International Journal of Medical and Health Research
ISSN: 2454-9142
Received: 20-03-2020; Accepted: 10-04-2020; Published: 20-04-2020
www.medicalsciencejournal.com
Volume 6; Issue 4; 2020; Page No. 14-18

A study on bacteriological profile and antimicrobial resistance pattern of urinary tract infection in children at tertiary care hospital, Jaipur

Beena Sharma[1], Rakesh Kumar Maheshwari[2], Ramesh Kumar Mishra[3*]
[1, 2] Department of Microbiology, SMS Medical College, Jaipur, Rajasthan, India
[3] SMS Medical College, Jaipur, Rajasthan, India

Abstract
Background: Urinary tract infection (UTI) is one of the most common infections in children. The incidence of UTI varies with the age and sex of the children. Fever may be the only symptom of UTI, especially in young children. *Escherichia coli is* the predominant pathogen in both the community-acquired urinary tract infection and hospital-acquired urinary tract infection. Drug resistance has been a common occurrence in infections among adults and elderly, but now it is frequently seen in children as well.
Objective: To determine the bacteriological profile and susceptibility pattern of organisms causing UTI among children.
Material and Methods: A total of 600 urine samples collected from the suspected cases of UTI were enrolled. A calibrated loop method (semi quantitative method) was used for the isolation of bacterial pathogens from urinary samples. Significant isolates were identified by conventional methods according to the standard laboratory protocol. The antibiotic sensitivity test was performed by modified Kirby Bauer disc diffusion technique as per CLSI
Results: A total of 600 clinically suspected cases of urinary tract infection were enrolled in our study among that 216 (36%) were significant growth and 384(64%) were sterile. Out of total 216 positive cases in which 118 cases (54.6%) belong to Female and 98 cases (45.4%) belong to Male category and the majority of cases (57.4%) found in the age group of 4 to 6 years. Among all the positive cases, *E. coli* was the most prevalent 136 (62.9%). Gram negative organisms showed highest sensitivity to Nitrofurantoin (74.5%) while Gram positive organisms showed highest sensitivity to linezolid (100%).
Conclusion: The constant evaluation of the antibiotic sensitivity pattern of UTI pathogens for commonly used antimicrobial agents in a particular environment should be carried out regularly.

Keywords: antimicrobial susceptibility testing, children, *Eschirichia. coli*, urinary tract infection

Introduction
Urinary tract infection (UTI) is one of the most common infections in children [1]. It is defined as the presence of bacteria in the urine in significant amounts [2]. The incidence of UTI varies with the age and sex of the children. Approximately 5% of all children less than two years of age with fever experience UTI [3].
UTI in paediatric age group differs in all the way from adults mainly by following congenital abnormalities of urinary tract namely posturethral valves, pelvi-ureteric junction obstruction, neurogenic bladder, stricture urethra, vesicoureteral reflux which is very true in infants (<1-year age group) [4].
Fever may be the only symptom of UTI, especially in young children [5, 7]. Newborns with pyelonephritis or urosepsis can present with nonspecific symptoms (failure to thrive, jaundice, vomiting, hyperexcitability, lethargy, hypothermia, and sometimes without fever) [8, 9].
UTI may lead to life threatening complications like sepsis and renal scaring. Renal scaring is the most common cause of hypertension in later childhood and renal failure in adulthood [10].
The pathogens causing urinary tract infections (UTI) in children are well known. *Escherichia coli is* the predominant pathogen in both the community-acquired urinary tract infection and hospital-acquired urinary tract infection and it is solely responsible for more than 80% of these infections [11]. The other bacteria which are also responsible for urinary tract infections are *Proteus, Klebsiella, Enterobacter, Pseudomonas, Enterococcus* and *Staphylococcus* species.
Treatment is often started empirically based on the local prevalence of organisms and susceptibility pattern. Drug resistance has been a common occurrence in infections among adults and elderly, but now it is frequently seen in children as well. Overuse and use of incomplete course of antibiotics as well as empirical antibiotic therapy have been the major contributing factors in the development of multidrug resistant bacteria [12]. Therefore, this study is undertaken to determine the bacteriological profile and susceptibility pattern of organisms causing UTI among children and to formulate guidelines for the empiric antibiotic treatment of childhood urinary tract infections in our region.

