UTI are caused by bacteria, which can be either Gram-positive or Gram-negative and account for 80–85% and 15-20% of cases, respectively (Pai and Nair, 2012), (Foxman, 2014). Urinary tract infections begin with peri-urethral contamination by uropathies found in intestinal flora colonization, which then travel up the urethra to the bladder and onto the kidney or prostate. Whether uropathies' are successfully colonized or eradicated depends on the interactions between the host-pathogen complex and the pathogen. UTIs are a relatively prevalent illness in the community and in medical facilities (Khandelwal et al., 2009).

E. coli and Klebsiella species are the most prevalent components of the intestinal microbial flora that cause community-acquired UTIs. Around the world, 80% and 5-15% of cases of community-acquired UTI are caused by E. coli and Saprophyticus, respectively. The remaining 5-10% of cases are caused by aerobic gram-negative rods such as Klebsiella spp., Proteus spp., and other Enterobacter SPP (Hooton et al., 2010).Since they are the ones that happen more frequently and are typically connected to the use of a medical instrument like catheterization, hospital-acquired urinary tract infections stand out from all other hospital-acquired infections. These infections are mostly healthcare-related. Compared to patients with CAUTI, hospitalized patients with UTI have more comorbidities, are recurrent, and have previously taken antibiotics more often (Hooton et al., 2010; Ashraf et al., 2015). Septicemia is frequently brought on by urinary tract infections, which increases death rates, lengthens hospital stays, and raises healthcare expenses (Fagan et al., 2015).

Antibiotics are frequently prescribed to patients with symptomatic UTIs; nevertheless, these medications have the potential to permanently change the natural microbiota of the vagina and gastrointestinal tract and to foster the growth of multidrug-resistant microbes (Kostakioti et al., 2012).The sensitivity of bacteria to antibiotics also changes with the period; with the advent of multidrug-resistant organisms since the discovery of antimicrobial drugs, germs have gained resistance to them via processes such as increased enzyme production and mutations (Anderson et al., 2012). Antibiotic resistance is a significant issue on a global scale (Graffunder et al., 2005).

2. Urinary tract infections (UTIs)

are widespread bacterial illnesses that impact 150 million people annually globally. Serious consequences include frequent recurrences, pyelonephritis, kidney damage, premature delivery, and difficulties brought on by repeated antibiotic treatment.

Uncomplicated and complicated UTIs are separated into two categories. People who are generally healthy and have no anatomical or neurological abnormalities of the urinary system are frequently affected by uncomplicated UTIs. The term "complicated UTIs" refers to UTIs that are linked to conditions that weaken the body's ability to protect the urinary tract, such as urinary obstruction, neurologically-related urinary retention, immunosuppression, renal failure, renal transplantation, pregnancy, and the presence of foreign objects like calculi, indwelling catheters, or other drainage devices (Flores-Mireles et al., 2015).

2.1. Bacterial Infection

Epidemiology of urinary tract infections ARE Both Gram-negative and Gram-positive bacteria, as well as certain fungi, are responsible for UTIs. Uropathogenic Escherichia coli is the most frequent culprit behind simple and complex UTIs (UPEC). Klebsiella pneumoniae, Staphylococcus saprophyticus, Enterococcus faecalis, group B Streptococcus (GBS), Proteus mirabilis, Pseudomonas aeruginosa, Staphylococcus aureus, and Candida spp. Follow UPEC in prevalence among the bacteria that cause simple UTIs (Foxman, 2010). Following UPEC as the most prevalent causative agent for complex UTIs, the order of majority for other causative agents is as follows: Enterococcus spp., K. pneumoniae, Candida spp., S. aureus, P. mirabilis, and P. aeruginosa (Jacobsen et al., 2008)**,** (Fisher et al., 2011).

2.2 Bacteria and Bacterial Syndromes

Gram-Positive Bacteria (GPB)**:** Gram-positive bacteria are categorized according to the color they take on when stained. The staining technique was created by Hans Christian Gram in 1884. The peptidoglycan present in gram-positive organisms' thick cell walls absorbs the crystal violet dye used in the staining process. When gram-positive organisms undergo this process, they take on a blue hue. Bacteria may be distinguished by shape using additional information. Branching filaments, bacilli, and cocci are all examples of Gram-positive bacteria. The peptidoglycan cell wall is thicker in gram-positive species. Staphylococci and streptococci are two examples of Gram-positive bacteria that can split their cell walls but not always separate themselves, continuing to proliferate as chains of cells (Sizar and Unakal, 2020).

