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Original Research Article

Prevalence and resistant patterns of multidrug-resistant urinary tract infection caused by *Escherichia coli* among patients admitted to a teaching hospital

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ABSTRACT

Background: Multi-drug resistant organisms, particularly in urinary tract infections, have become a significant concern in developing countries like Bangladesh. Physicians are facing challenges in treating hospitalized cases due to the ineffectiveness of conventional antibiotics and empirical treatment, as well as the emergence of multi-drug-resistant *Escherichia coli*. The main goal of the study was to observe the prevalence and resistant pattern of multidrug-resistant *Escherichia coli* urinary tract infections among patients admitted to a teaching hospital.
Methods: The cross-sectional study was conducted between August 2011 to February 2012 at Uttara Adhunik Medical College Hospital (UAMCH), Dhaka, Bangladesh. It included 100 cases, and detailed information was obtained through a standardized protocol.
Results: In a study of 100 UTI patients, 45 had MDR E. coli while 55 had non-MDR E. coli. Females accounted for 79% of the patients, with a mean age of 44.85±17.81 years. The majority of participants fell into the 31-40 years age group (28%) and 60 years age group (23%). Among the participants, 57% had a history of UTI while 43% had no previous UTI history. High resistance was observed against amoxicillin, amoxiclav, cephradine, cefuroxime, cefixime, ceftriaxone, ceftazidime, and nalidixic acid. However, ciprofloxacin (2.22%), levofloxacin (6.67%), and cotrimoxazole (31.11%) exhibited lower resistance rates among MDR samples. Imipenem and meropenem showed 100% effectiveness against all MDR samples.
Conclusion: MDR *E. coli* rates were alarmingly high in a teaching hospital in Bangladesh. Excessive antimicrobial drug consumption globally has led to antibiotic-resistant E. coli isolates, posing challenges for effective UTI treatment worldwide. Antibiotic therapy remains crucial in controlling these invasive agents.

Keywords: Urinary tract infection, Resistant pattern, *Escherichia coli*, Multidrug-resistant

INTRODUCTION

UTI- defined as multiplication of organisms in the urinary tract it is usually associated with the presence of WBC and 100 000 microorganisms/ml in a midstream sample of urine (MSU). Recurrent UTI's-culture-confirmed UTI'S ->3 in 1 year or >2 in 3 months. Relapse UTI -occurs within 2 weeks of Rx of an earlier UTI, same pathogen. Re-infection UTI occurs 4 weeks after earlier UTI different pathogen. *E coli*, known as Uropathogenic *E Coli* (UPEC),

is the most prevalent extra digestive pathogen causing Urinary Tract Infection (UTI) in children and accounts for about 80- 90% of the community-acquired cases.[1-3] The exact prevalence rate of UTI is not clear yet and varies with the age and gender of the individuals. Eighty percent of the girls and 20% of the boys stand the chance of infections including pyelonephritis and cystitis at least once in their childhood.[4,5] A remarkable increase in antibiotic resistance among the *E coli* isolates has been observed in the last few years.[6] Such using resistance is due to mechanisms of mutation and then resistance gene transfer by transport means. Since a plasmid or transpose can carry several resistance indexes, resistance to several antimicrobial agents may be acquired simultaneously and results in multiple drug-resistant (MDR) organisms.[7-10]

MDR bacteria, thus, refers to those which are resistant to a vast range of antibiotics with structural independence (at least of three or more antibiotics). Worldwide reports of antibiotic-resistant *E coli* isolates indicate the unwise and excessive consumption of antimicrobial drugs which in turn has brought about failure in treatment and consequently concerns about the related issues in all nations including the developed and developing ones. The gradual increasing resistance of the strains to fluoroquinolone is another growing concern among clinical practitioners. Since most UTI patients, in particularly developing nations, cannot afford the medical visits and lab tests, they recur empirical therapies which are not effective enough. Bangladesh is facing more problems regarding this, as there is no universal guideline or hospital policy for antibiotic resistance is a likely possibility. But there is no document published yet to support this. Hence institutionalized research is time demanding and crucial too. The urinary system consists of a pair of kidneys and their ureter, urinary bladder, and urethra. The kidneys produce urine and the ureter conveys it to the urinary bladder for temporary storage. Finally, the urine is evacuated from the bladder through the urethra.[11]