Material and Methods
Study Population
A total of 600 urine samples collected from the suspected cases of UTI from patients attending hospital both OPD and IPD were included in the study. Clean catch, mid-stream urine samples were received in sterile universal containers. Urine samples were processed within 2 hour of collection and in case of delay, the sample were refrigerated at 2-8°C.

Inclusion Criteria
a. Children below the age of 13 years
b. Patients with clinical suspicion of having UTI

Exclusion criteria
a. Children at the age of 13 years or above
b. Patients already on antibiotic therapy

Sample Processing
A calibrated loop method (semi quantitative method) [13] was used for the isolation of bacterial pathogens from urinary samples. A loopful urine sample was plated on Mac-Conkey agar & Blood agar (Hi Media Laboratories, Mumbai, India). The inoculated plates were incubated at 37°C for 24 hours. The number of isolated bacterial colonies was multiplied by 1000 for the estimation of bacterial load/mL of the urine sample. A specimen was considered positive for UTI if growth detected at a concentration of $\geq 10^5$ CFU/mL [14].
Significant isolates were identified by conventional methods according to the standard laboratory protocol, including colony morphology, gram staining and biochemical reactions. All gram-negative bacilli were identified to species level by their characteristic appearances on the media, Gram's stain, Oxidase test, Motility and biochemical reactions as per standard laboratory protocol. All gram-positive organisms were identified to species level by their characteristic appearances on the media, Gram's stain, Catalase test followed by Coagulase test. *Enterococcus* was identified by Bile Esculin disc test and it was also confirmed by Salt tolerance test (6.5% NaCl.)

Antimicrobial Susceptibility Testing
The antibiotic sensitivity test was performed by modified Kirby Bauer disc diffusion technique [70] with commercially available Hi-Media antibiotic discs according to Central Laboratory Standard Institute (CLSI) guidelines on Mueller Hinton agar plates. The antibiotics which were used in our study were based on the standard protocol of the hospital and departmental policies. (as per CLSI)

Statistical analysis
The qualitative data were expressed in proportion and percentages and the quantitative data expressed as mean and standard deviations. The difference in proportion was analyzed by using chi square test. Significance levels for tests were determined as 95% ($P< 0.05$).

Results
A total of 600 clinically suspected cases of urinary tract infection were enrolled in our study among that 216 (36%) were significant growth and 384(64%) were sterile. Out of total 216 positive cases in which 118 cases (54.6%) belong to Female and 98 cases (45.4%) belong to Male category and the majority of cases (57.4%) found in the age group of 4 to 6 years followed by 7 to 9 years (14.8%) and the least was 5.6% in 10-12 years of age.
Among all the positive cases, majority of the uropathogens were gram negative bacilli 188(87%) while Gram Positive cocci were 28(13%)
Among all the positive cases, in gram negative bacteria, *E. coli* was the most prevalent 136 (62.9%), followed by *Enterobacter* species 24(11.1%). Similarly, in gram positive bacteria, *Enterococcus* species was the most prevalent 19(8.8%) followed by CONS 05(2.3%)
Gram negative organisms showed highest sensitivity to Nitrofurantoin (74.5%), followed by Amikacin (55.4%) and Imipenem (48.5%). They showed least sensitivity to Cefotaxime (17.9%).
Pseudomaonas species showed highest sensitivity to Colistin (100%), followed by Piperacillin+Tazobactum (84.6%) and Gentamycin (69.2%) while the least sensitive was Ciprofloxacin (30.7%).
Gram positive organisms showed highest sensitivity to linezolid (100%) followed by Vancomycin and Teicoplanin (92.8%). They showed least sensitivity to Norfloxacin (17.8%).

