IOSR Journal of Nursing and Health Science (IOSR-JNHS)
e-ISSN: 2320–1959.p- ISSN: 2320–1940 Volume 6, Issue 5 Ver. VIII. (Sep. -Oct .2017), PP 60-65
www.iosrjournals.org

Susceptibility Pattern of Nitrofurantoin Against Uropathogens in Selected Areas of Dhaka city, Bangladesh

Nazmul Hossain*[1], Biswajit Das*[1], Md. Jahangir Alam[1], Farha Matin Juliana[2], Mohammod Johirul Islam[3], Mohammad Nazir Hossain[1], Babry Fatema[1], Badhan Rani Day[1], Runa Asma[4], Mohammad Asaduzzaman [†1]

** Contributed equally*
[1]*Department of Biochemistry, Primeasia University, Banani, Dhaka, Bangladesh*
[2]*Department of Biochemistry and Molecular Biology, Jahangirnagar University, Savar, Dhaka, Bangladesh*
[3]*Department of Biochemistry and Molecular Biology, Mawlana Bhashani Science and Technology University, Santosh, Tangail, Bangladesh*
[4]*Department of Laboratory Medicine, IBN SINA Diagnostic & Consultancy Center, Badda, Dhaka, Bangladesh*
[†]*Corresponding Author: Mohammad Asaduzzaman*

Abstract: *Resistance patterns of uropathogens in urinary tract infections (UTIs) show large inter-regional variability, and rates of bacterial resistance are changing due to different antibiotic treatment. Our aim was to assess the susceptible pattern of Nitrofurantoin antibiotic against uropathogens which cased Urinary Tract Infections. A total of* 9178 *urine samples were collected in 2016 (Jan-Dec) and out of which 890 (9.70%) were bacteriologically positive. Among the isolated uropathogens, 94.1% were gram negative and 5.9% gram positive organism. Male were found more prone to get UTI under 10 years and between 61-70 years of age and females were more affected in <10 to 70 years and but most affected in 21-30 years of age group. E. coli was the most prevalent (83.9%) isolate followed by Klebsiella spp. (7.1%), Staphylococcus aureus (3.1%), Enterococci spp. (2.6%), Pseudomonas spp. (2.2%), Proteus spp. (0.8%) and Staphylococcus saprophyticus (0.2%). Enterococci spp. was the most predominant sensitive organism to Nitrofurantoin with 100% sensitivity in both male and female patients and most resistant organism was Staphylococcus aureus (male 88.9% and female 72.7%). Around 28.1% male and 17.5% female were found resistant to nitrofurantoin against E. coli.*
Keywords*: Nitrofurantoin,UTI, Resistance, Uropathogen.*

Date of Submission: 13-10-2017 Date of acceptance: 28-10-2017

I. Introduction

Urinary Tract Infection (UTI) represents as one of the most common diseases encountered in medical practices these days and encompasses a broad range of clinical fields that are associated with a common finding of positive urine cultures [(1)]. Urinary tract infections (UTIs) are serious health problem affecting 150 million people globally in each year [(2)]. Urinary Tract Infection (UTI) is a very common infection all over the world but it is more prevalent in developing south Asian countries like Bangladesh [(3)]. They are the second most common types of infection in humans accounting for 8.3 million doctor's visit annually in USA [(4)]. They are the most common bacterial infection in patients of all ages with high risk in young women resulting in significant morbidity and health care costs [(5)].

Urinary tract infection is more common in female than male, because of the short length of the urethra and its proximity to anus. Pregnancy and sexual activity also make female more susceptible to UTI [(6)]. Different factors like age, sex, immunosuppression and urological instruments may affect prevalence of UTIs [(7)].

The etiology of UTIs and the antibiotic susceptibility of urinary pathogens, both in community and hospitals, have been changing over the past years and recently, the antibiotic resistance has become a major global problem [(8)]. UTI can be nosocomially ubiquitous in clinical environment so that prevalence rate of uropathogens is being alarmingly accelerated. To prevent these pathogens, different types of antibiotics and their super generations are used irrespectively with different doses in misused and overused forms. So uropathogens are getting resistant to efficacious drugs adopting different mechanisms of mutations and genetic transformations [(9)]. Antibiotic resistance is an increasing threat to life and morbidity and mortality [(10)].