The kidneys are paired bean-shaped, reddish-brown organs, situated on the posterior abdominal wall, one on each side of the vertebral column, behind the peritoneum. They are enclosed in a thin fibrous capsule, which can be stripped off from the kidney without difficulty. The kidneys are surrounded by a mass of perirenal fat, renal fascia and perinephric fat. Each kidney is about 11 cm long, 6 cm broad, and 3 cm thick. The left kidney is a little longer and narrower than the right kidney. The kidney has an internal medulla and an external cortex. The renal medulla is made up of about 10 conical masses called renal pyramids. Their apices form the renal papillae, which indent the minor calyces. The renal cortex is divisible into two parts; Cortical arches or cortical lobules which form caps over the bases of the pyramids, and renal columns which dip in between the pyramids. Each pyramid along with the overlying cortical arch forms a lobe of the kidney. The kidney is composed of numerous closely packed, tortuous uriniferous tubules, which are held together by connective tissue stroma. The uriniferous tubules consist of two parts, which are embryo-logically distinct namely the nephron or secretory part and collecting tubule. The nephron comprises of the renal corpuscle and renal tubule. Each renal corpuscle consists of a glomerular plexus of capillaries and a Bowman's capsule into which the plexus invaginates. The first of these systems is rudimentary and nonfunctional; the second may function for a short term during the early fetal period, and the third forms the permanent kidney.[12]

Each kidney is supplied by a renal artery, which is a branch of abdominal aorta. Right renal artery is longer than the left one, because abdominal aorta lies on the left side of the vertebral column. About 1 liter of blood circulates through both kidneys per minute. Sometimes an accessory renal artery arising from the aorta supplies upper or lower pole of the kidney without passing through the hilum. Normally the course of the ureter is obliquely for several centimeters through the bladder wall. The normal tone of the detrusor muscle in the bladder wall tends to compress the ureter thereby preventing backflow of the urine from the bladder when pressure builds up in the bladder during micturition or bladder compression. Each peristaltic wave along the ureter increases the pressure within the ureter so that the region passing through the bladder wall open and allows urine to flow into the bladder.[13,14]

Aim and objectives

General objective was to describe the prevalence of community-acquired MDR UTI in hospitalized patients and their resistant pattern. Specific objectives were; to detect the prevalence and resistant pattern of multidrug-resistant *Escherichia coli* urinary tract infections among patients admitted to a teaching hospital. To describe the prevalence of MDR *E. coli* in community-acquired UTI in patients admitted to a teaching hospital and to describe the associations between patients' demographic parameters and multi-drug resistance.

METHODS

It was a cross-sectional study conducted in the Department of Medicine and Department of Gynecology of UAMCH, Dhaka from August 2011 to February 2012. The study included 100 cases of admitted patients of UTI in UAMCH with clinical criteria, urine R/E, and culture-positive cases enrolled in the study. The sample size needed for this study was calculated by using the following statistical formula:

$$n = z2pq/d2$$

Where n = the desired sample size. Z= the standard normal deviation, usually set at 1.96 at 5% level which corresponds to 95% confidence level. The target population is p to have a particular characteristic. The degree accuracy or precision level is d which is considered at 5%. The higher value of d yield a lower sample size and the smaller value of D yielded a higher sample size. Suppose 15% (p=0.15) of the attending patients have UTI.

Z statistic is 1.96, which corresponds to the 95% confidence level. D is the level of accuracy that is considered 5%. 100 patients were selected from admitted patients in the department of medicine and department of gynecology both male and female in UAMCH.

Sampling method

Non-random purposive sampling method was used.