Table 1: Total number of samples tested

Urine culture	Number	Percentage (%)
Significant Growth	216	36
Sterile	384	64
Total	600	100.00

Table 2: Age and gender distribution of the culture positive urine samples (n=216)

Age Group in year	Male		Female		Total	
	No.	%	No.	%	No.	%
0 to 1	14	10.2	07	5.9	21	9.7%
1 to 3	09	9.1	18	15.2	27	12.5%
4 to 6	56	57.1	68	57.6	124	57.4%
7 to 9	17	17.3	15	12.7	32	14.8%
10 to 12	02	6.1	10	8.47	12	5.6
Total	98	100.00	118	100.00	216	100%

Table 3: Distribution of Bacteria in Positive Culture (n=216)

Gram negative Bacteria	Number	Percentage (%)
Escherichia coli	136	62.9 %
Enterobacterspp	24	11.1%
Klebsiellaspp	08	3.7%
Pseudomonas spp	13	6%
Citrobacterspp	04	1.8%
Proteus spp.	03	1.3%
Gram Positive Bacteria		
Enterococcus spp.	19	8.8%
Coagulase negative Staphylococcus	05	2.3%
Staphylococcus aureus	04	1.8%
Total	216	100.00

Table 4: Overall Antibiotic Sensitivity Pattern of Gram negative Uropathogens (n=173)

Antibiotic	Number	Percentage
Amikacin	96	55.4%
Ampicillin	45	26%
Cefipime	73	42.1%
Cefotaxime	31	17.9
Ceftazidime	53	30.6
Ceftazidime + Clavulanic acid	60	34.6%
Ciprofloxacin	45	26 %
Cotrimoxazole	42	24.2%
Doxycycline	47	27.1%
Imipenem	84	48.5%
Nitrofurantoin	129	74.5%

Table 5: Overall Antibiotic Sensitivity Pattern of Pseudomonas species (n=13)

Antibiotic	Number	Percentage
Amikacin	7	53.8%
Aztreonam	8	61.5%
CefoperazoneSulbactum	07	53.5%
Ceftazidime	05	38.4%
Cefipime	06	46.1%
Ciprofloxacin	04	30.7
Colistin	12	100 %
Gentamycin	9	69.2%
Imipenem	06	46.1%
Piperacillin+Tazobactum	11	84.6%
Tobramycin	05	38.4%

Table 6: Overall Antibiotic Sensitivity Pattern of Gram-positive bacteria (n= 28)

Antibiotic	Number	Percentage
Ampicillin	09	32.1%
Cefoxitin	08	28.5%
Doxycycline	12	42.8%
Gentamycin	13	46.4%
Linezolid	28	100%
Nitrofurantoin	24	85.7%
Norfloxacin	5	17.8%
Piperacillin+Tazobactum	24	85.7%
Teicoplanin	26	92.8%
Vancomycin	26	92.8%

Discussion

In this study 600 urine samples were processed, out of which 216 (36%) gave significant growth of pathogens. Our findings are in accordance with Shrestha *et al*. [15], Palak Gupta *et al*. [16] and Mehta *et al*. [17] who observed bacterial growth in 35.4%, 35.7% and 36.6% of the urine respectively. However, Prakash D *et al*. [18] (53.82%), Rangari A *et al*. [19] (58.82%) found high prevalence of UTI. There are studies which shows low prevalence of UTI which accounts for 17.7% [20], 18.5% [21], 33.3% [22] in India.

In this study we found a high prevalence of UTI in females (54.6%) than in males (45.4%). female outnumbered male. The male: female ratio was 1:1.2. Our findings are in accordance with various studies who also shown a female preponderance with a male: female ratio of 1:1.9 [23] and 1:2 [24].

