Antibiogram of the Common Uropathogenic Bacteria among Yemeni Patients in Sana’a City: A Recent Report

Hafez Alsumairy¹, Tawfique K. AlZubiery², Talal Alharazi¹*, Mufeed Baddah³ and Adel Al-Zubeiry⁴

¹Department of Medical Microbiology and Immunology, Faculty of Medicine and Health Sciences, Taiz University, Yemen.  
²Department of Medical Laboratory, Faculty of Medical and Health Science, Taiz University Al-Turbah Branch, Yemen.  
³Department of Biochemistry, Faculty of Medicine and Health Sciences, Taiz University, Yemen.  
⁴King Fahad Specialist Hospital-Dammam, Kingdom of Saudi Arabia.

Authors’ contributions

This work was carried out in collaboration between all authors. Author HA designed the study, wrote the protocol, and wrote the first draft of the manuscript. Authors TKA and MB managed the analyses of the study. Author TA performed the statistical analysis and managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/SAJRM/2018/v1i2759

Editors:
(1) Osunsanmi Foluso Oluwagbemiga, Department of Biochemistry and Microbiology, University of Zululand, South Africa.

Reviewers:
(1) Moustafa El-Shenawy, Egypt.  
(2) Emmanuel Ifeanyi Obeag, Michael Okpara University of Agriculture, Nigeria.

Complete Peer review History: http://www.sciencedomain.org/review-history/24827

Received 9th March 2018  
Accepted 21st May 2018  
Published 26th May 2018

ABSTRACT

Aims: This study aimed to identify the prevalence and antimicrobial susceptibility of the commonly isolated uropathogens in Sana’a city, Yemen.  
Study Design: A cross-sectional and descriptive study.  
Place and Duration of Study: The study was carried out at the hospitals and clinics of Sana’a city, Yemen between October 2016 and March 2017.  
Methodology: Clean-catch mid-stream urine samples were collected to detect the most common uropathogenic bacteria and their antibiotic susceptibility using Kirby Bauer standardized method.
Results: Urine cultures yielded 170 significant bacterial growths of uropathogens. *Escherichia coli* was the most often isolated pathogen (43.5%), followed by *Klebsiella pneumoniae* (24.7%), *Pseudomonas aeruginosa* (20.0%) and *Staphylococcus aureus* (11.8%). The overall sensitivity was high to an excellent pattern for Carbapenems, Nitrofurantoin, Amikacin, and Piperacillin-Tazobactam. *Escherichia coli* shows an excellent sensitivity (88%) for Nitrofurantoin and Imipenem, followed by (85%) Ertapenem. *Pseudomonas aeruginosa* exhibited moderate resistance to Carbapenems, Moxifloxacin, and Piperacillin-Tazobactam in this study. *Staphylococcus aureus* was more vulnerable to all Quinolones except Nalidixic acid and it displays a high sensitivity pattern, 90% for both Nitrofurantoin and Gentamicin, 83% for Penicillin, 80% for both Minocycline. Antibiogram of isolated organisms revealed that there was resistance to two and more antimicrobials.

Conclusion: In this study, we observe a high resistance rates to Beta-lactam, Quinolones, and Macrolides antibiotics. Nevertheless, most uropathogenic isolates were still sensitive to Nitrofurantoin, Imipenem, Ertapenem, and Amikacin, they considered as a proper antibiotics for empirical therapy of UTIs. Establishment of antibiogram of locally isolated organisms is necessary to avoid indiscriminating use of antibiotic and to decrease the resistance rate in our community.

Keywords: Antibiogram; Empiric Therapy; Uropathogens; Taiz University; Sana’a; Yemen.

1. INTRODUCTION

Urinary tract infections (UTIs) are one of the most common human diseases caused by bacterial infections faced by clinicians in developed as well as in developing countries, affecting all ages and gender groups [1]. Gram-negative bacteria, for instance, *Escherichia coli*, *Klebsiella pneumoniae*, *Proteus mirabilis* and *Pseudomonas aeruginosa* are the major cause of UTI while *Staphylococcus aureus* represents the Gram-positive bacteria [2]. *Escherichia coli* still the most causative agent among all bacterial species particularity among female due to anatomical reasons, pregnancy, and sexual activities [3,4]. It turns out to be more common in older males because of the obstruction of the urinary system in case of prostatic hypertrophy [5]. Urinary tract infections range from mild asymptomatic to severe type of infection like pyelonephritis according to the presence of risk factors and immune status as well as the location of infection and the type of pathogenic organism [6].