Treatment of UTIs cases is often started empirically and therapy is based on information determined form the antimicrobial resistance pattern of the urinary pathogen [(11)]. However, a large proportion of uncontrolled antibiotic usage has contributed to the emergence of resistant bacterial infections [(12)].

Over a period of a few decades, Nitrofurantoin have used as an important class of drugs used primarily to treat urinary tract infections in the world. Unfortunately, Nitrofurantoin usage is threatened by the rising occurrence of resistance, which has been observed in every species that is treated by this drug. The aim of our study was to see the pattern of Nitrofurantoin susceptibility against uropathogens in the selected areas (Doyagonj, Gandaria, Jatrabari, Sayedabad, Dhaka, Bangladesh).

II. Materials and Methods

Materials

Study Design:

Study Location: This was a retrospective analysis of laboratory data routinely collected from the microbiology department of IBN SINA Diagnostic and Consultation Center, Doyagonj, Dhaka from 1st January, 2016 to 31st December, 2016. The total sample volumes were 9178.

Methods

Sample Collection and Bacteriological Assessment: Early morning midstream urine samples were collected aseptically from 9178 (Male-2735 and female-6443) patients. The urine samples were collected into sterile wide container (China) with screw cap tops. On the label were the name, age, sex and time of collection. All the patients were instructed on how to collect the urine samples aseptically and taken to the laboratory immediately for culture. In the diagnostic laboratory, each well mixed urine sample (1µL) was inoculated on MacConkey agar (Oxoid) and Blood agar (Oxoid) media plate under class-II laminar airflow (NUVO Sanaji Malzemelzeni, Imalat Vc Ticaret A.S, Turkey). The inoculum on the plate was streaked out for discrete colonies with a sterile wire loop sterilized by auto loop sterilizer (Germany) following standard procedures. The culture plates were incubated at 37°C by an incubator (Germany) for 48 hours and observed for the growth of bacteria through formation of colonies. All the bacteria were isolated and identified using morphological, microscopy (Japan) and biochemical tests like TSI (HiMedia), MIU (HiMedia) and Simmons Citrate (HiMedia) agar following standard procedures [13].

Antibiotic Susceptibility Assessment: The disc diffusion technique was used for antibacterial susceptibility testing of the isolates using commercial antibiotics containing discs. We used the commercial antibiotic disc Nitrofurantoin (300µg, Oxoid). Interpretation of results was done using zone sizes. Zones of inhibition ≥17 mm was considered sensitive, 15-16 mm intermediate and <14 mm resistant. Isolates were classified as either sensitive or resistant based on the definition of the Clinical and Laboratory Standard Institute [14]. Some laboratory stains of known sensitivity of *Staphylococcus aureus*, *E. faecalis*, *E. coli* and *Pseudomonas aeruginosa* were used as quality control strains for the antimicrobial discs.

Statistical Analysis: Data were assessed using the Statistical Package for Social Science (IBM SPSS Statistics, version 18, IBM Corporation, SPSS Inc. Chicago, III, USA). The Trend chi square test for statistical comparisons between the groups.

III. Results

The total 9178 urine samples collected from patients, 890 (9.70%) samples were positive and 8288 (90.30%) samples were negative at 2016 (January-December) in selected areas (Doyagonj, Gandaria, Jatrabari, Sayedabad, Dhaka, Bangladesh).

Tabel-1: Distribution table of Urinary Tract Infection (UTI) patients by age groups and gender

Age	<10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	>90
Male	35	1	12	10	20	27	57	27	3	0
Female	72	64	125	76	116	92	85	48	12	8
Total	107	65	137	86	136	119	142	75	15	8

Table-1 showed the distribution of patients by age and gender. Highest of the study subjects belonged to the 61-70 years age group (142 patients=85 female + 57 male) and followed by 21-30 years age group (137 patients=125 female + 12 male), 41-50 years age group (136 patients=116 female + 20 male) and 51-60 years age group (119 patients= 92 females + 27 males) respectively. In our study we saw that mostly female patients are affected by uropathogens in all the age groups in contrast male patients. Most prevalent frequency of female patients affected by uropathogens was found in 21-30 years age group.