In this study we found that maximum number of patients (57.4%) was in the age group of three to six years followed by 7 to 9 years (14.8%) and the least was 5.6% in 10-12 years of age. Our results are consistent with Sharma *et al*. [25], G K Rai *et al*. [26], Singh *et al*. [27] and Malla *et al*. [24] also reported maximum number of patients (varying from 35-50%) in this age group. This could be because younger children are not well toilet trained and likelihood of ascending infection with fecal flora is more common in this age group [28, 29]. However, Gupta P *et al*. [16] and Gadge *et al*. [30] found maximum number of patients (56.5% and 37.7%, respectively) in the age group of less than 1 year of age. In one of the study eighty nine percent of the UTI in children was constituted by the age group of less than 6 years in one of the studies [31].

In this study we found that out of 216 significant growth *Escherichia coli* was the most common isolated urinary pathogen (62.9%). Our result is consistent with various studies [19, 21, 23] but differs from the reports in which *P. aeruginosa* [32] and *Klebsiella* spp [33] were recorded as the predominant bacteria in UTI. As *E. coli* is a major normal flora in the gut and most of the time poor hygiene will lead to cross contamination and then urinary tract infection occurs [34, 35].

Other bacteria isolated from UTI cases in this study were *Enterobacter* spp (11.1%), *Enterococcus spp* (8.8%), *Klebsiella* (6%), *Psedomonas spp* (3.7%), *Citrobacter spp*. (1.3%), CONS (2.3%), *Staphylococcus aureus* (1.8%) and the least was *Proteus* spp (0.31%). Our findings are consistent with various authors from different parts of India [16, 30, 36] and other countries across the world [24, 25, 27, 37, 38].

Enterobacteriacae have several factors responsible for their attachment to the uroepithelium. These gram-negative aerobic bacteria colonise the urogenital mucosa with adhesin, pili, fimbriae and P1-blood group phenotype receptor [39].

The incidence of *Enterobacter* spp is high in the present study (14.40%), as compared to the other gram-negative bacteria which is low as compared with other studies, signifying the geographic variations prevalent in a country [23, 40, 41].

In this study, gram positive organisms constituted 13% of the isolates the commonest being *Enterococcus spp* which is in line with studies conducted by Ami H Patel [42] have reported 12.4%.

Our study showed Enterococci to be the predominant amongst gram positive uropathogen followed by Coagulase negative Staphylococcus (2.3%), *Staphylococcus aureus* (1.8%) which is in accordance with the study conducted by Shobha KL *et al*. [43].

The antimicrobial susceptibility (AST) pattern differs in different studies as well as at different times in the same hospital in Indian and overseas studies because of the wide availability of over the counter antibiotics and different hospital based antibiotic policies. The pattern of antimicrobial resistance of the microorganism causing UTIs vary in their susceptibility to antimicrobials from place to place and from time to time.

In this study majority of Gram-negative bacteria were sensitive to Nitrofurantoin (74.5%), followed by amikacin (55.4%), Imipenem (48.5%) and the least sensitive was Cefotaxime (17.9%). Our findings are consistent with A Sharma *et al*. [3], N Kaur *et al*. [45], Gupta P *et al*. [46].

We observed that the most effective antibiotic for *E. coli* was Nitrofurantoin (73.22%), followed by amikacin (59.01%) and Imipenem (54.9%) which is similar to recent studies conducted by A sharma *et al*. [25], S P Shrestha *et al*. [15]. However, study by GK Rai [26] *et al*. at KCH has shown that *E. coli* was most sensitive to Amikacin, Chloromphenicol and Nitrofurantoin. This finding emphasizes the geographical variation seen in the susceptibility patterns of uropathogens to different drugs.

In this study the most effective drug for *Pseudomonas spp* was Colistin that shows 100% susceptibility followed by Piperacillin+Tazobactum (84.6%) and Gentammicin (69.2%), Aztreonam (61.5%) while Ciprofloxacin shows maximum resistant (70%) to *Pseudomonas spp*.