Inclusion criteria

Community-acquired culture-positive hospitalized UTI patient having *E. coli* was included in the study. Criteria for community-acquired UTI were met by at least one of the following Criteria; Positive urine culture for *E coli* with 100.000 microorganisms/cm3 with ≤2 species, Urine culture with ≥100.000 colonies/ml of *E. coli* as a single uropathogenic. Age: More than 18 years. Both complicated and uncomplicated UTIs were included. Relapse, re-infection, or resistance cases were also included in the study.

Exclusion criteria

Those who developed infection 48 hours after hospitalization. Age less than 18 years. Culture-negative cases or culture showing growth other than *E coli* or multiple organisms. If informed consent is not obtained.

Data analysis

Data for socio-demographic and clinical variables was obtained from all participants by the use of a pre-designed and easily understandable questionnaire. The socio-demographic variables studied were age, sex, place of residence, and occupation Socioeconomic levels were determined by occupation, household income, and expenditure After collection of all the data it was entered in the SPSS 11.5 statistical software. Measures of central tendency, such as mean and median, chi-square analysis to show correlation, and student t-test to compare the means with a ninety-five percent (95%) confidence interval are the statistical tools to be used.

RESULTS

This cross-sectional study aimed to examine and identify multidrug-resistant (MDR) patterns of uropathogenic *Escherichia coli* (*E. coli*) in Bangladesh. The findings of this study have the potential to inform the development of more effective strategies for treating urinary tract infections (UTIs) in the region, ultimately leading to a reduction in the prevalence of MDR organisms. (Table 1) shows 79% of patients were female and the rest those (21%) were male with a mean age of 44.85±17.81 years. Among the respondents, the majority of the age group was 31-40 years, comprising 28% of the participants, followed by individuals aged 60 years, accounting for 23% of the total.

Table 1: Demographical data distribution of the study population (n=100).

Parameters	N	%
Age group		
up to 20	06	06.0
21-30	21	21.0
31-40	28	28.0
41-50	12	12.0
51-60	10	10.0
>60	23	23.0
Mean (SD)	44.85±17.81	
Gender		
Male	21	21
Female	79	79
Occupation		
Labour	11	11.0
Farmer & land owner	8	8.0
House wife	67	67.0
Student	10	10.0
Business	02	2.0
Govt employee	02	2.0
Educational status		
Can read	15	15.0
Can read & write	62	62.0
Illiterate	23	23.0
Can read	15	15.0

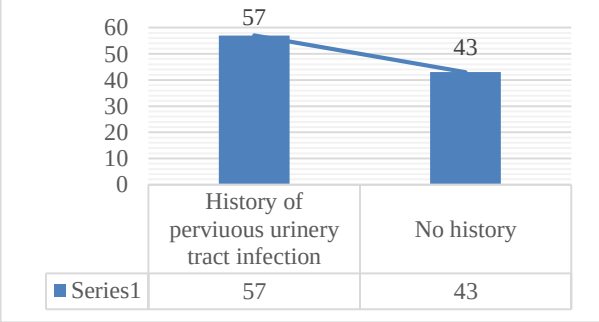

Figure 1: History of previous urinary tract infection.

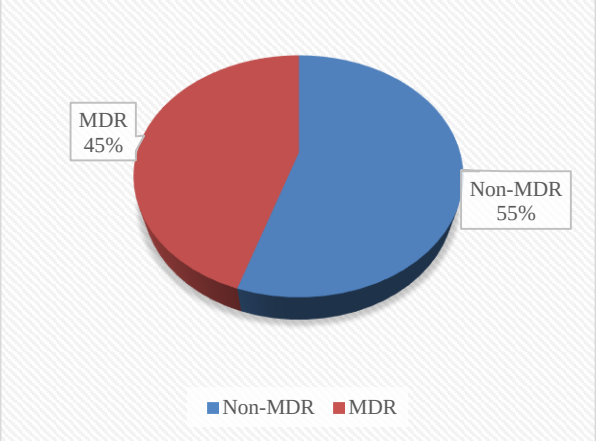

Figure 2: Prevalence of MDR UTI in 100 UTI patients.

Table 2: Febrile status of the UTI patients (n=100).