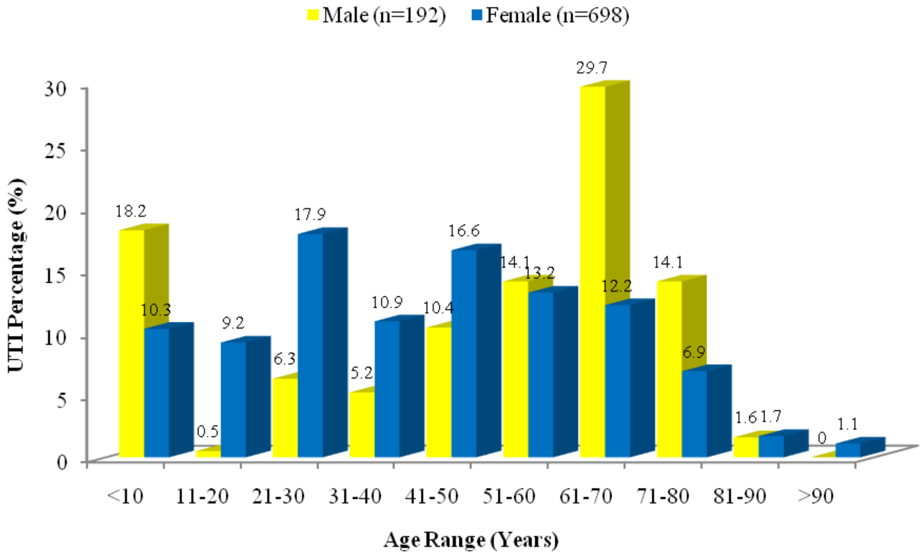

Figure-1: UTI percentage among different age groups of male (N=192) and female (N=698).

In this study, percentage of male patients were more porne to female patients (18.20% > 10.30%) under 10 years age groups. In between 11-20, 21-30, 31-40 and 41-50 years of age group female UTI infection (9.20%, 17.90%, 10.90% and 16.60% respectively) is higher than male (0.50%, 6.30%, 5.20% and 10.40% respectively). In between 51-60, 61-70 and 71-80 years age male infection (14.10%, 29.70% and 14.10 respectively) is higher than female (13.20%, 12.20% and 6.90% respectively). In between 81-90 and above 90 years age female infection (1.70% and 1.10% respectively) is higher than male (1.60% and 0.00% respectively) but here number of patients were very few.

Table-2: Distribution of specific uropathogen mediated UTI among UTI patients

Organisms	Percentage (n=890)		
	Male	**Female**	**Total**
E.coli	153 (17.2%)	594 (66.7%)	747 (83.9%)
Klebsiella spp.	16 (1.8%)	47 (5.3%)	63 (7.1%)
Staphylococcus aureus	4 (0.4%)	24 (2.7%)	28 (3.1%)
Enterococci spp.	7 (0.8%)	16 (2.6%)	23 (2.6%)
Pseudomonas spp.	9 (1.0%)	11 (1.2%)	20 (2.2%)
Proteus spp.	3 (0.3%)	4 (0.4%)	7 (0.8%)
Staphylococcus saprophyticus	0 (0.0%)	2(0.2%)	2 (0.2%)
Total	192 (21.6%)	698 (78.4%)	890 (100.0%)

Table-2 showed that the most predominant organism *E. coli* 747 (male 153 and female 594) found in UTI patients. As per number distribution, the second prevalent organism was *Klebsiella* spp. 63 (male 16 and female 47). Other isolated organism found as follows *Staphylococcus aureus* 28 (male 4 and female 24), *Enterococci* spp. 23 (male 7 and female 16), *Pseudomonas* spp. 20 (male 9 and female 11), *Proteus* spp. 7 (male 3 and female 4) and *Staphylococcus saprophyticus* 2 (female 2). On the other hand the study showed that the gram positive organism 5.9% and gram negative organism 94.1%.