In this study we found that majority of Gram-positive cocci are sensitive to Linezolid (100%) followed by Vancomycin and Teiocplanin (92.8%), Piperacillin+Tazobactum (84.6%) and the least sensitive to Norfloxacin (17.8%). We observed that resistance to vancomycin is reported among *Enterococci* which is consistent with the studies conducted by Gupta P *et al*. [16] However there are studies which shows

100% susceptible to Vancomycin among Gram positive cocci [21].

It has been observed that all studies have their own susceptibility pattern of that region, the reason for difference might be factors related to difference in antibiotic use, patient population and prescribing rate [41, 44, 45]. Effective management of patients suffering from bacterial UTIs in children depends mainly on the type of organisms and selection of an effective antibiotic agent to the organism. Diagnosis of UTIs and its treatment requires a good cooperation between the clinician and the microbiologist.

Conclusion

A high isolation rate of pathogens from urine samples of clinically suspected UTI shows a good correlation between clinical findings and microbiological methods. This study highlights the need for the development of protocol for rational use of antibiotics and local chemist as well as clinician should be train for importance of rational use of antibiotics. We recommend that constant evaluation of the antibiotic sensitivity pattern of UTI pathogens for commonly used antimicrobial agents in a particular environment should be carried out regularly.

References

1. Khatoon A, Rizvi M, Sultan A, Khan F, Shukla I, Khan H, *et al*. Prevalence, microbial profile and antimicrobial sensitivity pattern of uropathogens isolated from paediatric patients. International Journal of Current Microbiology and Applied Sciences. 2015; 1:10-8.
2. Bensman A, Dunand O, Ulinski T. Urinary tract infection. Dalam: Avner ED, Harmon WE, Niaudet P, Yoshikawa N, editor. Paediatric Nephrology 6th Edition. Berlin Heidelberg. Springer-Verlag, 2009, 1299-1310.
3. Jitendranath A, Radhika R, Bhargavi I, Bhai G, Beevi R. Microbiological profile of urinary tract infection in paediatric population from a tertiary care hospital in South Kerala. Journal of Bacteriology and Mycology, 2015; 1:1-5
4. Taneja N, Chatterjee SS, Singh M, Singh S, Sharma M. Paediatric urinary tract infections in a tertiary care center from North India. Indian J Med Res. 2010; 131:101-5.
5. Hoberman A, Chao HP, Keller DM, Hickey R, Davis HW, Ellis D, *et al*. Prevalence of urinary tract infection in febrile infants. J Pediatr. 1993; 123:17-23.
6. Craig JC, Williams GJ, Jones M, *et al*. The accuracy of clinical symptoms and signs for the diagnosis of serious bacterial infection in young febrile children: prospective cohort study of 15 781 febrile illnesses. BMJ, 2010; 340:c1594.
7. Slater M, Krug SE. Evaluation of the infant with fever without source: an evidence-based approach. Emerg Med Clin North Am. 1999; 17:97-126.
8. Beetz R. Evaluation and management of urinary tract infections in the neonate. Curr Opin Pediatr. 2012; 24:205-11.
9. Biyikli NK, Alpay H, Ozek E, Akman I, Bilgen H. Neonatal urinary tract infections: analysis of the patients and recurrences. Pediatr Int. 2004; 46:2-5.