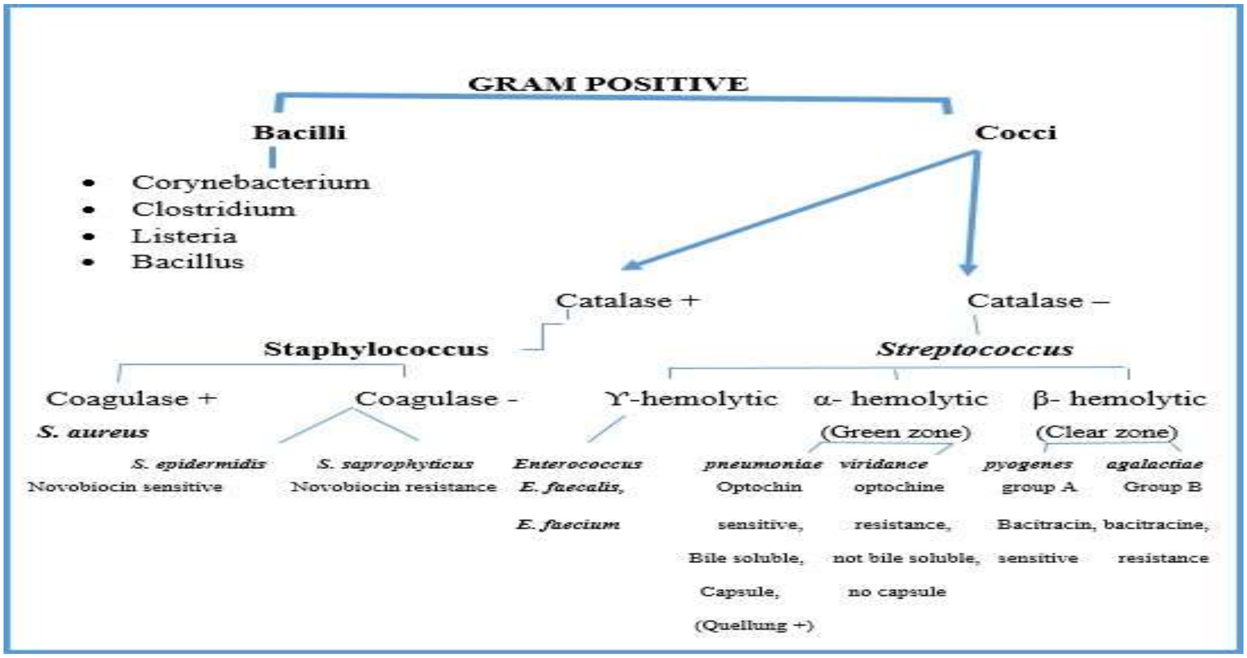


Figure 1: Species identification of GPB in clinical settings (Sizar and Unakal, 2020).

2.3 Gram-Negative Bacteria (GNB)

Gram-staining, a technique for differentiating gram-negative bacteria, does not cause crystal violet to absorb the color. Gram-negative bacteria are distinguished by their thin peptidoglycan cell walls, which are sandwiched between the inner and outer membranes of the cytoplasm. Bacilli are gram-negative and comprise a wide variety of species. Some of them result in urinary issues (Enterobacter cloacae, Escherichia coli, Serratia marcescence, and Proteus mirabilis), gastrointestinal issues (Pseudomonas aeruginosa, Klebsiella pneumoniae, and Legionella pneumophila), and respiratory illnesses (Legionella pneumophila) (Salmonella typhi, Salmonella enteritidis, and Helicobacter pylori). Acinetobacter baumannii, a gram-negative bacterium that causes secondary meningitis, bacteremia, and ventilator-associated pneumonia in intensive care units, is one of the gram-negative bacteria linked to hospital-acquired illnesses (Levison, 2014).

