Antibiotic Susceptibility Pattern of Uropathogens towards Nitrofurantoin and Nalidixic Acid: A Comparative Study

S.Subathra Devi¹, Y.Lakshmi Sarayu¹ and V.Natarajan²

¹Department of Microbiology, Rajah Muthiah medical College, Chidamaram,Tamilnadu, India.
²Department of Microbiology, RMMCH, Annamalai University, Chidambaram, Cuddalore District, Tamilnadu - 608001, India.

http://dx.doi.org/10.22207/JPAM.11.3.42

(Received: 15 June 2017; accepted: 30 August 2017)

The objective of the study is to assess the sensitivity pattern of commonly isolated uropathogens towards the drugs Nitrofurantoin and Nalidixic acid. Widespread and irrational use of antibiotics has led to the development of highly resistant microorganisms. As the antibiotic sensitivity patterns of the microorganisms are frequently changing, this study was performed to assess the antibiotic sensitivity pattern of Nitrofurantoin and Nalidixic acid in urinary tract infections. This was a prospective, cross-sectional, observatory study conducted in the Department of Microbiology from January 2017 to July 2017 at RMMC, Chidambaram.300 culture positive urine samples were studied for the antibiotic susceptibility testing towards Nitrofurantoin and Nalidixic acid. The processing of the samples were done by standard microbiological methods. The antibiotic susceptibility was measured by disk diffusion test. CLSI guidelines were used for the antibiotic susceptibility evaluation[1]. Out of the 300 culture positive samples, the most common pathogen isolated in this study was *E.coli* (145), followed by *Klebsiella* (63), *Staphylococcus aureus* (35), *Pseudomonas* (36), *Staphylococcus saprophyticus* (10), *Enterococcus* (6), *Streptococcus* (4), *Proteus* (1). The antibiotic susceptibility pattern for Nitrofurantoin: *E.coli* showed sensitivity (n=105) and resistance (40), *Klebsiella* showed sensitivity (47) and resistance (16), *Staphylococcus aureus* showed sensitivity (30) and resistance (5), *Pseudomonas* showed sensitivity (12) and resistance (24), *Staphylococcus saprophyticus* showed sensitivity (4) and resistance (2), *Enterococcus* showed sensitivity (5) and resistance (1), *Streptococcus* showed sensitivity (4) and resistance (0) and *Proteus* showed sensitivity (0) and resistance (1). The antibiotic susceptibility pattern for Nalidixic acid: *E.coli* showed sensitivity (n=23) and resistance (122), *Klebsiella* showed sensitivity (29) and resistance (43), *Staphylococcus aureus* showed sensitivity (9) and resistance (30), *Pseudomonas* showed sensitivity (4) and resistance (32), *Staphylococcus saprophyticus* showed sensitivity (2) and resistance (4), *Enterococcus* showed sensitivity (1) and resistance (5), *Streptococcus* showed sensitivity (0) and resistance (4) and *Proteus* showed sensitivity (0) and resistance (1). Urinary pathogens were more sensitive to Nitrofurantoin than *E.coli*. Hence Nitrofurantoin can be used as an effective drug in UTI.

**Keywords**: *E. coli, Enterococcus spp, Pseudomonas spp, Nitrofurantoin, Nalidixic acid, UTI.*

Urinary tract infection (UTI) is one of the most common bacterial infection in the human population affecting all the age groups.¹ It remains a major public health problem. UTI is defined by a combination of clinical feature and the presence of significant bacteria in urine. Significant bacteria are defined by the presence of more than 100,000 colony forming unit of single bacteria in culture in urine. The clinical feature of UTI may include both specific and nonspecific signs and symptoms. UTI is more common in women especially in the reproductive age group. Short female urethra,
proximity of the female urethral meats to the vagina and rectal mucosa with their abundant microbial flora and sexual intercourse have been reported as influencing factors for the higher occurrence of UTI in women. Study showed, UTI is most common in the age group of 61-80 years among males. Elderly males had a higher incidence of UTI when compared with the elderly females. This finding is like study conducted by Shah et al and Sood et al. This is probably because with advancing age, the incidence of UTI increases among males due to prostate enlargement, neurogenic bladder and requirement of catheterization in the form of intervention.

