How to Cite:
Khan, S. M., Ali, A., Ikramullah, Q., Zaman, A., Mehmood, T., & Jadoon, S. (2023). Incidence of multidrug resistance and extended spectrum beta-lactamase expression in community-acquired urinary tract infection among different age groups of patients. *International Journal of Health Sciences*, *7*(S1), 25–32. https://doi.org/10.53730/ijhs.v7nS1.14147

Incidence of multidrug resistance and extended spectrum beta-lactamase expression in community-acquired urinary tract infection among different age groups of patients

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Abstract---Background and Aim: Escherichia coli was the most prevalent cause for urinary tract infections (UTIs). These bacteria also generate extended spectrum b-lactamases (ESBL), which inactivate penicillins and cephalosporins. The purpose of the current study is to determine the incidence of multidrug resistance and extended beta-lactamase expression in community-acquired urinary tract infection (UTIs) among patients of different age groups. Patients and Methods: This prospective cross-sectional study was conducted on 186 uropathogens investigated in the diagnostic center of Tertiary Care

Manuscript submitted: 18 Dec 2022, Manuscript revised: 09 Feb 2023, Accepted for publication: 27 March 2023

Hospital Peshawar from January 2022 to December 2022. Patients of either gender or any age with suspected UTIs associated with K. pneumoniae and E. coli were derived from urine specimen were enrolled. Identification and analysis of antimicrobial susceptibility was done using Disc diffusion method and Double Disc synergy test. SPSS version 27 was used for data analysis. Results: Of the total 186 Gram-negative uropathogens, there were 57 (30.6%) male and 129 (59.4%) female. The incidence of E. coli and K. pneumoniae was 138 (74.2%) and 48 (25.8%) respectively. The prevalence of uropathogens identified was in 71% females and 29% males. Age-wise distribution of patients was as follows: 5 (2.7%) <1 year, 28 (15.1%) 1-10 years, 48 (25.8%) 11-20 years, 18 (9.7%) 21-30 years, 26 (14%) 31-40 years, 37 (19.8%) 41-50 years, and 24 (12.9%) >50 years. The incidence of positive ESBL in E. coli and K. pneumonia was 52 (37.7%) and 8 (16.7%) respectively. The most effective treatment alternatives were amikacin, imipenem, piperacillin, fosfomycin, and tazobactam. ESBL-producing uropathogens were significantly associated with resistance to amoxicillin/clavulanic acid, ciprofloxacin, and enoxacin. Conclusion: This study showed that, UTIs can be effectively treated with adequate ESBL screening and culture sensitivity instead of empiric medication. During empiric antibiotic therapy, uropathogens have established a significant rate of resistance to fluoroquinolones, sulphonamides, and broad-spectrum cephalosporins.

Keywords---urinary tract infections, E. coli, multi-drug resistance, extended spectrum beta-lactamase.

Introduction

Urinary tract infections (UTIs) are most prevalent with annual rate of 18/1000 population worldwide [1, 2]. UTIs can affect either gender irrespective of their age; however, females are more susceptible due to urothelial mucosa containing high bacterial load, anatomical predisposition or other factors such as pregnancy, coitus, and blockage of urinary tract [3, 4]. The etiologies of UTIs are implicated by various uropathogen both gram-negative and positive. Escherichia coli was the most prevalent cause for urinary tract infections (UTIs). These bacteria also generate extended spectrum b-lactamases (ESBL), which inactivate penicillins and cephalosporins [6, 7]. The prevalence of community-acquired urinary tract infections (UTIs) caused by Escherichia coli increase by producing extended-spectrum b-lactamase (ESBL) globally [8]. Apart from their ability to spread quickly and widely, ESBL producing bacteria are significantly related with ESBL resistance [9]. About 80% cases of UTIs among healthy women aged 18 years to 39 years are caused by E. coli followed by 20% cases of Staphylococcus saprophyticus [10]. Other less prevalent uropathogens are Pseudomonas, Enterobacter, Proteus, and Klebsiella [11].

Clinicians usually utilize empirical antibiotic therapy to treat UTIs; hence, repeated antibiotic overuse may build resistance in uropathogens [12]. There is growing concern over the progressive rise of antibiotic resistance in infections caused by uropathogens [13]. The antibiotic sensitivity of isolated bacterial strains from urine specimen and culture measures the UTIs prevention and treatment by optimum antimicrobial medication. Early diagnosis and treatment with antimicrobials assist to reduce kidney injury and renal failure [14].