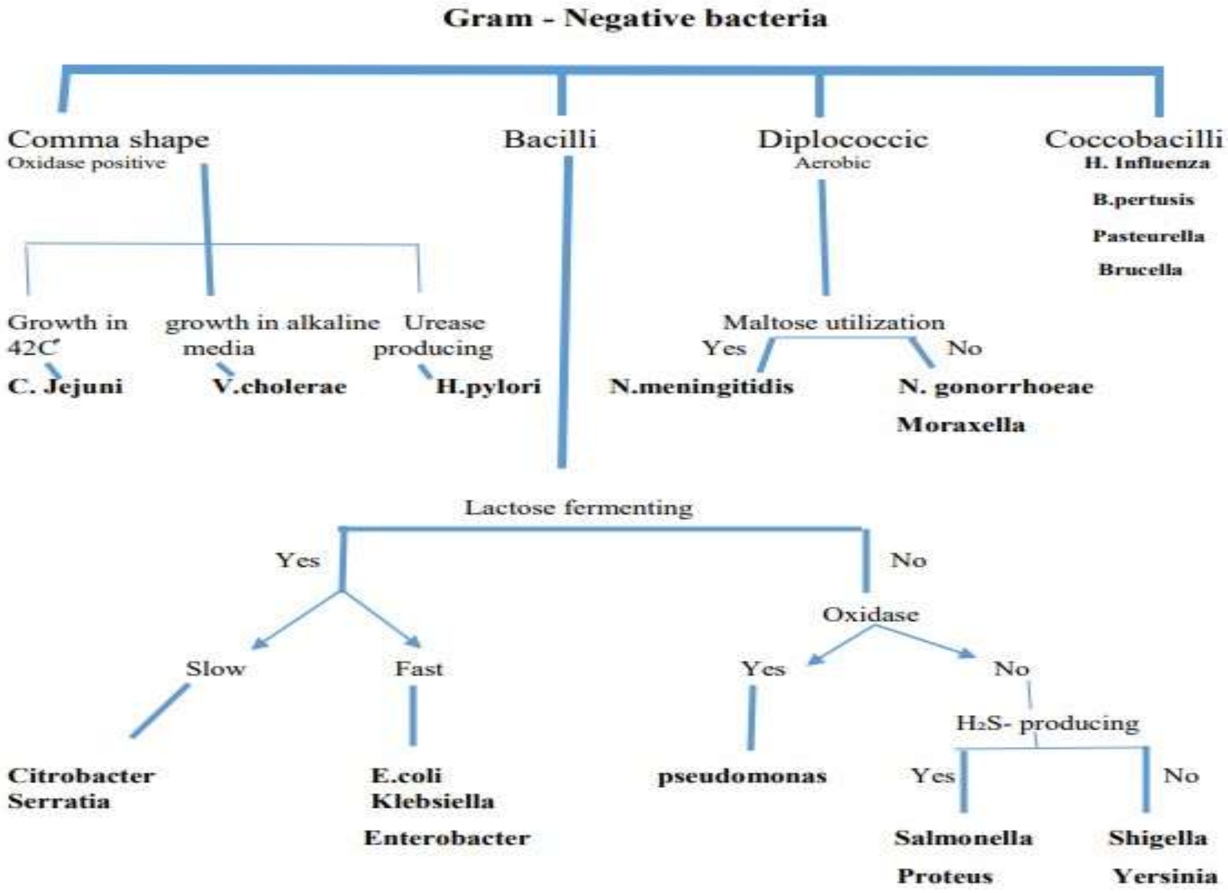


Figure 2: Species identification of GNB in a clinical setting (Levison, 2014).

2.4 Antibacterial Prophylaxis

Antibacterial prophylaxis is a popular method for reducing the risk of infections in patients. Antibacterial prophylaxis involves taking precautions and balancing efficacy against potential risks. Decreases in fever, sepsis, and bacteremia are indicators of prophylactic effectiveness. Drug toxicities, bacterial infections, antibiotic resistance, invasive fungal diseases, and other medical conditions are examples of possible side effects of prophylaxis (Lehrnbecher

& Sung, 2014). Several studies illustrated that the prophylaxis of antibacterial cause to decrease in documented infections and febrile events, their tolerability is typically hospitalization, and suitable may be avoided or shortened, resulting in cost saving. Instead, the concept of antibiotic prophylaxis is challenged owing to possible side effects such as toxicity of the drugs and the development of resistance. Fluoroquinolone prophylaxis increased resistance to fluoroquinolone in isolator es bacteremia. Prophylaxis of sulfamethoxazole-trimethoprim was effective in reducing infection mortality and bacteremia, related when compared to no antibiotic controls, although increased trimethoprim, sulfamethoxazole resistance in isolates bacteremia. Prophylaxis cephalosporin reduced bacteremia but didn’t reduce infection-related mortality, with antibiotic resistance not being evaluable (Egan et al., 2019).