This situation is further complicated by the fact that accurate diagnosis depends upon both the presence of symptoms and a positive urine culture, although in the most outpatient setting this the diagnosis is made without the benefit of culture. Catheter-associated UTI is the most common nosocomial infection, according for >1 million case in hospital and nursing home. Urinary tract infection is due to an inflammatory response of urothelium to the invading pathogenic organisms. Uropathogenic *E.coli* is responsible for >80% of community acquired UTIs. Other organisms causing UTI are *Klebsiella pneumoniae*, *Pseudomonas sp*, *Staphylococcus aureus*, *Staphylococcus saprophyticus*, *Enterococcus sp*, *Streptococcus sp*, and *Proteus sp*. *E.coli* causes most of the urinary infections in patients with or without catheters, in situations of urinary calculi and urological abnormalities. To treat UTIs, an updated knowledge of the organisms causing UTI and their antibiotic susceptibility pattern is required.

Periodic evaluation of antibacterial susceptibility pattern is needed to update the information. High prevalence of urinary tract infection, irrational use of antibiotics, over-the-counter availability of antibiotics leads to the development of multidrug resistance. This study was conducted to know the sensitivity pattern of uropathogens towards Nitrofurantoin and Nalidixic acid.

**Inclusion criteria**
Positive urine cultures showing pure growth of organism and their sensitivity pattern with the following criteria were included in the study:

- Both sex
- Both inpatients and out patients
- Only bacterial isolate.

**Exclusion criteria**
Urine cultures showing mixed organisms

**Study population and sample processing**
Total 300 positive urine culture samples were taken for this study their antibiotic susceptibility pattern for Nitrofurantoin and Nalidixic acid were done by Kirby Bauer method. Majority of the samples were midstream clean catch urine and others included catheterized urine samples. Samples were collected in a sterile screw-capped wide-mouth container. The containers were labelled with a unique sample number, date and time of collection. The urine samples were processed within two hours after collection in the clinical microbiology laboratory. Using a calibrated loop (volume - 0.005ml) streaking was done on cysteine lactose electrolyte deficient medium. Isolates were tested for antimicrobial susceptibility testing on Mueller-Hinton agar plates by the standard Kirby-Bauer disc diffusion method. Plates were incubated at 37°C for 18-24 hours, after that inhibition zones were measured and reported as per clinical and laboratory standards institute guidelines (CLSI). Nitrofurantoin disc containing concentration of 300 mcg and Nalidixic acid disc containing concentration of 30 mcg were used. The results were interpreted according to clinical and laboratory standards institute guidelines. Analyzation of data was carried out on focusing on the gender, age, isolation of bacteria, gram staining and Antimicrobial sensitivity. The quality control strains used were *E. coli* American type culture collection (ATCC) 25922, *Pseudomonas aeruginosa* ATCC 27853, *Enterococcus fecalis* ATCC 29212 and *Staphylococcus aureus* ATCC 25923 for antimicrobial discs.

**METHODS**
A prospective study was conducted from January 2017 to July 2017.
DISCUSSION

- *E. coli* is still the most common urinary isolate irrespective of geographical area and this study confirmed it. There are several factors responsible for their attachment to uroepithelium. They colonize in the urogenital mucosa with adhesins, pili, fimbriae, and P-1 blood group phenotype receptor.
- The data collected from other places around the world, also showed that *E. coli* and *Klebsiella* spp. are still the commonest uropathogens isolated.
- Nitrofurantoin, a chemotherapeutic compound of the Nitrofuran family, was introduced into clinical practice in 1952. Nitrofurantoin is a synthetic antimicrobial derived from furan by the addition of a nitro group and a side chain containing hydantoin. Nitrofurantoin is a weak acid and its solubility is affected by pH. Nitrofurantoin spectrum of in vitro susceptibility includes the majority of *Escherichia coli*, Citrobacter species, group B *Streptococci*, *Enterococci*, *Staphylococcus aureus*, *S. saprophyticus*, *Klebsiella pneumoniae* and *Enterobacter* species. Thus, its antibacterial spectrum is broad and is particularly effective against the main uropathogens, hence its use for the treatment of urinary tract infections (UTI).