One of the obstacles confronting the clinician of UTIs is the antibiotic resistance that increases dramatically [2]. This public health problem remains of cosmopolitan distribution especially in developing countries like ours [4,5]. Illogical and haphazard use of antibiotics besides fake drugs is common in these countries [6]. Previous studies noticed the tendencies of antibiotic susceptibility change patterns [6,7]. The antibiogram is an interallic summary of antibiotic susceptibilities of local bacterial isolates submitted to the clinical microbiology laboratory which, used by doctors to judge local susceptibility degrees, as a help in selecting an empiric antibiotic treatment, and in observing resistance tendencies over time within an organization [8].

In Yemen, few studies that mainly focused on specific groups as pregnant women have been carried out on the occurrence and antimicrobial resistance patterns of UTIs [9–15]. The significance of this study is to rationalize the use of antibiotics based on the proper selection of empirical for UTI treatment, hence to avoid spreading of the resistant strains, reducing the complications and additional costs among the community and each patient. Continuous checking of the susceptibility pattern is of vital importance [4]. In addition, this can enhance the therapeutic guidelines development at the local level [8]. Therefore, the recent study aimed to identify the prevalence and antimicrobial susceptibility of the commonly isolated uropathogens in Sana’a city, Yemen.

2. MATERIALS AND METHODS

2.1 Study Design

Cross-sectional and descriptive study.

2.2 Location, Target Population, Study Period & Ethics

This study was conducted, among patients presenting with UTI and have significant bacteriuria, on bacterial isolated from urine
cultures that referred for routine microbiological examining along with clinician orders in the hospitals or clinics of Sana’a city, Yemen during October 2016 to March 2017. Related information for all selected isolates retrieved from request forms and medical records. Consent to do this study was achieved from the management of Sana’a city hospitals and clinics. All of these specimens were a part of the routine diagnosis. We consider all related ethics.

2.3 Target Pathogenic Bacteria

All common uropathogens isolated from urine specimens were undergone complete microbial investigation during the period of the study, beginning with pyuria and bacteriuria detection microscopically then culturing, full identification and antibiotic susceptibility testing according to the standardized technique. Briefly, 40 µl of urine specimens were inoculated aseptically using a calibrated wire loop on Cystine Lactose Electrolyte-Deficient medium, Blood agar and MacConkey agar (Oxoid, Basingstoke, UK) and incubated at 37°C, aerobically overnight [16–18]. Only aerobic and/or facultative anaerobic Gram-negative Klebsiella pneumoniae, Escherichia coli, Pseudomonas aeruginosa and Gram-positive Staphylococcus aureus were included in this study. Single urine sample yielded a significant growth was obtained from each patient was included in this study.

2.4 Methods

2.4.1 Laboratory identification of isolates

A total of 170 microorganisms were isolated, identified and antimicrobial susceptibility tested from midstream clean-catch urine specimens during the five months of study period using standard microbiological techniques. Confirmation of the species level was done by using API 20 E diagnostic system (BioMerieux, France) and according to manufacturer directions [2].

2.4.2 Antimicrobial susceptibility test

After complete identification using standard microbiological technique was done for all isolates, their antibiotic susceptibility pattern was detected on Muller Hinton agar (Oxoid, UK), by disk diffusion method according to the Kirby–Bauer method [2]. Thirty antimicrobial agents were tested and standardized according to the MIC break-points recommended by the National Committee for Clinical Laboratory Standards with CLSI guidelines [16,17] susceptibility was defined as sensitive and resistant based on the diameter of the zone of inhibition. Using the following antimicrobial drugs; Penicillin 10 U, Ampicillin 10 µg, Amoxicillin 10 µg, Piperacillin 100 µg, Ticarcillin 75 µg, Carbenicillin 100 µg, Amoxiclav 20/10 µg, Piperacillin-Tazobactum 100+10 µg, Aztreonam 30 µg, Imipenem 10 µg, Ertapenem 10 µg, Cefradine 30 µg, Cefazolin 30 µg, Cephalothin 30 µg, Cefaclor 30 µg, Cephalexin 30 µg, Cepiprome 30 µg, Cefuroxime 30 µg, Ceftizoxime 10 µg, Cefoxitin 30 µg, Ceftaxime 30 µg, Cefazidime 30 µg, Cefepime 30 µg, Nalidixic acid 30 µg, Nitrofurantoin 300 µg, Ciprofloxacin 5 µg, Norfloxacin 10 µg, Ofloxacin 5 µg, Pefloxacin 5 µg, Lomefloxacin 10 µg, Levofloxacin 5 µg, Moxifloxacin 5 µg, Erythromycin 15 µg, Azithromycin 15 µg, Roxithromycin 15 µg, Amikacin 30 µg, Kanamycin 30 µg, Gentamicin 10 µg, Tobramycin 10 µg, Tetracycline 30 µg, Minocycline 30 µg, Doxycycline 30 µg, Cotrimoxazole 25 µg, Chloramphenicol 30 µg. Oxoid Ltd. Hampshire, United Kingdom, manufactured all the antibiotic discs used in this study.