2.5 Antimicrobial Resistance

Innate resistance, which is the bacteria's own built-in resistance to certain antibiotics, and acquired resistance are both causes of antimicrobial resistance in bacteria. For instance, certain antibiotics may not be naturally permeable to some organisms due to their cell structure. An organism can develop resistance to antimicrobial agents through conjugation, transformation of plasmid from one cell to another cell (the uptake of produced naked DNA when cells break down, or transduction (DNA transfer by bacteriophage). This resistance can also result from changes in the genetic material within the cell, or from the acquisition of tennis resistance from other drug-resistant cells (Anderson et al., 2012). Hospital cleanliness issues, selection pressures created by antibiotic abuse, and mobile genetic components that can encode bacterial resistance mechanisms are the main causes of antimicrobial drug resistance in hospitals (Mnyambwa et al., 2021).

Klebsiella pneumonia, Escherichia coli, and non-lactose fermenting bacteria, including Actinobacteria sp. and Pseudomonas aeruginosa, are all members of the Enterobacteriaceae family. have been identified as a major source of bacterial infections that are resistant to many drugs (Rossolini et al., 2007). Gram-negative bacteria are becoming more resistant to the medications they typically utilize, making it harder to treat common illnesses (Le Doare et al., 2015). Both hospital- and community-acquired illnesses are mostly caused by pathogenic microorganisms that are resistant. It is quite concerning that gram-positive bacteria are becoming more and more resistant to the fluoroquinolones, beta-lactams, macrolides, and other antibiotics that are often used to treat them, especially in cases of severe illnesses brought on by MDR bacteria. In addition to infections like Staphylococci and Streptococci, Methicillin-resistant forms are of particular concern (Koulenti et al., 2020).

2.6 The study's main goals are:

1- Determine the frequency of bacteria that cause urinary tract infections.

2. To understand the range of organisms and their profiles of antimicrobial susceptibility.

3. METHODOLOGY

Study Design and Participants:

The MLT Department of Shaqlawa Technical College's ethics committee approved this study, and all of the participants consented to participate. The specially created survey was created for such a purpose:

A questionnaire created for this purpose is divided into two sections depending on the following study goals:

A. Demographic information: includes (age non-limited, gender, occupation)

B: Clinical information. Patients who were both inpatients and outpatients who had been diagnosed with urinary tract infections were included.

Duration of the study:

Through the period extending from October 2021 to April 2022, 185 clinically related specimens of urine have been collected from Rizgary Teaching Hospital in Erbil- Kurdistan region.

Collection of samples

Both instances of urinary tract infection (UTI), both symptomatic and asymptomatic, had midstream pee collected using a sterile urine container. Standard wire loop (0.001/mL) urine samples collected midstream were utilized for culturing. 5% blood sheep agar and MacConkey agar were both used. For 18 to 24 hours, all of the media were incubated at 37°C.

Procedure for Identification and Cultivation:

Cultures were cultured for 24 hours at 37°C in an aerobic environment. A midstream pee colony count of 105 CFU/mL was considered a positive urine culture. The cultural morphology of bacteria, such as the hemolysis phenomenon and lactose fermentation, as well as the identification of bacterial shape according to the results of the Gram stain method, are all factors in the isolation, identification, and purification of isolated bacteria using traditional methods.

Antibiotics Susceptibility Testing:

According to the Clinical and Laboratory Standards Institute, the standard Kirby-Bauer disk diffusion technique was used to assess the antimicrobial susceptibility of all isolates (CLSI).

Statistical analysis:

The data were statistically analyzed by Excel (MS 2016 and (SPSS) Version 24).

4. RESULTS

4.1 the sociodemographic profile of the study's case participants

As shown in Figure (3), 185 cases (132 females and 53 males) of urinary tract infections cases were isolated during the research study.