Table-3: Prevalence of different uropathogens among male and female patients.

Organisms	Male (n=192)		Female (n=698)	
	Number	**Percentage**	**Number**	**Percentage**
E.coli	153	79.7%	594	85.1%
Klebsiella spp.	16	8.3%	47	6.7%
Staphylococcus aureus	9	4.7%	11	1.6%
Enterococci spp.	3	1.6%	4	0.6%
Pseudomonas spp.	4	2.1%	24	3.4%
Proteus spp.	7	3.6%	16	2.3%
Staphylococcus saprophyticus	0	0%	2	0.3%
Total	192	100%	698	100%

In our study table-3 showed that the prevalence of the uropathogens among male and female UTI patients. 192 samples (21.6%) were obtained from male subjects while the remaining 698 (78.4%) were from female. Among the male and female patients the most prone uropathogen *E. coli* was found 79.7% and 85.1%

followed by *Klebsiella* spp. 8.3% and 6.7%, *Staph.aureus* 4.7% and 1.6%, *Enterococci* spp. 1.6% and 0.6%, *Pseudomonas* spp. 2.1% and 3.4%, *Proteus* spp. 3.6% and 2.3% and *Staphylococcus saprophyticus* 0.0% and 0.3% respectively. The study noted that male patients were more infected by all of the organism (*Klebsiella* spp. *Staphylococcus aureus, Enterococci* spp. and *Proteus* spp.) except some organisms (*E. coli*, *Pseudomonas* spp. and *Staphylococcus saprophyticus)* which were more infected female patients than male patients.

Table-4: Susceptibility pattern of Nitrofurantoin against uropathogens among male UTI patients (n=192)

Name of organisms	Sensitive		Resistant	
	Number	Percentage	Number	Percentage
E. coli	110	71.9%	43	28.1%
Klebsiella spp.	7	43.8%	9	56.3%
Staphylococcus aureus	1	11.1%	8	88.9%
Enterococci spp.	3	100.0%	0	0.0%
Pseudomonas spp.	4	100.0%	0	0.0%
Proteus spp.	4	57.1%	3	42.9%
Total	129	67.19%	63	32.81%

Table-4 showed that Nitrofurantoin were sensitive against isolated uropathogenic bacteria in male 67.19% and rest of resistant 32.81%. All of them (100%) *Enterococci* spp., *Pseudomonas* spp. were sensitive to Nitrofurantoin but here numbers were very few. On the other hand the most prevalent resistant organism was *Staphylococcus aureus* (88.9%). In contrast *E. coli* was the most significant organism which was 71.9 % sensitive and 28.1 % resistant to Nitrofurantoin. The other sensitivity patterns were *Klebsiella* spp. 43.8%, *Staphylococcus aureus* 11.1% and *Proteus* spp. 57.1% and resistant 56.3%, 88.9% and 42.9% respectively.

Table-5: Susceptibility pattern of Nitrofurantoin against uropathogens among female UTI patients (n=698)

Name of organisms	Sensitive		Resistant	
	Number	Percentage	Number	Percentage
E.coli	491	82.7%	103	17.3%
Klebsiella spp.	22	46.8%	25	53.2%
Staphylococcus aureus	3	27.3%	8	72.7%
Enterococci spp.	4	100.0%	0	0.0%
Pseudomonas spp.	18	75.0%	6	25.0%
Proteus spp.	10	62.5%	6	37.5%
Staphylococcus saprophyticus	2	100.0%	0	0.0%
Total	550	78.8%	148	21.2%

Table-5 showed that Nitrofurantoin were sensitive against isolated uropathogenic bacteria in female 78.8% and rest of resistant 21.2%. All of them (100%) *Enterococci* spp., *Staphylococcus saprophyticus* was sensitive to Nitrofurantoin but here numbers were very few. On the other hand the most prevalent resistant organism was *Staphylococcus aureus* (72.7%). In contrast *E. coli* was the most significant organism which was 82.7 % sensitive and 17.3 % resistant to Nitrofurantoin. The other sensitivity patterns were found *Klebsiella* spp. 46.8%, *Staphylococcus aureus* 27.3%, *Pseudomonas* spp. 75% and *Proteus* spp. 62.5% and resistant 53.2%, 72.7%, 25% and 37.5% respectively.

