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Microbial Etiology and Antibiotic Sensitivity Patterns of Urinary Tract Infections in a Tertiary Care Hospital

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ABSTRACT

Background: Urinary tract infections (UTIs) are a significant health concern worldwide, with varying microbial etiology and antibiotic sensitivity patterns. This study is designed to determine the microbial etiology and antibiotic sensitivity patterns of UTIs in a tertiary care hospital.

Methods: A descriptive cross-sectional study was conducted in the Department of Urology at Lady Reading Hospital in Peshawar. A total of 100 patients with signs and symptoms of UTIs were selected using purposive consecutive sampling. Urine cultures and antibiotic sensitivity testing were performed to identify the causative organisms and their sensitivity patterns.

Results: E. coli was the most common microorganism isolated from urine cultures, accounting for 49.4% of the cases. Klebsiella pneumoniae and Pseudomonas aeruginosa were the second and third most common organisms, respectively. E. coli showed highest sensitivity to fosfomycin (79.1%), nitrofurantoin (74.4%), and amikacin (69.8%). High resistance was observed to fluoroquinolones (ciprofloxacin and levofloxacin), beta-lactams (co-amoxiclav), and third-generation cephalosporins (cefotaxime and ceftriaxone).

Conclusion: The study highlights the importance of knowing the local microbiological profile and antibiotic sensitivity patterns in the management of UTIs. The findings suggest that fosfomycin, nitrofurantoin, and amikacin are effective antibiotics for the treatment of UTIs, while fluoroquinolones and cephalosporins may not be effective due to high resistance.

Keywords: *Urinary Tract Infections (UTIs), Antibiotic Resistance, Microbial Etiology.*

1. INTRODUCTION

Urinary tract infections (UTIs) is the infiltration of micro-organism in any part of urinary tract i.e. kidney, ureter, bladder or urethra and its incidence in general population is documented as 18 per 1000[1, 2]. UTIs have equal affinity to affect both males and females, but females are at high risk of developing UTIs due to anatomical and hormonal factors i.e. short urethra, hormonal changes, pregnancy, sexual activity etc[3]. UTIs patients usually presents with dysuria, urinary urgency, hematuria, frequent urination, abdominal discomfort, and pelvic pain[4]. UTIs may be complicated which is due to some neurological or structural cause like urinary retention due to enlarge prostate or stricture, pregnancy, presence of indwelling catheters or calculi. While uncomplicated UTIs are without any structural or neurological cause which mainly affect the healthy functions of individuals[5]. The incidence of UTI is almost 30% in children. As per the literature 50% females are affected by UTIs at some stage in her life. Almost 150 million people are affected by UTIS globally each year[1, 6].

Both gram positive and gram negative bacteria causes UTIs but most prevalent among them is gram negative bacteria among which E.coli is most common. E.coli is the culprit for causing UTIs in almost 80% of females between 18-39 years of age. Almost 15-20% of the UTIs are caused by Staphylococcus saprophyticus. Other less common organism that also causes UTI are enterococcus, pseudomonas, proteus etc. Another study find E.coli to the most prominent organism causing UTI followed by Staphylococcus saprophyticus and then Klebisella in 11% of the cases[7, 8]

In majority of the cases and setups empirical antibiotics are started without any culture and sensitivity pattern of causative microorganism. Such type of practices leads to the development of drug resistance in general population to uropathogens. Antibiotic susceptibility testing guides targeted therapy that will prevent use of wrongful antibiotics[9, 10]. Targeted antibiotics therapy will also prevent renal scarring and damage in complicated UTIs[11].

In view of literature we are conducting this study to guide specific antibiotic therapy by finding the antibiotics sensitivity pattern of microorganisms and their rising resistance as the local data is deficient, current study will help to guide for specific antibiotic therapy in our setup.

2. MATERIALS AND METHODOLOGY:

Study design:

Descriptive Cross sectional study

Study setting:

Department of Urology Lady Reading Hospital Peshawar.

Study Duration:

06 months

Sample Size:

100

Sampling technique:

Purposive consecutive sampling

Inclusion Criteria:

Both Genders between 16-60years of age

Patients having sign and symptoms of UTIs

Patients who haven't used antibiotics in last 24 hours

Exclusion Criteria:

Already catheterized patients

Immunocompromised patients

Having Hypospadias, phimosis or Paraphimosis

Ethical Consideration:

Ethical approval was granted before conducting this research from Institutional Review Board (IRB) of Lady Reading Hospital with Ref ID. 482/LRH/MTI Informed consent will be taken from patients enrolled in this study.