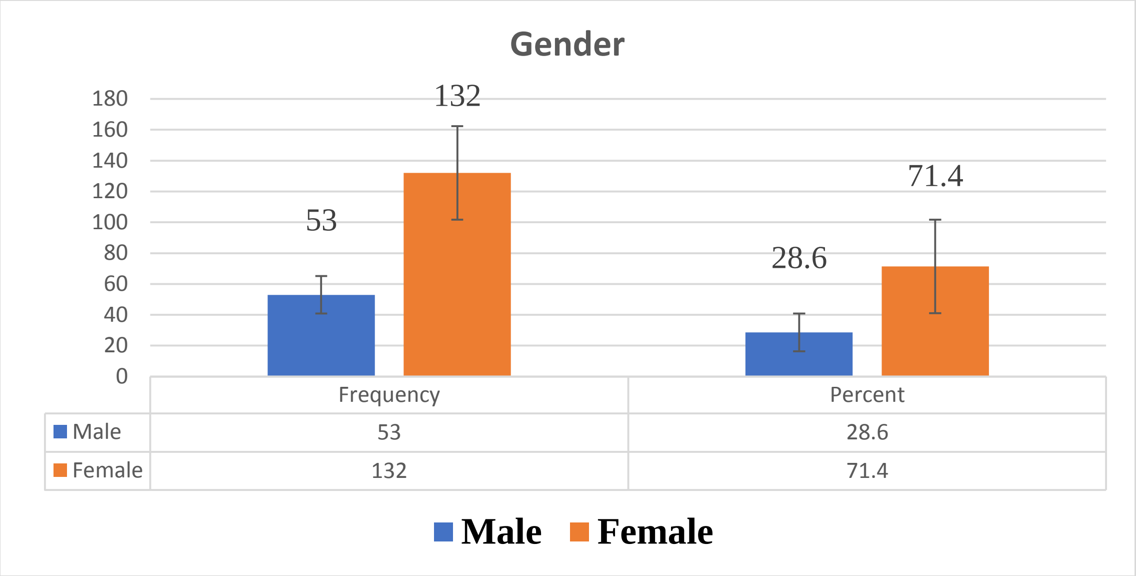
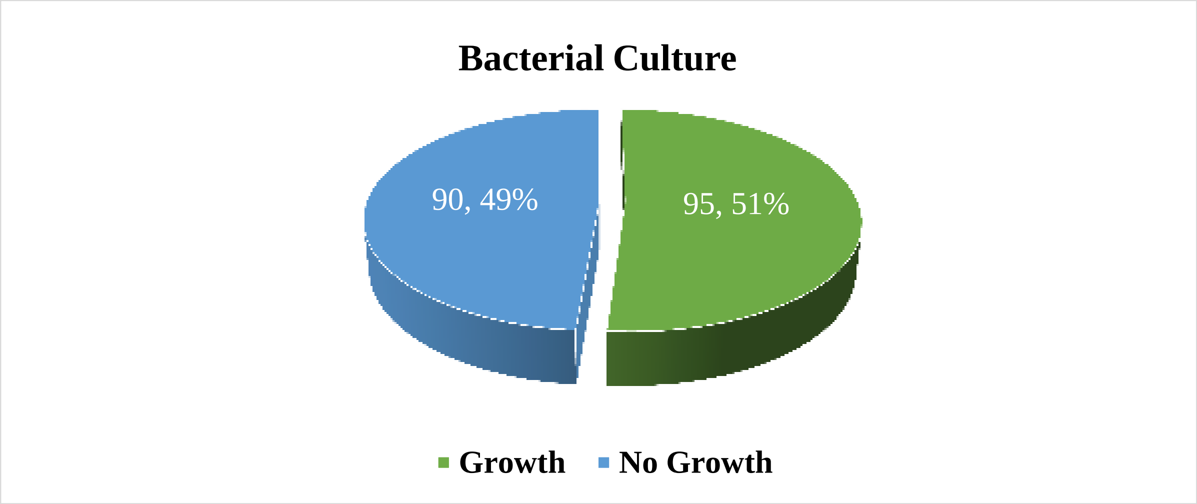


Figure 3: Demographic information of patients with urinary tract infection according to gender

4.2 Bacterial profiles based on isolation location

The findings showed that 95 out of 185 individuals who were sent for bacterial pathogen culture tested positive for it. According to the patient's complaints, several types of specimens were collected from the investigated patients; among them, bacterial growth could be easily recognized from urine samples, which made up 95 (51%) of all specimens' growth, as shown in Figure (4).

Figure 4: This pi-chart of the number and percentage of bacterial culture isolates