IV. Discussion

Due to overuse, underuse and misuse of antibiotics, followed by an increase in the bacterial resistance rates, this study aimed to evaluate the pattern of antimicrobial susceptibility of bacteria isolated from patients with UTI seen at the IBN SINA diagnostic center, Doyagonj, Dhaka, Bangladesh. Moreover, we identified the major bacterial species associated with UTI and described the susceptibility profile to Nitrofurantoin. It is important that clinicians are aware of the regional antibiotic resistance rates before initiating experimental antimicrobial therapy for UTI treatment, as it is well-described that urinary infection with a resistant pathogen is more likely to lead to bacteriological/clinical failures [(15)]. In this study, we tested total 9178 urine samples and 890 (9.70%) were bacteriological positive and 8288 (90.30%) were bacteriological negative found. Females were more suffered with UTI and it caused by *E. coli* (85.1%). This may explain the highest frequency of UTIs observed in women when compared to men, which is often attributed to a shorter urethra that facilitates colonization by these microorganisms. Furthermore, another mechanism that could explain the lower frequency of UTI in men would be the prostatic fluid, which has antibacterial substances [(3)].

UTIs are particularly common among the female population with an incidence of about 1% of school-aged girls and 4% of women through child-bearing years. Incidence of infection in females increases directly with sexual activity and child-bearing. In the women, 25-30% of women between 20-40 years of age will get UTIs [(16)]. The anatomical relationship of the female urethra and the vagina makes it liable to trauma during sexual intercourse as well as bacteria been massaged up the urethra into the bladder during pregnancy and child birth. It has been reported in several studies that women who are sexually active, and especially if they use contraceptives, foams, gels, diaphragm and spermicides which are known to promote greater colonization of the vagina are at higher risk of developing UTIs [17]. In our study we found that most predominant age group was 20-30 years age than other age group and female were more predominant than male. There were found significant difference between age groups and sex at 5% ($P<0.05$).

In this study the most predominant organism *E. coli* (83.9%), as gram negative bacteria that cause urinary tract infection. There was a statistically significant difference in favor of *E. coli* ($P>0.05$) than others. The other organisms were isolated *Klebsiella* spp. (7.1%), *Staphylococcus aureus* (3.1%), *Enterococci* spp. (2.6%), *Pseudomonas* spp. (2.2%), *Proteus* spp. (0.8%), and *Staphylococcus saprophyticus* (0.2%) in order of ranking, and out of these, majority of the isolates were from female subjects. Several studies have shown that *E. coli* is the major bacterial species associated with UTIs, and *Klebsiella pneumoniae* is the second most important bacteria in this type of infection [18]. The early introduction of effective drugs against bacterial infections in the last century has changed the medical behavior and has significantly reduced the mortality rates due to these agents. However, the widespread use of antibiotics has induced different mechanisms of bacteria resistance to these drugs [19]. There were found significant difference between age groups and sex at 5% ($P<0.05$).

Treatment of urinary tract infections is becoming more complicated with an increase of the number of resistant strains to antibiotics and prevalence of antibiotic resistance mechanisms. It had observed that horizontal gene transfer is a factor in the emergence and spread of antimicrobial resistance in clinical isolates. Consequently, it has been suggested that the high prevalence of resistance to a particular antibiotic does not always reflect antibiotic consumption in a given environment [20].