Data Analysis:

The data was analyzed by using SPSS 25. Mean and SD were calculated for age and frequency and percentage for gender, marital status and clinical characteristics. Chi square / Fisher's Exact test was used to compare the resistance rates of the most frequent urinary tract pathogens against tested antibiotics with a significant p-value ≤ 0.05.

3. RESULTS:

Total of 100 patients were selected based on positive reports of culture and sensitivity with microorganism isolates and antibiotics sensitivity and resistance pattern with majority of them being females accounting for 65% of the cases and males 35% of the cases.

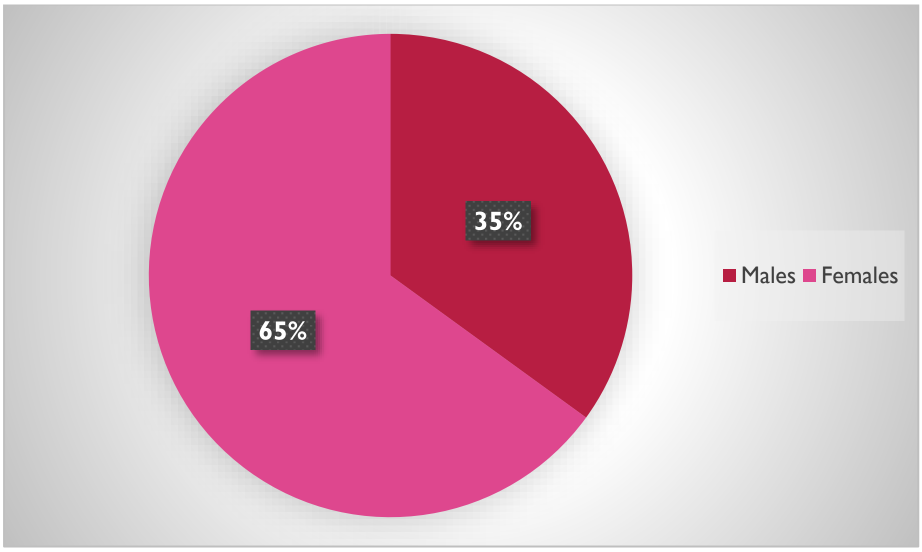

Figure.1: Demographics

The most common microorganism isolates was E.coli in 49% of the cases followed by Klebisella in 14.9% of the cases then Pseudomonas Aeruginosa in 10.3% of the cases and the rest of less common organisms as being given in the table

Organism	Frequency	Percentage
E. coli	43	49.4%
Klebsiella	13	14.9%
Pseudomonas aeruginosa	9	10.3%
Enterococcus faecium	6	6.9%
Enterococcus faecalis	2	2.3%
Candida albicans	3	3.4%
Enterobacter	1	1.1%
Staphylococcus haemolyticus	5	5.7%
Staphylococcus aureus	3	3.4%
Staphylococcus(unspecified)	2	2.3%