Fever	N	%
Intermittent	48	48.0
Continued	31	31.0
A febrile	20	20.0
Remittent	01	01.0
Total	100	100.0

Table 3: Association between DM with MDR UTT of *E. coli.*

Parameters	UTI N (%)		Total	P value
	MDR	Not MDR		
DM	29 (558)	23 (44.2)	52 (100)	0.02
Non-DM	16 (3.33)	32 (66.7)	48 (100)	
Total	45	55	100	

The 21-30 years age group represented 21% of the respondents, while the 41-50 years age group made up 12%. In terms of gender distribution, the majority were female, constituting 79%, while males accounted for 21%. When considering the occupation of the respondents, the largest group, comprising 67%, identified as housewives. Laborers constituted 11% of the participants, students accounted for 10%, and farmers and landowners represented 16% of the respondents. Regarding literacy levels, 62% of the respondents were able to read and write, while 23% were illiterate. The remaining 15% had basic reading skills. (Figure 1) Shows 57% had a history of previous urinary tract infection and 43% had no history of previous urinary tract infection. (Table 2) shows most of the patients of UTI have intermittent fever (48%), then continued fever (31%), then febrile (20%) and remittent (1%). It demonstrates that a large number of patients are febrile. (Figure 2) shows out of 100 UTI patients 45% were MDR and 55% were non MDR. (Table 3) shows association between DM with MDR UTI. Out of 52 DM 29(55.8%) were MDR. 23(44.2%) were not MDR ($p<0.05$) which is statistically significant. (Table 4) shows the association of catheterization with MDR in UTI patients, out of 26 catheterized patients 19 (73.1%) were MDR and 07 (26 9%) were non-MDR ($p<0.05$) which is statistically significant. Table 5 shows that the highest resistance was observed in all 100 samples toward beta-lactam antibiotics and cephalosporins in MDR UTI patients. This was followed by 44 samples (97.88%) showing resistance to quinolones, 12 samples (26.66%) resistant to aztreonam and nitrofurantoin, and 9 samples (20%) resistant to mecillinam. All samples were sensitive to carbapenem and aminoglycoside. Table 6 shows the lowest sensitivity among the MDR agents was against Amoxycillin Amoxyclave, Cephradine, Cefuroxime, Cefixime, and Ceftriaxone. Ceftazidime and Nalidixic acid, all of them were 0% sensitive. Furthermore, among MDR samples ciprofloxacin was sensitive to 1 (2.22%), Levofloxacin 3 (6.67%), Cotrimoxazole 14 (31.11%), Aztreonam 11 (24.44), Nitrofurantoin 33 (73.33%). Mecillinam 36 (80.0%), Amikacin 38 (84.44%), Netilmycin 43 (95.55%), Imipenem 45 (100%), Meropenem 45 (100%). That is, all the MDR *E coli* were sensitive to both Imipenem and Meropenem. (Table 7) shows the highest antibiotic resistance in 4 groups 20 (44.44%), followed by 3 groups 10 (22.22%), 6 groups 8 (17.77%), and 5 groups 7 (15.55%).

Table 4: Association of catheterization with MDR UTI patients.

Parameters	UTI N (%)		Total	P value
	MDR	Not MDR		
Catheterization	19 (73.1)	07 (26.9)	26 (100)	0.01
No catheterization	26 (35.6)	48 (64 4)	73 (100)	
Total	45	55	100	

Table 5: Resistant pattern of different groups of antibiotics of E. coli in UTI and MDR UTI.

Antibiotic groups	Resistant of *E.coli* N (%)	
	UTI N=100	MDR N=45
Beta-Lactum	75 (75)	45 (100)
Caphalosphorin	59 (59)	45 (100)
Quinolones	56 (56)	44 (97.88)
Aztreonam	14 (14)	12 (26.66)
Mecillinam	10 (10)	09 (20.0)
Nitrofurantoin	14 (14)	12 (26.66)
Aminoglycoside	00 (00)	00 (00)
Carbapenem	00 (00)	00 (00)

Table 6: Individual antibiotic sensitivity pattern of *E. Coli* in UTI and MDR UTI patients.