In our study there were 192 male patients found with UTI. *E. coli* mediated UTI was more prevalent than other organisms. For 7.9% UTI cases *E. coli* showed sensitive against nitrofurantoin and for rest 28.1% showed resistant. Other organisms such as Pseudomonas spp. and *Enterococci* spp. showed 100% sensitivity against nitrofurantoin followed by *Klebsiella* spp. (43.8%), Staphylococcus aureus (11.1%) and Proteus spp. 57.1%, Most prevalent resistant of nitrofurantoin was found against *Staphylococcus aureus* (88.9%) and followed by *Klebsiella* spp. (56.3%) and *Proteus* spp. (42.9%). There is significant difference between resistant and sensitivity of nitrofurantoin at 5% ($P<0.05$). In our study also showed that there were 698 female patients found with UTI. *E. coli* mediated UTI was more prevalent than other organisms. For 82.7% UTI cases *E. coli* showed sensitive against nitrofurantoin and for rest 17.3% showed resistant. Other organisms such as *Enterococci* spp. and *Staphylococcus saprophyticus* showed 100% sensitivity against nitrofurantoin followed by *Klebsiella* spp. (46.8%), *Staphylococcus aureus* (27.3%) and *Pseudomonas* spp. (75.0%), *Proteus* spp. (62.5%), Most prevalent resistant of nitrofurantoin was found against *Staphylococcus aureus* (72.7%) and followed by *Klebsiella* spp. (53.2%) and *Pseudomonas* spp. (25.0%), *Proteus* spp. (37.5%). There is significant difference between resistant and sensitivity of nitrofurantoin at 5% ($P<0.05$).

Antimicrobial therapy for treatment of UTIs especially when using the nitrofurantoin should be based on local experience of sensitivity, tolerability and resistance patterns. Bacterial resistance has become a public health issue and has increasingly been associated with risk factors that put life in danger [21]. Awareness is needed of both the population and health professionals about the importance for the correct use of antibiotics. The nitrofurantoin use should be performed only after the microbial susceptibility confirmation, and it is necessary to find other alternatives for the empirical treatment. The bacterial resistance prevention can be performed through control measures that limit the spread of resistant bacteria and the rational use of antimicrobial policy [3]. Nitrofurantoin drugs are still now most effective drugs for urinary tract infection patients. So we showed control the misuse and abuse the drugs.

V. Conclusion

In a nutshell, the results showed that there was a high prevalence of occurrence of urinary tract infection among patients of areas (Doyagonj, Gandaria, Jatrabari, Sayedabad, Dhaka, Bangladesh). Most of the bacteria were susceptible to nitrofurantoin. The prescribed nitrofurantoin antibiotic were still effective against the uropathogens, but should be reserved for only complicated UTIs and should use to follow the antibiotic guidelines in order to prevent emergence of multi drug resistant organisms.

References

[1]. Castro-Orozco R, Barreto-Maya AC, Guzman-Alvarez H, Ortega-Quiroz RJ, Benitez-Pena L (2010). Antimicrobial resistance pattern for gram-negative uropathogens isolated from hospitalised patients and outpatients in Cartagena, 2005-2008]. Rev Salud Publica (Bogota). 12(6):1010-1019

[2]. Orenstein R, Wong ES (1999). Urinary tract infections in adults. Am Fam Physician, 59:1225-34.

[3]. Jahangir Alam, Farha Matin Juliana, Md Rahimgir, Mohammad Nazir Hossain, Babry Fatema, Mohammad Asaduzzaman (2017). "Resistance Pattern of Ciprofloxacin against common Uropathogens in Selected Area of Dhaka city, Bangladesh." IOSR Journal of Nursing and Health Science (IOSR-JHNS), 6:5:52-57.

[4]. Annabelle TD, Jennifer AC (1999). Surveillance of pathogens and resistance patterns in urinary tract infection. Phil J Microbial Infect Dis.28:11-4

[5]. Stamm WE, Norrby SR (2001). Urinary tract infections: disease panorama and challenges. J Infect Dis,183(Suppl 1):S1-4. Ramesh N, Sumathi CS, Balasubramanian V, Ravichandran KP, Kannan VR (2008). Urinary tract infection and antimicrobial susceptibility pattern of extended spectrum of beta lactamase producing clinical isolates. Advan Biol Res. 2(5-6):78-82.