Table.1: Micro-organism Isolates from culture

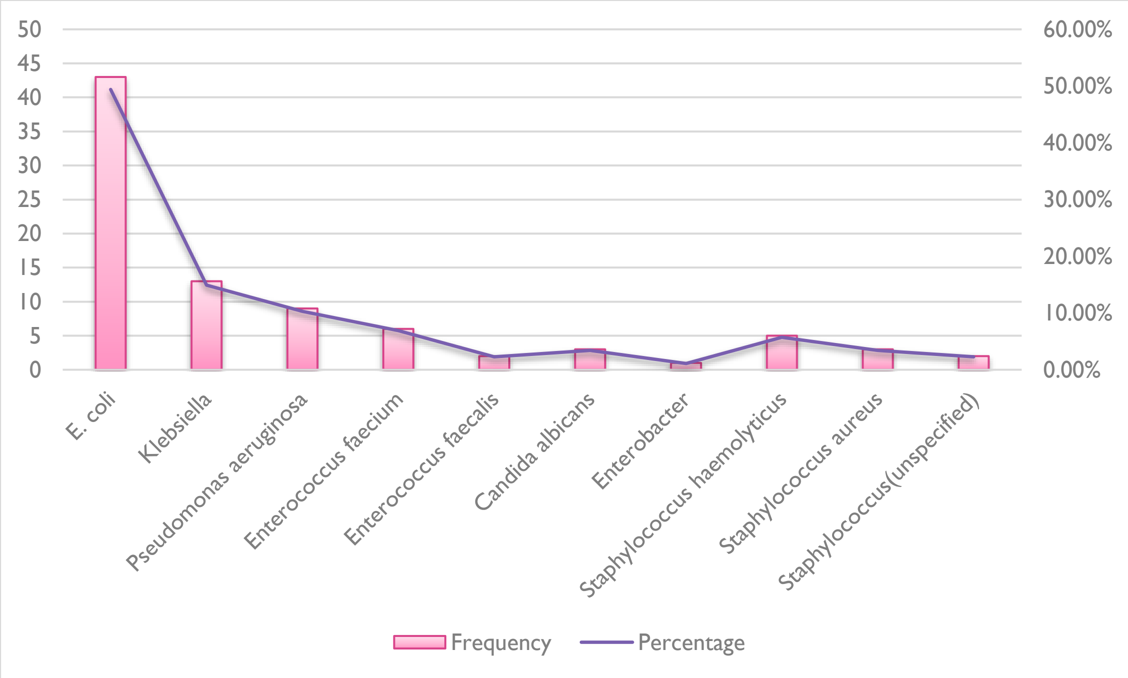

Figure.2: Frequency and percentages of Microorganism isolates

E. coli as being the most common isolates from culture and sensitivity shows highest sensitivity to fosfomycin 79% followed by Nitrofurantoin 74% then Amikacin 69% and then imipenem and meropenem 62% sensitivity to each of them. The rest of sensitivity pattern is given below. As per the resistance pattern E.coli is highly resistant to Cefixime, Ceftazidime, Co-amoxiclav Levofloxacin, Ciprofloxacin, Cefepime give in table below

E.coli		
Drug	**Sensitive**	**Resistant**
Fosfomycin	79.1% (34)	20.9% (9)
Nitrofurantoin	74.4% (32)	25.6% (11)
Amikacin	69.8% (30)	30.2% (13)
Imipenem	62.8% (27)	37.2% (16)
Meropenem	62.8% (27)	37.2% (16)
Piperacillin/Tazobactam	63.6% (7)	36.4% (4)
Cefoperazone/Sulbactam	57.1% (20)	42.9% (15)
Cefepime	53.5% (23)	46.5% (20)
Ceftriaxone	46.5% (20)	53.5% (23)

E.coli		
Drug	**Sensitive**	**Resistant**
Cefotaxime	41.9% (18)	58.1% (25)
Ciprofloxacin	30.2% (13)	69.8% (30)
Levofloxacin	30.2% (13)	69.8% (30)
Co-amoxiclav	14% (6)	86% (37)
Ceftazidime	2.3% (1)	97.7% (42)
Cefixime	0% (0)	100% (4)

Table.2: Antibiotic Sensitivity and Resistance pattern of E.coli

Klebisella as being the second most common bacterial isolates from culture and sensitivity and its sensitivity and resistance pattern toward antibiotics were given below.

Klebisella		
Antibiotic	**Sensitivity**	**Resistant**
Amikacin	100% (14)	0% (0)
Colistin	100% (6)	0% (0)
Imipenem	100% (14)	0% (0)
Meropenem	100% (14)	0% (0)
Nitrofurantoin	100% (1)	0% (0)
Cefoperazone+Sulbactam	100% (2)	0% (0)
Doripenem	100% (1)	0% (0)
Ceftazidime	87.5% (7)	12.5% (1)
Ciprofloxacin	14.3% (2)	85.7% (12)

Klebisella		
Antibiotic	**Sensitivity**	**Resistant**
Levofloxacin	14.3% (2)	85.7% (12)
Fosfomycin	66.7% (4)	33.3% (2)
Co-amoxiclav	64.3% (9)	35.7% (5)
Cefepime	50% (7)	50% (7)
Ceftriaxone	42.9% (6)	57.1% (8)
Ampicillin	0% (0)	100% (1)
Azithromycin	0% (0)	100% (1)
Moxifloxacin	0% (0)	100% (1)

Table.3: Antibiotic Sensitivity and Resistance pattern of Klebisella

Pseudomonas Aeruginosa as being isolated from 10.3% of the cases and its sensitivity and resistance patter n toward different antibiotics are given in the table.