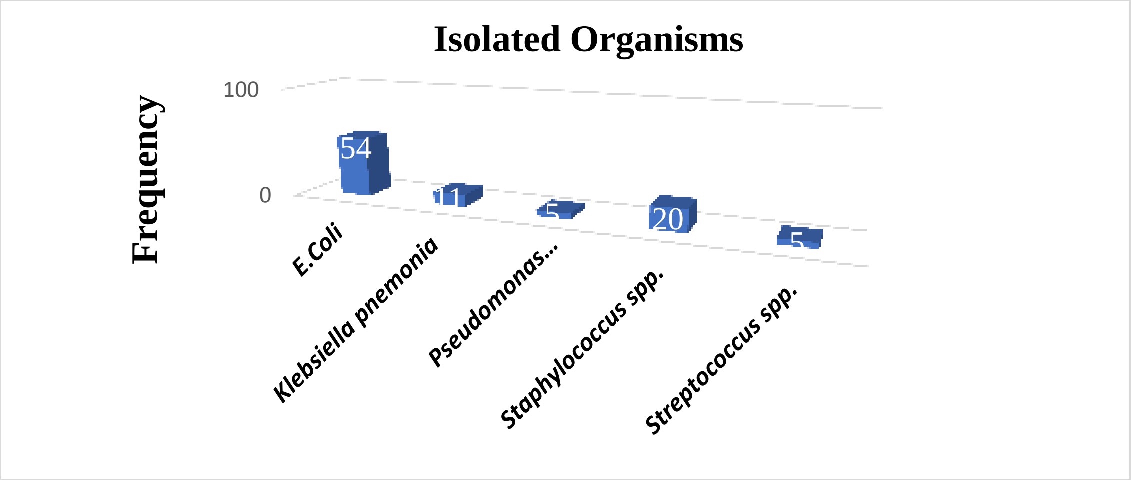
pattern.

4.3 The most common kind of bacteria found in pee sample cultures

In the present study, it was shown that Escherichia coli, which accounted for 54 (56.8%) of the isolates, Staphylococcus spp., which accounted for 20 (21%), Klebsiella pneumoniae, which accounted for 11 (11.57%), Pseudomonas aeruginosa, and Streptococcus spp., which each accounted for 5 (5.2%) of the isolates, were the most common (5).

Figure 5: The number of isolated organisms in urine specimen sites.

4.4 Testing for antibiotic resistance in the most common Gram-negative bacteria



E. coli, Klebsiella pneumoniae, and Pseudomonas aeruginosa were the three most common strains of Gram-negative bacteria identified in the current investigation. Details regarding their sensitivity and resistance pattern were so revealed.

Cefotaxime is extremely resistant to E. coli., 27(50%), Nalidixic acid, 17(31%), and Amikacin 13(24%). While it was highly sensitive for Imipenem 43(79%), Amikacin 27(50%), Levofixic Acid 24(44%).

Klebsiella pneumoniae showed similar high resistant pattern for Cefotaxime 7(63.6%), Amikacin 4(36%), and Cfixime 3(27%). On the other hand, Klebsiella pneumoniae was extremely sensitive to Levofixic Acid and Imipenem 5(54%). It also showed 4(36%) sensitivity for Amikacin.

Regarding Pseudomonas aeruginosa, it was highly resistant to Sulfamethoxazole/Trimethoprim 3 (60 %), followed by Nitrofurantoin and Nalidixic acid 2(40%), while it showed an equally resistance pattern (20%) to Imipenem, Amikacin, Levofixic Acid, Cefotaxime, and Ceftriaxone. The bacteria showed 4(80%) sensitivity for Norfloxacin and Cfixime 3(60%), it was equally sensitive for Cefotaxime, Imipenem, Amikacin, and Tobramycin2 (40%), shown in table (1).

Table 1: The amount and sensitivity of 14 different antibiotics against the major gram-negative bacteria.

Antimicrobial tested	***GNB Isolates, N (%)***					
	***E. coli* (N = 54)**		***Klebsiella pneumonia* (N=11)**		***Pseudomonas aeruginosa* (N=5)**	
	R	S	R	S	R	S
Ciprofloxacin (CIP)	9 (16%)	13(24%)	1(9%)	1(9%)	0%	1(20%)
Nalidixic acid (NA)	17(31%)	4(7%)	2(20%)	1(10%)	2(40%)	1(9%)
Cefotaxime (CTX)	27(50%)	20(37%)	7(63.6%)	2(18)%	1(20)	2(40)
Gentamycin (CN)	8(14%)	14(25%)	2(18%)	1(9%)	x	x
Imipenem (IPM)	1(1.0%)	43(79%)	1(9%)	5(54%)	1(20%)	2(40%)
Amikacin (AK)	13(24%)	27(50%)	4(36%)	4(36%)	1(20%)	2(40%)
Levofixic Acid (LEV)	12(22%)	24(44%)	2(18%)	5(54%)	1(20%)	1(20%)
Ceftriaxone (CRO)	6(11%)	8(14%)	1(9%)	2(18%)	1(20%)	1(20%)
Cfixime (CFM)	8(14%)	8(14%)	3(27%)	1(9%)	x	3(60%)
Norfloxacin (NOR)	10(18%)	7(12%)	2(18%)	2(18%)	x	4(80%)
Nitrofurantoin(NF)	4(7%)	6(11%)	1(9%)	1(9%)	2(40%)	1(20%)
Tobramycin(TB)	3(5%)	7(12%)	2(18%)	x	x	2(40%)
Sulfamethoxazole/Trimethoprim(SXT)	6 (11%)	8(14%)	1(9%)	2(18%)	3(60%)	x
Amoxicillin/Clavulanic acid (AMC)	7(12%)	2(3%)	3(27%)	1(9%)	1(20%)	x