The ESBL positive E. coli causing the community-acquired UTIs are significantly associated with various risk factors such as diabetes, old age, UTIs recurrent episodes, and prior usage of antibiotic such as cephalosporins and aminopenicillins [15]. Currently, ESBL production associated with uropathogens have grown in various age groups patients. In these settings, with limited therapeutic alternatives, clinicians' ability to make an empirical antibiotic decision becomes increasingly difficult [16]. The purpose of the current study was to determine the incidence of multidrug resistance and extended beta-lactamase expression in community-acquired urinary tract infection (UTIs) among patients of different age groups.

Methodology

This prospective cross-sectional study was conducted on 186 uropathogens investigated in the diagnostic center of Tertiary Care Hospital Peshawar from January 2022 to December 2022. Patients of either gender or any age with suspected UTIs associated with K. pneumoniae and E. coli were derived from urine specimen were enrolled. Identification and analysis of antimicrobial susceptibility was done using Disc diffusion method and Double Disc synergy test. Urine samples from individuals with suspected UTIs caused by bacteria other than K. pneumoniae and E. coli were excluded. According to the CLSI recommendations, the disc diffusion technique was utilized for antimicrobial susceptibility pattern using Mueller-Hinton agar. DDST was used to detect the presence of ESBL using three antibiotic discs: CTX, ceftazidime (30 g), and AMC. The AMC disc was placed in the centre, and the other two were placed 30 mm away from the centre disc, and incubated for 24 hours. SPSS (version 27) was used to analyze the data. Univariate analysis was used to identify potential risk factors for ESBL-producing uropathogens. Antimicrobial susceptibilities were regarded statistically significant at P 0.05.

Results

Of the total 186 Gram-negative uropathogens, there were 57 (30.6%) male and 129 (59.4%) female. The incidence of E. coli and K. pneumoniae was 138 (74.2%) and 48 (25.8%) respectively. The prevalence of uropathogens identified was in 71% females and 29% male. Age-wise distribution of patients was as follows: 5 (2.7%) <1 year, 28 (15.1%) 1-10 years, 48 (25.8%) 11-20 years, 18 (9.7%) 21-30 years, 26 (14%) 31-40 years, 37 (19.8%) 41-50 years, and 24 (12.9%) >50 years. The incidence of positive ESBL in E. coli and K. pneumonia was 52 (37.7%) and 8 (16.7%) respectively. The most effective treatment alternatives were Amikacin, imipenem, piperacillin, fosfomycin, and tazobactam. ESBL-producing uropathogens were significantly associated with amoxicillin/clavulanic acid resistance, ciprofloxacin, and enoxacin. Age-wise distribution are shown in Table-I. Incidence of E. coli and K. pneumoniae are demonstrated in Figure-1. Table-II shows the uropathogens antimicrobial susceptibility and resistance. Table-III represents the gender, multidrug resistance, and uropathogens are statistically associated with extended spectrum betalactamase synthesis.

Table I
age-wise distribution of patients (N=186)

Age group (years)	N (%)
<1	5 (2.7)
1-10	28 (15.1)
11-20	48 (25.8)
21-30	18 (9.7)
31-40	26 (14)
41-50	37 (19.8)
>50	24 (12.9)

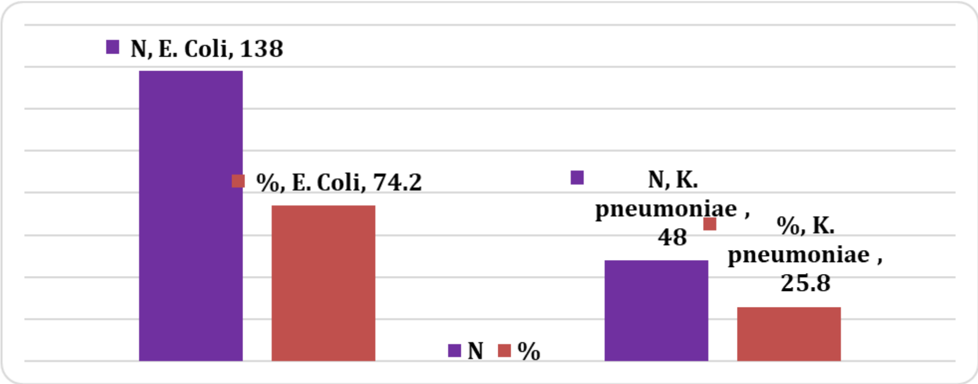

Figure 1. Incidence of E. coli and K. pneumoniae (N=186)