Pseudomonas Aeruginosa		
Antibiotic	**Sensitive**	**Resistant**
Cefepime	9 (100%)	0 (0%)
Ceftazidime	9 (100%)	0 (0%)
Ciprofloxacin	8 (100%)	0 (0%)
Levofloxacin	8 (100%)	0 (0%)
Nitrofurantoin	8 (100%)	0 (0%)
Fosfomycin	9 (81.8%)	2 (18.2%)
Piperacillin + Tazobactam	7 (77.8%)	2 (22.2%)
Amikacin	2 (66.7%)	1 (33.3%)
Imipenem	1 (33.3%)	2 (66.7%)
Meropenem	1 (33.3%)	2 (66.7%)

Table.4: Antibiotic Sensitivity and Resistance pattern of pseudomonas Aeruginosa

Enterococcus faecium and enterococcus faecalis bacteria was detected in 6.9% and 2.3% of the culture positive cases which shows highest sensitivity to fosfomycin and nitrofurantoin followed by meropenems and imipenem’s and highest resistant to ciprofloxacin and Ampicillins. Staphylococcus haemolyticus and staphylococcus aureus bacteria was detected in 5.7% and 3.4% of the cases and they shows highest sensitivity to Ampicillin-clavulanic acid, meropenems and linezolid and lowest sensitivity to levofloxacin, azithromycin, cefepime etc.

4. DISCUSSION

Urinary tract infections (UTIs) rank among the most frequent bacterial infections worldwide, affecting both individuals in the community and those in hospitals. The specific microbes causing these infections and their resistance to antibiotics change by region. This depends on how antibiotics are prescribed, how infections are controlled, and what germs are common in the area. This investigation gives important local information from a hospital, showing that *Escherichia coli* is the most common cause of UTIs, followed by *Klebsiella* and *Pseudomonas aeruginosa*. It's concerning that high levels of resistance to commonly used antibiotics were seen, which impacts how treatment is started and how antibiotics are managed.

Our work showed that *E. coli* was the main cause of UTIs, making up 49.4% of the samples, with *Klebsiella* spp. (14.9%) and *Pseudomonas aeruginosa* (10.3%) coming after. Less common causes were *Enterococcus faecium* (6.9%), *Staphylococcus haemolyticus* (5.7%), *Candida albicans* (3.4%), *Staphylococcus aureus* (3.4%), *Enterococcus faecalis* (2.3%), and *Enterobacter* (1.1%). These results agree with other local studies. Muzammil et al. found *E. coli* in 39.6% of samples, *Enterococcus* spp. in 33.9%, and *Pseudomonas* in 13.2% in Multan, Pakistan[12]. Kazmi et al. saw *E. coli* in 76% of cases, followed by *Klebsiella* (11.1%) and *Enterococcus* (8.9%)[13]. Sohail et al. found *E. coli* as the main cause of UTIs (62%), followed by *E. faecalis* (15%) and *Pseudomonas* (6%) in Punjab[14]. In Nepal, Amatya et al. reported *E. coli* in 67% and *Klebsiella* in 21%[15], while in India, Akram et al. saw *E. coli* in 62% and *Klebsiella* in 21% [16]. Shaifali et al. also reported similar findings in India[17].

Worldwide, *E. coli* is the most common cause of UTIs acquired outside of hospitals, causing 70–90% of cases in women. In Europe, Kahlmeter reported *E. coli* in 77% of community UTIs, with *Klebsiella* and *Proteus* being less common[18]. In the United States, Karlowsky et al. found *E. coli* as the main isolate (80%) from women who were not in the hospital[19,20]. In the Middle East, Alqasim et al. noted multidrug-resistant *E. coli* as the major germ among Saudi patients[21]. Studies in Africa, such as Dash et al. in India and Hamdan et al. in Sudan, also found *E. coli* as the main germ, though resistance levels varied greatly[22,23]. Our finding of *Pseudomonas aeruginosa* in 10.3% of cases is worth noting, as it's more than the 4–6% reported in most community studies[24]. This might be because we are a larger hospital with more patients using catheters and staying in the hospital, where *Pseudomonas* is a common infection. Similarly, fungal isolates like *Candida albicans* (3.4%) suggest a significant number of patients with weak immune systems, diabetes, or long-term catheter use.

In our work, *E. coli* was most sensitive to fosfomycin (79.1%), nitrofurantoin (74.4%), and amikacin (69.8%), with some response to carbapenems (imipenem and meropenem, 62.8%). Resistance was very high to fluoroquinolones (ciprofloxacin and levofloxacin, 69.8%), beta-lactams like co-amoxiclav (86%), and third-generation cephalosporins (cefotaxime 58.1%, ceftriaxone 53.5%). Resistance was almost total to ceftazidime (97.7%) and cefixime (100%). These results match local information. Kazmi et al. reported that *E. coli* was not very sensitive to ampicillin (20.4%) and ciprofloxacin (32.4%) but was still sensitive to nitrofurantoin (96.9%) and amikacin (86.7%)[2] [2]. Bashir et al. saw *E. coli* resistance to ampicillin (92%), ciprofloxacin (62%), and co-trimoxazole (80%)[25]. Bano et al. also noted high fluoroquinolone resistance in Pakistan[26].