Name of Antibiotic	Antibiotic sensitivity N (%)	
	UTI (N=100)	MDR UTI (N=45)
Amoxycillin	00 (00)	00 (00)
Amoxyclave	25 (25)	00 (00)
Cephradine	02 (02)	00 (00)
Cefuroxime	37 (37)	00 (00)
Cefixime	35 (35)	00 (00)
Ceftriaxone	35 (35)	00 (00)
Ceftazidme	37 (37)	00 (00)
Nalidixic acid	15 (15)	00 (00)
Ciprofloxacin	39 (39)	01 (2.22)
Levofloxacin	37 (37)	03 (6.67)
Cotrimoxazole	52 (52)	14 (31.11)
Aztreonam	43 (43)	11 (24.44)
Nitrofurantoin	86 (86)	33 (73.33)
Mecillinam	90 (90)	36 (80.0)
Amikacin	86 (86)	38 (84 44)
Netilmycin	94 (94)	43 (95.55)
Imipenem	100 (100)	45 (100)
Meropenem	100 (100)	45 (100)

Table 7: Groups of antibiotic-resistant MDR UTI by *E. coli.*

Name of Antibiotic	N	%
6 groups of antibiotic	08	17.77
Bet-Cph Qui+Azt+Mec+Nit	02	4.4
Bet+Cph+Qui+Azt+Nit+cot	06	13.3
5 groups of antibiotic	07	15.55
Bet+Cph+Qui+Azt+Nit	04	8.9
Bet+Cph+Qui+Mec+cot	03	6.7
4 groups of antibiotic	20	44.44
Bet+Cph+Qui+Mec	02	4.4
Bet+Cph+Qun+cot	18	40.0
3 groups of antibiotic	10	22.22
Bet+Cph+Mec	01	2.2
Bet +Cph Qun	09	20.0
Total	45	100

Bet= Beta-Lactum, Cph = Caphalosphonn, Qui = Quninolones, Azte = Aztreonam, Mec= Mecillinam, Nite = Nitrofurantoin and Cot= Cotrimoxazole.

DISCUSSION

Urinary tract infections (UTIs) having as etiologic agent Escherichia coli are common infections with an estimated annual global incidence of at least 250 million cases, being costly to both patients and health care funding systems. It must be appreciated that substantial geographic variations may exist in Beta Lactum and cephalosporin group's resistance, as well as in the resistances to other antimicrobials, and therefore surveillance data must be available at the institutional, regional and national levels. In addition, patient demographic data is a useful supplement to susceptibility data in helping to identify patient groups at higher risk of being infected with resistant organisms, such as MDR E coli. In the present study, the prevalence of resistant isolates was lower among males than females for all agents under study. This trend likely reflects the tendency for males to present more often with complicated UTIs, which may be associated with more antimicrobial-resistant pathogens. Previous studies have described isolates from females only and have not reported gender or have not elaborated upon gender differences.[15-18]

The present study shows 57% had a history of previous urinary tract infection and 43% had no history of previous urinary tract infection and out of 100 UTI patients 45% were MDR and 55% were non-MDR. Patients with UTI have intermittent fever (48%), then continued fever (31%), then febrile (20%) and remittent (1%) It demonstrates that a large number of patients are febrile.

In the present study, greatest resistance among the MDR agents was against. Amoxycillin, Amoxyclave, Cephradine, Cefuroxime Cefixime, Ceftriaxone, Ceftazidime and Nalidixic acid, all of them were 100% resistant. The greatest resistance in the Farshad et al study was to ampicillin co-trimoxazole and tetracycline which were introduced by WHO in 2007 as the drugs of choice.[19,20] Reports from developed and developing nations such as Turkey, Senegal, Brazil, Slovenia, southern India and Australia are consistent with the Farshad et al findings.[21-24] It is worth mentioning that in the present study 77.88% of the samples were resistant to three or more antibiotics and most notably to Amoxycillin Amoxyclave Cephradine. Cefuroxime Cefixime, Ceftriaxone Ceftazidme, and Nalidic acid, of them, were 100% resistant. The MDR percentage varies with countries, in the USA it was 7.1% in 2000, and in Slovenia 42% in 2006.[25-27]