2.5 Statistical Analysis

A bacterial resistance pattern of all uropathogenic isolates was determined and expressed as frequencies with percent. Descriptive statistics of antibiotics activity and other characteristics of the isolated bacterial population were calculated. The Statistical Package for Social Sciences (SPSS) software package version 22 did all the statistical analysis. (SPSS Inc. Chicago, Illinois, USAT).

3. RESULTS AND DISCUSSION

Distribution of the uropathogenic isolates is presented in Table 1. One hundred and seventy urine samples yielded significant bacterial growth was obtained from Yemeni patients predicted of having UTI, according to clinical presentation and laboratory findings, during 5 months study period. Gram-negative isolates were 150 (88.2%), whereas Gram-positive isolates were 20 (11.8%). Overall isolates the Escherichia coli was the predominant one 74 (43.5%) followed by Klebsiella pneumoniae 42 (24.7%) and none fermenting Gram-negative bacteria Pseudomonas aeruginosa 34 (20.0%). The last prevalence rate was Coagulase positive Staphylococcus aureus 22 (11.8%).
## Macrolides

- Azithromycin
- Erythromycin
- Moxifloxacin
- Lemafloxacin
- Norfloxacin
- Ciprofloxacin

## Beta-antibiotics classes

- Cefotaxime
- Cefpirome
- Cefaclor
- Cephalexin
- Cefazolin
- Cefradine

## Beta-lactam inhibitors

- Piperacillin-Tazobactam
- Amoxiclav

## Carbapenems

- Imipenem
- Ertapenem

## Cephalosporins

- Cefadine
- Cefazolin
- Cephalexin
- Cephalothin
- Cefaclor
- Cefpirome
- Cefuroxime
- Cefoxitin
- Cefotaxime
- Cefpodoxime

## Quinolones

- Nalidixic acid
- Giprofloxacin
- Norfloxacino
- Ofloxacino
- Pefloxacino
- Lermefloxacino
- Levofloxacino
- Moxifloxacino