Across the world, increasing fluoroquinolone and cephalosporin resistance has been observed. The European Centre for Disease Prevention and Control noted resistance levels of *E. coli* to ciprofloxacin above 30% in some areas[27]. In the United States, resistance to trimethoprim-sulfamethoxazole reached 30% and ciprofloxacin 25% in samples from people not in the hospital [8]. Falagas et al. reported similar resistance trends in Greece, pointing out misuse of fluoroquinolones in primary care[28]. Nitrofurantoin and fosfomycin remain effective against *E. coli*, making them good choices for uncomplicated UTIs[29]. Our results agree with this, showing >70% susceptibility. These drugs are now recommended in many guidelines as the first choice for bladder infections because they continue to work well[30].

Klebsiella isolates in our work were fully sensitive to amikacin, colistin, and carbapenems, but highly resistant to fluoroquinolones (85.7%) and cephalosporins (ceftriaxone 57.1%, cefepime 50%). These results are similar to those of Afridi et al., who noted widespread ESBL production among *Klebsiella* isolates in Pakistan[31]. Similar results were reported in India, where *Klebsiella* showed >70% resistance to third-generation cephalosporins[16]. Globally, multidrug-resistant *Klebsiella pneumoniae* has become a significant problem, with high levels of carbapenemase production in southern Europe, South Asia, and the Middle East[32]. While our isolates were still sensitive to carbapenems, we need to monitor closely as resistance is spreading rapidly worldwide.

Our *Pseudomonas* isolates were highly sensitive to ceftazidime, cefepime, ciprofloxacin, and levofloxacin (100%), but quite resistant to carbapenems (66.7%). This differs from past reports, where *Pseudomonas* often showed multidrug resistance, including to fluoroquinolones[24]. The carbapenem resistance seen in our group is concerning, as carbapenems are considered the last resort. Studies worldwide indicate that carbapenem resistance is rising in *Pseudomonas*, with levels above 40% in some areas[32].*Enterococcus* spp. and *Staphylococcus* species were less common but clinically significant. Past studies in South Asia reported that enterococci were usually sensitive to vancomycin and linezolid but resistant to cephalosporins and fluoroquinolones[14]. The presence of *Candida albicans* in 3.4% of isolates points to fungal UTIs, especially in patients using catheters, as previously reported by Hamdan et al.[23].

Our results highlight the urgent need for evidence-based empirical treatment. The widespread resistance to fluoroquinolones and cephalosporins makes them unreliable for initiating treatment. Instead, nitrofurantoin and fosfomycin remain effective for uncomplicated UTIs, while aminoglycosides and carbapenems may be reserved for more severe cases. However, the emergence of carbapenem-resistant *Pseudomonas* in our work and rising ESBL-producing Enterobacteriaceae in Pakistan and worldwide indicate diminishing treatment options. Inappropriate prescribing, over-the-counter antibiotic availability, and lack of robust stewardship programs exacerbate this trend. Global guidelines emphasize the need for local antibiogram data to guide empirical treatment[30]. In regions with high resistance, routine urine cultures are critical to avoid treatment failures. Additionally, antibiotic stewardship, infection prevention, and surveillance programs must be strengthened.

Our work is limited by being from a single center and having a limited sample size, which might not capture all the resistance patterns in the region. We did not perform tests to identify specific resistance mechanisms, such as ESBL or carbapenemase genes.

5. CONCLUSION

Our study shows that *Escherichia coli* remains the primary cause of urinary tract infections, with *Klebsiella* spp. and *Pseudomonas aeruginosa* following. Less common isolates included *Enterococcus*, *Staphylococcus* species, and *Candida albicans*. *E. coli* was susceptible to nitrofurantoin, fosfomycin, and aminoglycosides but resistant to fluoroquinolones and cephalosporins. *Klebsiella* was sensitive to carbapenems and aminoglycosides but resistant to fluoroquinolones and beta-lactams. *Pseudomonas* was susceptible to cephalosporins and fluoroquinolones but not carbapenems. Gram-positive cocci were mostly susceptible to glycopeptides and linezolid. The presence of *Candida* suggests the need to consider fungal UTIs in high-risk patients. These findings support the use of nitrofurantoin and fosfomycin as first-line treatments for uncomplicated UTIs, cautious use of carbapenems for severe cases, and enhanced surveillance and stewardship to guide empirical therapy for infections where the cause is not yet identified.

6. FUNDING:

None

7. CONFLICT OF INTEREST:

None.

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