R: Resistant, S: Sensitive, X: Not performed.

4.5 Testing for antibiotic resistance in the most common Gram-positive bacteria

Regarding Gram-positive bacteria, *Staphylococcus spp.* 14(14 strain) (70%) sensitive for Imipenem and *Streptococcus spp.* 4(4strain), (80%) sensitive for Imipenem, Ciprofloxacin, and Norfloxacin. *Staphylococcus spp. 10 (*50) followed 2(40%) *Streptococcus spp.* sensitive for Amikacin. While *Streptococcus spp.* highly sensitive for Cefotaxime 5(5 stain) (100%). On the other hand, *Staphylococcus spp.* was highly resistant to Cefotaxime 8 (42%), followed by 3(60%) *Streptococcus spp*. Resistant for Nalidixic acid, as show in table (2).

Table 2: The quantity and proportion of major Gram-positive bacteria responding to 14 different antibiotics.

Antimicrobial tested	***GPB Isolates, N (%)***			
	Staphylococcus spp. (N = 20)		***Streptococcus spp. (N=5)***	
	R	S	R	S
Ciprofloxacin (CIP)	1(5%)	6(31%)	x	4(80%)
Nalidixic acid (NA)	2(10%)	2(10%)	3(60%)	2(40%)
Cefotaxime (CTX)	8 (42%)	5(26%)	x	5(100%)
Vancomycin(VA)	x	4(21%)	x	2(40%)
Ceftriaxone (CRO)	x	5(26%)	x	3(60%)
Imipenem (IPM)	x	14(70%)	x	4(80%)
Doxycycline (DO)	1(5%)	5(26%)	x	2(40%)
Azithromycin(AZM)	3(15%)	7(36%)	1(20%)	3(60%)
Amikacin (AK)	1(5%)	10(50%)	x	2(40%)
Levofixic Acid (LEV)	2(10%)	7(35%)	x	3(60%)
Erythromycin (E)	6(31%)	2(10%)	1(20%)	1(20%)
Norfloxacin (NOR)	2(10%)	4(20%)	x	4(80%)
Tetracycline (TE)	1(5%)	1(5%)	1(20%)	2(40%)
Aztreonam(ATM)	5(26%)	1(5%)	2(40%)	1(20%)

5. DISCUSSIONS

One of the most critical medical issues of the day is urinary tract infections. Are typical bacterial illnesses that impact 150 million people worldwide each year. In this study, 95 (51.3%) of the 185 patients investigated had bacterial infections. A study from Iraq found that 68.79% of patients with urinary tract infections had bacterial infections (Assafi et al., 2015). According to a different survey conducted in East Africa (Mbwambo et al., 2021), India had a (87%) (55.34%) rate of poverty (Meena et al., 2021). Variations in geographic location and differences in the study population may help to explain the discrepancy in prevalence.

Our study's male: female ratio indicates a more considerable female preponderance based on the prevalence of urinary tract infections by gender (53 men and 132 females). According to research conducted in India that is consistent with the current study, women experience more urinary tract infections than males (Saijan et al., n.d.) In Libya (Mostafa et al., 2021).

In the current investigation, E. coli (56.8%) and K. pneumoniae (11.5%) were the two most prevalent bacterial isolates among UTI patients. Staphylococcus spp. (21% of gram-positive isolates) and Streptococcus spp. (5.2%) were the two most common species. This is consistent with earlier research demonstrating a strong association between UTI patients and Gram-negative bacteria. According to research from Iraq, Escherichia coli was found to be the most often isolated bacteria from individuals with urinary tract infections (Assafi et al., 2015).