Varying rates in different countries are indicative of how more antibiotic prescription is controlled. The minimum resistance in the present study was found against imipenem, meropenem, Netilmycin amikacin, and nitrofurantoin. Adwan Tariq and Mathai also reported a high sensitivity to imipenem as the drug of choice for UTI.[28-30] The high sensitivity to imipenem and meropenem in our country is most probably due to less or even no use of imipenem and meropenem as the drug of choice. Unfortunately, the lack of sufficient data about bacterial resistance to antimicrobial agents in developing countries, including Iran, may be responsible for the increasing emergence of MDR.[19] What is evident in developing nations, in comparison with Western and European nations, is the growing resistance to the antibiotics such as ampicillin, co-trimoxazole, tetracycline, ceftazidime, and gentamicin conventionally used in the treatment of infants with UTI caused by E coli. To reduce the rate, urine culture, and antibiotic sensitivity test prior to the onset of the main treatment seems highly recommended. Also, the choice of antibiotic should be based on the site of infection at the pharmacodynamics spectrum of the drug isolation of the patients suspected of resistant strains is another effective measure in this arena.

To fight against the bacterial resistance gene in their genomes, new generation, and semi-synthetic antibodies should be produced or even other therapeutic agents including bacteriophage be suggested. Regional variability in resistance to single and multiple agents, the increases in ampicillin and SXT resistance among urinary pathogens over time 20 the predictability of the organisms causing acute bacterial cystitis, and evidence that the in vitro susceptibilities of common UTI pathogens are an important consideration for empiric therapy of UTIs emphasize the value of local, regional, and national surveillance programs.[20,27,31,32]

The growing antimicrobial resistance may be due to the irrational use of antibiotics and the transfer of resistance genes by transport means including antibiotic resistant plasmids, bacteriophages, transposons, and integrons. Since a plasmid or transposon can carry several resistance indexes, simultaneous resistance to multiple antimicrobial agents may be developed and the result would be MDR organisms. In present study most frequent pattern of resistance found to Beta-Lactum (100%), Caphalosphorin (100%), and Quninolones (97.88%) among the 45 MDR

UTI patients. For example, resistance to co-trimaxazole is usually accompanied by resistance to Ampicillin, cephalothin, and Tetracycline.

To alleviate this suffering situation in developing nations clinicians should prescribe antibiotics wisely and sufficiently and there should be periodic supervision of the drug consumption by the respective organizations.[31] Because antimicrobial resistance patterns are continually evolving, properly designed and conducted regional surveillance studies will continue to be essential to ensure the provision of safe and effective empiric therapy. Clearly, the current prevalence of multidrug resistance among urinary tract isolates of *E coli* in the United States (7.1%) suggests that monitoring these phenotypes is important and should be a consideration as the guidelines for the empiric treatment of UTIs evolve.

Limitations

The limitations of the studies were as follows: **t**his study was conducted in a tertiary hospital only and may not reflect the actual situation of the country. This was a cross-sectional study sample size was small and the study period was short, so may not give the actual conclusion. Recall bias may be one of the most important limitations of this study, as many patients could not remember about the past history of UTI and prior antibiotics taken.

CONCLUSION

The primary approach to treating urinary tract infections (UTIs) is through antibiotic therapy, which helps to control the causative agents. However, there is a clear correlation between the excessive use of antimicrobials and the growing emergence of antibiotic-resistant bacteria. Reports from around the world highlight the alarming prevalence of antibiotic-resistant *E. coli* strains, indicating the unwise and excessive consumption of antimicrobial drugs.

This trend has led to treatment failures and raised concerns about related issues in both developed and developing nations. In order to address this challenge, it is crucial for physicians to stay informed about the current antimicrobial susceptibility patterns of *E. coli* and other pathogens causing UTIs in their local communities. Antimicrobial susceptibilities can change over time and vary geographically. By being aware of these patterns, healthcare professionals can make more informed decisions regarding antibiotic prescriptions, helping to mitigate the development and spread of antibiotic resistance

Recommendations

Regional variability in resistance to single and multiple agents, along with the increasing resistance to Beta-Lactam, cephalosporin, and quinolone among urinary pathogens over time, highlights the importance of considering in vitro susceptibilities when treating acute bacterial cystitis. Evidence suggests that local, regional, and national surveillance programs play a crucial role in predicting the organisms causing UTIs and guiding empiric therapy.