RESULTS

Table 1. Antibiotic susceptibility pattern of uropathogens towards Nitrofurantoin:

<table>
<thead>
<tr>
<th>Organism</th>
<th>Total</th>
<th>Sensitive</th>
<th>Resistant</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>E. coli</em></td>
<td>145(48.33%)</td>
<td>105(72.41%)</td>
<td>40(27.59%)</td>
</tr>
<tr>
<td><em>Klebsiella</em></td>
<td>63(21%)</td>
<td>47(74.60%)</td>
<td>16(25.40%)</td>
</tr>
<tr>
<td><em>Pseudomonas</em></td>
<td>36(12%)</td>
<td>12(33.33%)</td>
<td>24(66.66%)</td>
</tr>
<tr>
<td><em>Staph. aureus</em></td>
<td>35(11.66%)</td>
<td>30(85.71%)</td>
<td>5(14.28%)</td>
</tr>
<tr>
<td><em>S. saprophyticus</em></td>
<td>10(3.33%)</td>
<td>7(70%)</td>
<td>3(30%)</td>
</tr>
<tr>
<td><em>Enterococcus</em></td>
<td>6(2%)</td>
<td>5(83.33%)</td>
<td>1(16.66%)</td>
</tr>
<tr>
<td><em>Streptococcus</em></td>
<td>4(1.33%)</td>
<td>4(100%)</td>
<td>_</td>
</tr>
<tr>
<td><em>Proteus</em></td>
<td>1(0.33%)</td>
<td>_</td>
<td>1(100%)</td>
</tr>
</tbody>
</table>

Table 2. Antibiotic susceptibility pattern of uropathogens towards Nalidixic acid:

<table>
<thead>
<tr>
<th>Organism</th>
<th>Total</th>
<th>Sensitive</th>
<th>Resistant</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>E. coli</em></td>
<td>145(48.33%)</td>
<td>23(15.86%)</td>
<td>122(84.14%)</td>
</tr>
<tr>
<td><em>Klebsiella</em></td>
<td>63(21%)</td>
<td>20(31.75%)</td>
<td>43(68.25%)</td>
</tr>
<tr>
<td><em>Pseudomonas</em></td>
<td>36(12%)</td>
<td>4(11.11%)</td>
<td>32(88.89%)</td>
</tr>
<tr>
<td><em>Staph. aureus</em></td>
<td>35(11.66%)</td>
<td>4(11.43%)</td>
<td>31(88.57%)</td>
</tr>
<tr>
<td><em>S. saprophyticus</em></td>
<td>10(3.33%)</td>
<td>2(20%)</td>
<td>8(80%)</td>
</tr>
<tr>
<td><em>Enterococcus</em></td>
<td>6(2%)</td>
<td>1(16.67%)</td>
<td>5(83.33%)</td>
</tr>
<tr>
<td><em>Streptococcus</em></td>
<td>4(1.33%)</td>
<td>_</td>
<td>4(100%)</td>
</tr>
<tr>
<td><em>Proteus</em></td>
<td>1(0.33%)</td>
<td>_</td>
<td>1(100%)</td>
</tr>
</tbody>
</table>
study. The other less frequently isolated bacteria were and *strepotococcus* sp (*n* = 4, 1.33%) *Proteus spp.* (*n* = 1, 0.33%).

*E. coli* was the common pathogen isolated (48.33%) in this study and it was 72.41% sensitive to Nitrofurantoin. Even though the percentage of isolation of *Klebsiella* was less 21%, it was more sensitive to Nitrofurantoin (74.60%). Pseudomonas isolation rate was 12% and it was 33.33% sensitive to nitrofurantoin and 66.66% resistant to it. *Staphylococcus aureus* showed high sensitivity 85.71% towards Nitrofurantoin. *Staphylococcus saprophyticus* showed sensitivity of 70% and resistance of 30% towards Nitrofurantoin. *Enterococcus* sp also showed high percentage of sensitivity towards Nitrofurantoin (83.33%) and resistance rate of 16.66%. *Streptococcus* showed 100% sensitivity toward Nitrofurantoin.

*Proteus* sp are intrinsically resistant to Nitrofurantoin and in this study also Proteus sp isolated were 100% resistant to it.

Most of the uropathogens isolated were resistant to Nalidixic acid. The drug sensitivity rate was 31.75% for *Klebsiella* followed by 20% for *Staphylococcus saprophyticus*. Nalidixic acid resistant rate was high for *Pseudomonas* sp (88.89%)
followed by Staphylococcus aureus (88.57%), E. coli (84.14%) and Enterococcus sp (83.33%). Streptococcus sp and Proteus sp were 100% resistant to Nalidixic acid.

**CONCLUSION**

In this study most of the urinary pathogens isolated were more sensitive to Nitrofurantoin than to Nalidixic acid. Nitrofurantoin is an orally available drug and is active against most of the urinary pathogens. Thus, there is a need for making and following antibiotic usage policy that will guide the prescription and use of antibiotics through the regular surveillance of resistant organisms in the environments.

**REFERENCES**