[6]. Iqbal T, Naqvi R, Akhter SF. (2010). Frequency of urinary tract infection in renal transplant recipients and effect on graft function. J Pak Med Assoc. 60(10):826-829.

[7]. Akram M, Shahid M, Khan AU (2007). Etiology and antibiotic resistance patterns of community-acquired urinary tract infections in J N M C Hospital Aligarh, India. Ann Clin Microbiol Antimicrob. 6:4.

[8]. Laisa Ahmed Lisa, Dipak Kumar Paul, Sudhangshu Kumar Biswas, Nirmal Chandra barman, Shital Kumar Barman (2015). Drug Resistance Profiles of Potential Gram Negative Rods Isolated from Urinary Tract Infected (UTI) Patients of Bangladesh with Four South Asian Countries. Int J Pharma Sciences, 5(4):1160-1166

[9]. A.M. El-Mahmood, A.T. Tirmidhi, A. Mohammed (2009). Antimicrobial susceptibility of some quinolone antibiotics against some urinary tract pathogens in a tertiary hospital, Yola, Adamawa State, Nigeria. J Cli Med & Research,1(2):026-034.

[10]. Wilson ML, Gaido L (2004). Laboratory Diagnosis of Urinary Tract Infections in Adult Patients. Clin Infect Dis. 38:1150-1158.

[11]. National Committee for Clinical Laboratory Standards (2000). Performance standards for antimicrobial disc susceptibility tests. 7th ed.Wayne, Pennsylvania, USA: NCCLS, M2-A7.

[12]. Cheesborough M (2006). District Laboratory practice in Tropical Countries, Cambridge United Press, UK, part 2 ,pp 7-106.

[13]. Clinical and Laboratory Standard Institute (2006). Methods for the Dilution Antimicrobial Susceptibility Tests for Bacteria. That Grow Aerobically. Approved Standards, Seventh Edition (M07), Villanova pp. MO 7-A 7.

[14]. Zhanel GG, Hisanaga TL, Laing NM, DeCorby MR, Nichol KA, Weshnoweski B, Johnson J, Noreddin A, Don E.Low DE, Karlowsky JA, Hoban DJ (2006). Antibiotic resistance in Escherichia coli outpatient urinary isolates: final results from the North American Urinary Tract Infection Collaborative Alliance (NAUTICA). Int J Antimicrob Agents. 27(6):468-75.

[15]. Wilma JP (2002). Shafers Medical Surgical Nursing. 7th edition, B.I. Publications: New Delhi. 637-40.

[16]. Mbata TI (2007). Prevalence and antibiogram of UTIs among prisons immates in Nigeria. Int. J.Microbiol. 3(2).

[17]. Costa LC, Silva PMF, Belém LF, Pereira HS, Silva JED; Leite TR, Pereira GJS (2010). Infecções urinárias em pacientes ambulatoriais: prevalência e perfil de resistência aos antimicrobianos. Rev Bras Anal Clin. 42:175-80.

[18]. Silveira GP, Nome F, Gesser JC, Sá MM, Terenzi H (2006). Estratégias utilizadas no combate a resistência bacteriana. Quím Nova. 29:844-55.

[19]. Brown JR, Daniel G, Julie A, Ingraham BK, David JH, Stanhope MJ (2003). Horizontal transfer of drug-resistant amino-acyl-transfer-RNA synthetases of anthrax and Gram-positive pathogens. EMBO Rep. 4(7):692-698.

[20]. Ana CCR, Susana RSS, Siane CS, Milena GS, Thassila NP, Ricardo RO (2016). Ciprofloxacin resistance pattern among bacteria isolated from patients with community-acquired urinary tract infection. Rev. Inst. Med. trop. S. Paulo, 58.

Nazmul Hossain. “Susceptibility Pattern of Nitrofurantoin Against Uropathogens in Selected Areas of Dhaka city, Bangladesh.” IOSR Journal of Nursing and Health Science (IOSR-JNHS) , vol. 6, no. 5, 2017, pp. 60–65.