Given the ongoing evolution of antimicrobial resistance patterns, properly designed and conducted regional surveillance studies remain vital for ensuring safe and effective treatment approaches. The high prevalence of multidrug resistance in *E. coli* urinary tract isolates found in this study emphasizes the importance of monitoring this organism. As guidelines for empiric treatment of multidrug-resistant UTIs continue to evolve, it is crucial to take into account the presence of MDR E. coli and consider appropriate measures accordingly. 1 choice-Imepenem Meropenem, 2 choice-Amikicin. Netilmycin, 3 choice-Nitrofurantoin, Mecillinam.

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REFERENCES

1. Marrs CF, Zhang L, Foxman B. Wicher K. Escherichia coli mediated urinary tract infection are there distinct. Microbiol Lett. 2005;252:183-9.
2. Ejrnaes K, Sandvang D, Lundgren B, Ferry S, Holm S, Monsen T, et al. Pulsed-field gel electrophoresis typing of Escherichia coli strains from samples collected before and after pivmecillinam or placebo treatment of uncomplicated community-acquired urinary tract infection in women. J Clin Microbiol. 2006;44(5): 1776-81.
3. Johnson JR, Russo TA. Molecular epidemiology of extraintestinal pathogenic (uropathogenic) Escherichia coli. J Med Microbiol. 2005;295:383-404.
4. Overturf GD. Urinary tract infection. In: Pediatric infection disease. 2nd ed. Baltimore: Saunders Company; 2002:983-4.
5. Karimi MM, Karimi A, Sharifian H. Urinary Interleukin 8 in acute pyelonephritis of children. Iranian J Kidney Dis. 2008;2:193-6.
6. Li Q, Sherwood JS, Logue CM. Characterization of antimicrobial resistant Escherichia coli isolated from processed bison carcasses. J Appl Microbiol. 2007; 103(6):2361-9.
7. Hughes VM, Datta N. Conjugative plasmids in bacteria of the 'pre-antibiotic' era. Nature. 1983;302(5910):725-6.
8. Davies J. Inactivation of antibiotics and the dissemination of resistance genes. Science. 1994;264: 375-81.
9. L'Abée-Lund TM, Sørum H. Class 1 integrons mediate antibiotic resistance in the fish pathogen Aeromonas salmonicida worldwide. Microb Drug Resist. 2001; 7(3):263-72.