Table II
uropathogens antimicrobial susceptibility and resistance

Antibodies	E.coli Susceptibility	E.coli Resistance	K. pneumoniae Susceptibility	K. pneumoniae Resistance
AMC	70 (50.7)	68 (49.3)	17 (35.4)	31 (64.6)
CTX	51 (37)	87 (63)	26 (54.2)	22 (43.8)
FOS	131 (94.9)	7 (5.1)	37 (77.1)	11 (22.9)
SXT	42 (30.4)	96 (69.6)	23 (47.9)	25 (52.1)
AMP	6 (4.3)	132 (95.7)	0 (0)	48 (100)
CFM	46 (33.3)	92 (66.7)	20 (41.7)	28 (58.3)
CRO	58 (42)	80 (58)	30 (62.5)	18 (37.5)

Table III
Gender, multidrug resistance, and uropathogens are statistically associated with extended spectrum betalactamase synthesis

Parameters	Positive EBSL (N=60) N (%)	Non-ESBL (N=126) N (%)	P-value
Gender			0.849
Male	17 (28.3)	40 (31.7)	
Female	43 (71.7)	86 (68.3)	
Multidrug resistance			0.263
MDR	58 (96.7)	122 (96.8)	
Non-MDR	2 (3.3)	4 (3.2)	
Uropathogens			0.006
E. coli	52 (86.7)	90 (71.4)	
K. pneumoniae	8 (13.3)	36 (28.6)	

Discussion

Effective uropathogen management is usually based on identifying the organism's type causing these infections and select a suitable treatment in terms of antibiotic [17]. Many studies on the incidence and resistance of numerous ESBL-associated uropathogens have been done in Pakistan [18, 19]. The antibiotic susceptibility pattern and ESBL frequency in E. coli isolated from UTIs patients are shown in this investigation. The majority of E.coli was isolated from female patients (75%), which is consistent with prior results [20]. Adult patients (aged 21 to 40 years) generated more than half of the isolates, which is consistent with previous findings [21]. Our study investigated 186 Gram-negative uropathogens out of which, 71% of UTIs were isolated from females, whereas 29% were isolated from males, indicating a greater prevalence in females; possible causes include illiteracy and poor hygiene habits. A previous study carried out in Pakistan reported 62.5% female cases which resemble our findings [22]. UTIs risks have risen as a result of hormonally driven changes in vaginal flora [23].

According to P. Shakya et al, young girls between the ages of 18 and 30 are at a significant risk of UTIs [24]. Moreover, they revealed that the most common uropathogens were E. coli and K. pneumoniae. Statistics from throughout the world reported that E. coli is the most common uropathogen found 46.1% in Mexico and 90% in USA [25, 26]. Another study reported that female patients were predominant in higher incidence of E. coli infections associated with ESBL [27]. This study also showed that E. coli uropathogens have substantially higher resistance to routinely given antibiotics such as AMC, cephalosporins, SXT, fluoroquinolones, and AMP. Another investigation reported similar outcomes with increased resistance rate [28, 29].

The current study also revealed that E. coli uropathogens have substantially higher resistance to routinely given antibiotics such as cephalosporins, AMP, and fluoroquinolones. The ESBL emergence and resistance against antibiotics were significant in the present study. As a result, our findings restrict the positive ESBL in UTIs treatment with fluoroquinolones and AMC as first and second priority [30]. Another study carried out in Turkey reported that the chance of resistance increased with CIP usage for E.coli uropathogens treatment [31]. Treatment and management of UTIs could be challenging due to certain complications like high rates of resistance and complications. There were limited drugs available for the treatment, out of which fosfomycin and nitrofurantoin were the suitable choices of treatment which is consistent with previous findings [32]. The frequencies of ESBL positive and ciprofloxacin resistance are greater than in previous investigations. One reason for these high rates is that data were gathered from tertiary-care facilities. Another issue is that the definition of 'community-acquired' illnesses needs to be changed in some circumstances, as noted by C. Zhu et al. [33]. As a result, because we evaluated both tertiary-care admissions and healthcare-associated illnesses, our estimates of resistance rates may be overstated.

Conclusion

The present study found that, UTIs can be effectively treated with adequate ESBL screening and culture sensitivity instead of empiric medication. During empiric antibiotic therapy, uropathogens have established a significant rate of resistance to fluoroquinolones, SXT, and broad-spectrum cephalosporins. This shows why these antibiotics should not be used as a first line treatment for community-onset UTIs. Therefore, adequate screening is required for ESBL detection in our setup.

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