According to other studies, E. coli was the most prevalent gram-negative isolated bacteria. The findings of Mustafa (Libya) and Mohanty (Korea) (Mostafa et al., 2021) were comparable to our conclusion (Mohanty et al., 2022). support for this study, K. pneumoniae (31.2%) and E. coli (22.2%) were the two most common isolates among patients with urinary tract infections in Egypt (Ashour & El-Sharif, 2009). The most frequent commensal resident of the gastrointestinal system is E. coli, a common pathogen linked with community-associated and hospital-acquired illnesses (Drago et al., 2010).

According to the antimicrobial resistance pattern among GNB in the current investigation, they were very susceptible to imipenem and levofixic acid and highly resistant to cefotaxime, nalidixic acid, and amikacin. While Cefotaxime and Nalidixic Acid were resistant to GPB, Imipenem, Ciprofloxacin, Norfloxacin, and Amikacin were also highly susceptible to GPB. Due to the misuse of broad-spectrum antibiotics, several investigations found that GNBs were more likely to resist cephalosporins and penicillin (Assafi et al., 2015). (Mohanty et al., 2022). Antibiotic-resistant E. coli was shown to be more resistant to ampicillin, co-trimoxazole, aztreonam, levofloxacin, and cefuroxime, according to another study conducted in Iraq. Imipenem and Amikacin, however, have a significant level of susceptibility against E. coli. Imipenem and Amikacin were the two antimicrobials most effective against Klebsiella pneumonia. Similar high resistance patterns for Cefotaxime, Amikacin, and Cfixime were displayed by Klebsiella pneumoniae. Sulfamethoxazole/Trimethoprim, Nitrofurantoin, and Nalidixic acid were the three antibiotics that Pseudomonas aeruginosa was most sensitive to, followed by Cefotaxime, Imipenem, and Amikacin (Mohanty et al., 2022). This study agrees with our findings regarding the sensitivity component but disagrees with them regarding the resistance pattern.

Imipenem was shown to be the most efficient antibiotic for reducing the susceptibility of gram-positive organisms, according to a retrospective investigation conducted in Iraq, supporting our conclusion (Al-Zubaidy et al., 2020). Ampicillin, Clindamycin, and vancomycin were shown to be highly resistant to Streptococcus spp. in research that was compatible with this study's findings (Leszczynski et al., 2019).

The regularity of prescribing or changing an antibiotic regimen based on urine culture. Results of urine cultures are frequently disregarded because patients respond well to empirical treatment. The main issue that might result from this misinformation is a relapse of UTI. Unresolved bacteriuria is frequently the outcome of poor antibiotic treatment. Sometimes the uropathogenic is found in a location protected from antibiotic treatment. These protected areas are typically anatomical anomalies. Finding the anatomical abnormality is crucial since it can need surgery to eliminate the infection's source (Chang & Shortliffe, 2006).

Additionally, the level of bacterium resistance to antibiotics is rising. This is a severe crisis, and there are several factors contributing to it, including the fact that many antibiotic prescriptions are written in clinical settings without first checking for infectious germs and without running an antibiotic sensitivity test, that patients do not always adhere to their treatment plans strictly, stopping before the infection has spread completely, and that certain bacteria are more likely to develop drug resistance. Several medications in the market (pharmacy) were produced with inadequate sanitation, quality, and cleanliness in addition to terrible storage conditions and high and low temperatures (Uso & Taher, 2021).

CONCLUSIONS

One of the most frequent bacterial illnesses doctors encounter in underdeveloped nations is urinary tract infections (UTI). The doctor may be assisted in selecting the best empirical treatment by area-specific monitoring studies designed to learn more about the types of bacteria causing urinary tract infections and their resistance patterns. This study aimed to identify the kind and pattern of antibiotic resistance in urine pathogens isolated from Rizgary Teaching Hospital patients. The following are the study's findings:

1. Both males and females had similar incidences and causal uropathogens to earlier investigations.
2- There were more gram-negative bacteria isolates than gram-positive bacteria.
3. The most typical bacterium identified from urinary tract infections was Escherichia coli.
4- The bulk of the bacterial isolates showed the usual antibiotic resistance.

5-2- RECOMMENDATIONS

1. the culture and susceptibility approach must be used to choose the best course of action.
2 Rather than following worldwide or even national standards, clinicians should base their empirical antibiotic selection on their knowledge of the local prevalence of the bacterial profile and antibiotic sensitivities.
3- Molecular methods like polymerase chain reaction (PCR) are advised for precise bacterial isolation identification.

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