10. Bickerton MW, Ducket JW. Urinary tract infection in pediatric patients. American Urological Association, Houston, Texas, 1985.
11. Alzohairy M, Khadri H. Frequency and Antibiotic Susceptibility Pattern of Uro-Pathogens Isolated from Community and Hospital-Acquired Infections in Saudi Arabia - A Prospective Case Study. British Journal of Medicine & Medical Research. 2011; 1(2):45-56.
12. Srinivasan S, Madhusudhan NS. Prevalence of multidrug resistant pathogens in children with urinary tract infection: a retrospective analysis. Int J Med Res Health Sci. 2014; 3:954-8.
13. Procorp GW, Church DL, Hall GS, Janda WM, Koneman EW, Schreckenberger PC, *et al*. Koneman's Color Atlas and Textbook of Diagnostic Microbiology. 7th ed. Philadelpha: Wolters Kluwer, 2017, p.83.
14. Baron EJ, Peterson LR, Finegold SM. 11th ed. St Louis: Mosby. Bailey and Scott's Diagnostic Microbiology, 2002, 259-83.
15. Shrestha SP, Shrestha Ak, Lamsal L, Joshi M. Bacteriological Profile of Urinary Tract Infection in Children At GMC Teaching Hospital. Journal of Chitwan Medical College. 2013; 3(5):22-5.
16. Gupta P, Mandal J, Krishnamurthy S, Barathi D, Pandit N. Profile of urinary tract infections in paediatric patients. Indian J Med Res. 2015; 141(4):473-7.
17. Mehta M, Bhardwaj S, Sharma J. Screening of urinary isolates for the prevalence and antimicrobial susceptibility of enterobacteria other than *Escherichia coli*. Int J Life Sci Pharma Res. 2013; 3:100-4.
18. Prakash D, Ramchandra Sahai Saxena. Distribution and Antimicrobial Susceptibility Pattern of Bacterial Pathogens Causing Urinary Tract Infection in Urban Community of Meerut City, India ISRN Microbiology Volume 2013, 2013. Article ID 749629, 13 pages
19. Rangari A, Sharma S, Tyagi N, Singh P, Singh G, Thakur R, *et al*. Antibiotic Susceptibility Pattern of Bacterial Uropathogens Isolated from Patients at a Tertiary Care Hospital in Western Uttar Pradesh of Indi Int. J. Curr. Microbiol. App. Sci. 2015; 4(10):646-57.
20. Kumar S, Budhani D, Sayal P. Bacterial Uropathogens and Empirical Treatment in Urinary Tract Infection in a Tertiary Care Institute. Int. J Curr. Microbiol. App. Sci. 2016; 5(4):47-54.
21. Dalal P, Jayshri Pethani, Hetal Sida, Hiral Shah. Microbiological profile of urinary tract infection in a tertiary care hospital. Journal of Research in Medical and Dental Science. 2016; 4(3):203-9.
22. Singh VP, Mehta A. Bacteriological profile of urinary tract infections at a tertiary care hospital in Western Uttar Pradesh, India. Int J Res Med Sci. 2017; 5:2126-9.
23. Akram M, Shahid M, Khan AU. Etiology and antibiotic resistance patterns of community-acquired urinary tract infections in JNMC Hospital Aligarh, India. Ann Clin Microbiol Antimicrob, 2007; 6:4.
24. Malla KK, Sarma MS, Malla T, Thapalial A. Clinical profile, bacterial isolates and antibiotic susceptibility pattern in urinary tract infection in children-hospital based study. J Nepal Paeditr Soc. 2008; 28:52-61.
25. Sharma A, Shrestha S, Upadhyay S, Rijal P. Clinical and bacteriological profile of urinary tract infection in children at Nepal Medical College Teaching Hospital. Nepal Medical College Journal. 2011; 13:24-6.
26. GK Rai, HC Upreti, SK Rai, KP Shah, Shrestha RM. Causative agents of urinary tract infections in children and their antibiotic sensitivity pattern: a hospital-based