10. Hall RM, Collis CM. Mobile gene cassettes and integrons: capture and spread of genes by site-specific recombination. Mol Microbiol. 1995;15(4):593-600.
11. Datta AK. Essentials of Human Anatomy Thorax and Abdomen. 4th ed. USA: Current Books International; 1997:301-41.
12. Langman S. Medical Embryology. 9th ed. USA: Lippincott Williams & Wilkins; 2004:321-36.
13. Guyton E, Hall E. Text Book of Medical Physiology 11th ed. USA: Lippincott Williams & Wilkins; 2010.
14. Ganong WF. Review of Medical Physiology. 22nd ed. USA: Mc Graw Hill; 2005:699-726.
15. Gupta K, Hooton TM, Wobbe CL, Stamm WE. The prevalence of antimicrobial resistance among uropathogens causing acute uncomplicated cystitis in young women. Int J Antimicrob Agents. 1999;11(3): 305-8.
16. Gupta K, Scholes D, Stamm WE. Increasing prevalence of antimicrobial resistance among uropathogens causing acute uncomplicated cystitis in women. JAMA. 1999;281(8):736-8.
17. Jones RN, Kugler KC, Pfaller MA, Winokur PL. Characteristics of pathogens causing urinary tract infections in hospitals in North America: results from the SENTRY Antimicrobial Surveillance Program, 1997. Diagn Microbiol Infect Dis. 1999;35(1):55-63.
18. Zhanel GG, Karlowsky JA, Harding GK, Carrie A, Mazzulli T, Low DE, Hoban DJ. A Canadian national surveillance study of urinary tract isolates from outpatients: comparison of the activities of trimethoprim-sulfamethoxazole, ampicillin, mecillinam, nitrofurantoin, and ciprofloxacin. The Canadian Urinary Isolate Study Group. Antimicrob Agents Chemother. 2000;44(4):1089-92.
19. van Driel AA, Notermans DW, Meima A, Mulder M, Donker GA, Stobberingh EE, Verbon A. Antibiotic resistance of Escherichia coli isolated from uncomplicated UTI in general practice patients over a 10-year period. Eur J Clin Microbiol Infect Dis. 2019; 38(11):2151-2158.
20. Konca C, Tekin M, Uckardes F, Akgun S, Almis H, Bucak IH, Genc Y, Turgut M. Antibacterial resistance patterns of pediatric community-acquired urinary infection: Overview. Pediatr Int. 2017;59(3):309-315.
21. Wolff O, Maclennan C. Evidence behind the WHO guidelines: hospital care for children: what is the appropriate empiric antibiotic therapy in uncomplicated urinary tract infections in children in developing countries? J Trop Pediatr. 2007;53(3):150-2.
22. Yüksel S, Oztürk B, Kavaz A, Ozçakar ZB, Acar B, Güriz H, Aysev D, Ekim M, Yalçinkaya F. Antibiotic resistance of urinary tract pathogens and evaluation of empirical treatment in Turkish children with urinary tract infections. Int J Antimicrob Agents. 2006;28(5): 413-6.
23. Dromigny JA, Nabeth P, Juergens-Behr A, Perrier-Gros-Claude JD. Risk factors for antibiotic-resistant Escherichia coli isolated from community-acquired urinary tract infections in Dakar, Senegal. J Antimicrob Chemother. 2005;56(1):236-9.
24. Powell MSS, Curtis CV. Cephalosporin resistant urinary tract infection in young children. J Paediatr Child Health. 2004;40(1-2):48-52.
25. Sahm DF, Thornsberry C, Mayfield DC, Jones ME, Karlowsky JA. Multidrug-resistant urinary tract isolates of Escherichia coli: prevalence and patient demographics in the United States in 2000. Antimicrob Agents Chemother. 2001;45(5):1402-6.
26. Gulsun S, Oguzoglu N, Inan A, Ceran N. The virulence factors and antibiotic sensitivities of Escherichia coli isolated from recurrent urinary tract infections. Saudi Med J. 2005;26(11):1755-8.
27. Rijavec M, Starcic Erjavec M, Ambrozic Avgustin J, Reissbrodt R, Fruth A, Krizan-Hergouth V, Zgur-Bertok D. High prevalence of multidrug resistance and random distribution of mobile genetic elements among uropathogenic Escherichia coli (UPEC) of the four major phylogenetic groups. Curr Microbiol. 2006; 53(2):158-62.
28. Mathai E, Grape M, Kronvall G. Integrons and multidrug resistance among Escherichia coli causing community-acquired urinary tract infection in southern India. APMIS. 2004;112(3):159-64.
29. Adwan K, Abu-Hasan N, Adwan G, Jarrar N, Abu-Shanab B, Al-Masri M. Molecular epidemiology of antibiotic-resistant Escherichia coli isolated from hospitalized patients with urinary tract infections in Northern Palestine. Pol J Microbiol. 2004;53(1):23-6.
30. Tang N, Jaffery T, Ayub R, Alam AY. Frequency and antimicrobial susceptibility of aerobic bacterial vaginal isolates J Coll Physicians Surg. 2006;16:196-9.
31. Ebrahimzadeh MA, Mahdavee MR, Vahedi M. Antibiotic resistance in E coli isolated from urine A2-years study molated from patient with urinary tract infections in Iran. J Cell Tissue Res. 2005;52:445-8.

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