study. Nepal Med Coll J. 2008; 10(2):86-90.
27. Singh SD, Madhup SK. Clinical Profile and Antibiotics Sensitivity in Childhood Urinary Tract Infection at Dhulikhel Hospital. Kathmandu Univ Med J. 2013; 44(4):319-324.
28. Elder JS. Urinary tract infections. In: Kliegman R. M., Behrman R.E., Jenson H.B., Stanton B.E., Nelson Textbook of Pediatrics. Philadelphia: Saunders, 2007, 2223-8.
29. Chon CH, Lai FC, Shorthffe LM. Pediatric urinary tract infections. Pediatr Clin North Amer. 2001; 48:1447-59.
30. Ghadge DP, Nale SS, Kamble DS, Mule VS, Wankhade AB, Mali RJ, *et al*. Study of Aetiology and Anti-biogram of Uropathogens in Children-A Retrospective Analysis. J Clin Diagn Res. 2014; 8(1):20-2.
31. Al-Ibrahim AA, Girdharilal RD, Jalal MA, Alghamdy AH, Ghazal YK. Urinary tract infection and vesicoureteral reflux in Saudi children. Saudi J Kidney Dis Transplant. 2002; 19:24-8.
32. Ehinmidu JO, Bolaji RO, Adegboye EEA. "Isolation and antibiotic susceptibility profile of Neisseria gonorrhoeae isolated fromurine samples in Zaria, Northern Nigeria," Journal of Phytomedicine and Therapeutics. 2003; 8(11):20-4
33. Aboderin OA, Abdu LR, Odetoyin BW, Lamikanra A. "Antimicrobial resistance in *Escherichia coli* strains from urinary tract infections," Journal of the National Medical Association. 2009; 101(12):1268-73.
34. Kaper JB, Nataro JP, Mobley HL. Pathogenic *Escherichia coli.* Nat Rev Microbiol. 2004; 2(2):123-40.
35. Bien J, Sokolova O, Bozko P. Role of Uropathogenic *Escherichia coli* Virulence Factors in Development of Urinary Tract Infection and Kidney Damage. Int J Nephrol. 2012; 2:1-15.
36. Benachinmardi K, Padmavathy M, Malini J, Navaneet BV. Microbiological profile and antibiogram of uropathogens in pediatric age group. Int J of Health Allied Sci. 2015; 4(1):61-4.
37. Ibeneme CA, Oguonu T, Ikefuna AN, Okafor HU, Ozumba UC. Bacteriology of urinary tract infection and antimicrobial sensitivities in under-five children in Enugu. Niger J Paed. 2014; 41(3):188-93.
38. Edlin RS, Shapiro DJ, Hersh AL, Copp HL. Antibiotic resistance patterns of outpatient pediatric urinary tract infections. J Urol. 2013; 190(1):222-7.
39. Das RN, Chandrashekhar TS, Joshi HS, Gurung M, Shrestha N, Shivananda PG, *et al*. Frequency and susceptibility profile of pathogens causing urinary tract infections at a tertiary care hospital in western Nepal. Singapore Med J. 2006; 47(4):281.
40. Tambekar DH, Dhanorkar DV, Gulhane SR, Khandelwal VK, Dudhane MN. "Antibacterial susceptibility of some urinary tract pathogens to commonly used antibiotics," African Journal of Biotechnology. 2006; 5(17):1562-65.
41. Byarugaba DK. Antimicrobial resistance in developing countries and responsible risk factors. Int J Antimicrob Agents. 2004, 24:105-10.
42. Ami H Patel, Rekha H Bhavsar, Pinakin Trivedi, Shivani R Mehta. Urinary Tract Infections in Children: Clinical Profile, Bacteriology and Antibiotic Sensitivity Pattern GCSMC J Med Sci. 2015; 4(2):75-81.
43. Shobha KL, Jessica Sushma D'souza, Meena Alva, Anand KM, Gowrish S Rao. Ramachandra Study of Uropathogens and Its Antibiogram at a Tertiary Care Hospital at Coastal Karnataka. IJPPR. 2015; 4(2):100-9
44. European Centre for Disease Prevention and Control: Antimicrobial Resistance Surveillance in Europe 2009. Annual Report of the European Antimicrobial Resistance Surveillance Network (EARS-Net). Stockholm: ECDC, 2010.
45. Nys S, Terporten PH, Hoogkamp-Korstanje JA, Stobberingh EE. Trends in antimicrobial susceptibility of *Escherichia coli* isolates from urology services in The Netherlands. J Antimicrob Chemother. 2008; 62:126-32.