## Macrolides

- Erythromycin
- Azithromycin

## Table 1. Frequency and percentage of the resistant pattern of commonly isolated UTI pathogens

<table>
<thead>
<tr>
<th>Antibiotics classes</th>
<th>Antibiotic sub-classes</th>
<th>E. coli (N=74)</th>
<th>K. pneumoniae (N=42)</th>
<th>P. aeruginosa (N=34)</th>
<th>S. aureus (N=20)</th>
<th>Total (N=170)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>Penicillin</td>
<td>Penicillin</td>
<td>73</td>
<td>98.6</td>
<td>42</td>
<td>100.0</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>Ampicillin</td>
<td>72</td>
<td>97.3</td>
<td>41</td>
<td>97.6</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Amoxicillin</td>
<td>68</td>
<td>91.9</td>
<td>40</td>
<td>95.2</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>Aztreonam</td>
<td>44</td>
<td>59.5</td>
<td>29</td>
<td>69.0</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Ticarcillin</td>
<td>61</td>
<td>82.4</td>
<td>36</td>
<td>85.7</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Carpanicillin</td>
<td>61</td>
<td>82.4</td>
<td>36</td>
<td>85.7</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Pipracillin</td>
<td>43</td>
<td>58.1</td>
<td>37</td>
<td>88.1</td>
<td>33</td>
</tr>
<tr>
<td>Beta-lactam inhibitors</td>
<td>Piperacillin-Tazobactam</td>
<td>15</td>
<td>20.3</td>
<td>19</td>
<td>45.2</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Amoxiclav</td>
<td>37</td>
<td>50.0</td>
<td>26</td>
<td>61.9</td>
<td>24</td>
</tr>
<tr>
<td>Carbapenems</td>
<td>Imipenem</td>
<td>9</td>
<td>12.2</td>
<td>6</td>
<td>14.3</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Ertapenem</td>
<td>11</td>
<td>14.9</td>
<td>10</td>
<td>23.8</td>
<td>17</td>
</tr>
<tr>
<td>Cephalosporins</td>
<td>Cefradine</td>
<td>66</td>
<td>89.2</td>
<td>41</td>
<td>97.6</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>Cefazolin</td>
<td>59</td>
<td>97.7</td>
<td>41</td>
<td>97.6</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Cephalexin</td>
<td>64</td>
<td>86.5</td>
<td>40</td>
<td>95.2</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Cephalothin</td>
<td>63</td>
<td>85.1</td>
<td>38</td>
<td>90.0</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Cefaclor</td>
<td>61</td>
<td>82.4</td>
<td>39</td>
<td>92.9</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Cefpirome</td>
<td>35</td>
<td>47.3</td>
<td>26</td>
<td>61.9</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Cefuroxime</td>
<td>60</td>
<td>81.1</td>
<td>32</td>
<td>76.2</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>Cefoxitin</td>
<td>57</td>
<td>77.0</td>
<td>31</td>
<td>73.8</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Cefpodoxime</td>
<td>51</td>
<td>68.9</td>
<td>33</td>
<td>78.6</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Cefotaxime</td>
<td>57</td>
<td>77.0</td>
<td>32</td>
<td>76.2</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Ceftazidime</td>
<td>62</td>
<td>83.8</td>
<td>35</td>
<td>83.3</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Ceferpine</td>
<td>35</td>
<td>47.3</td>
<td>26</td>
<td>61.9</td>
<td>28</td>
</tr>
<tr>
<td>Quinolones</td>
<td>Nalidixic acid</td>
<td>55</td>
<td>74.3</td>
<td>40</td>
<td>95.2</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>Giprofloxacin</td>
<td>45</td>
<td>60.8</td>
<td>37</td>
<td>88.1</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>Norfloxacino</td>
<td>46</td>
<td>62.2</td>
<td>36</td>
<td>85.7</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Ofloxacino</td>
<td>49</td>
<td>66.2</td>
<td>30</td>
<td>31.4</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Pefloxacino</td>
<td>40</td>
<td>54.1</td>
<td>26</td>
<td>61.9</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Lermefloxacino</td>
<td>50</td>
<td>67.6</td>
<td>30</td>
<td>71.4</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Levofloxacino</td>
<td>29</td>
<td>39.2</td>
<td>28</td>
<td>66.7</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Moxifloxacino</td>
<td>34</td>
<td>45.9</td>
<td>24</td>
<td>57.1</td>
<td>15</td>
</tr>
<tr>
<td>Macrolides</td>
<td>Erythromycin</td>
<td>71</td>
<td>95.9</td>
<td>40</td>
<td>95.2</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Azithromycin</td>
<td>48</td>
<td>64.9</td>
<td>21</td>
<td>50.0</td>
<td>24</td>
</tr>
<tr>
<td>Antibiotics classes</td>
<td>Antibiotic sub-classes</td>
<td>E. coli (N=74)</td>
<td>K. pneumoniae (N=42)</td>
<td>P. aeruginosa (N=34)</td>
<td>S. aureus (N=20)</td>
<td>Total (N=170)</td>
</tr>
<tr>
<td>--------------------</td>
<td>------------------------</td>
<td>---------------</td>
<td>---------------------</td>
<td>---------------------</td>
<td>-----------------</td>
<td>--------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>Aminoglycosides</td>
<td>Roxithromycin</td>
<td>73</td>
<td>98.6</td>
<td>41</td>
<td>97.6</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Amikacin</td>
<td>17</td>
<td>23.0</td>
<td>10</td>
<td>23.8</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Kanamycin</td>
<td>38</td>
<td>51.4</td>
<td>24</td>
<td>57.1</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Gentamicin</td>
<td>32</td>
<td>43.2</td>
<td>20</td>
<td>47.6</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Tobramycin</td>
<td>56</td>
<td>75.7</td>
<td>28</td>
<td>66.7</td>
<td>23</td>
</tr>
<tr>
<td>Tetracycline</td>
<td>Tetracycline</td>
<td>56</td>
<td>75.7</td>
<td>33</td>
<td>78.6</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Minocycline</td>
<td>30</td>
<td>40.5</td>
<td>22</td>
<td>52.4</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Doxycycline</td>
<td>43</td>
<td>58.1</td>
<td>29</td>
<td>69.0</td>
<td>20</td>
</tr>
<tr>
<td>Others</td>
<td>Cotrimoxazole</td>
<td>39</td>
<td>52.7</td>
<td>33</td>
<td>78.6</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Chloramphenicol</td>
<td>21</td>
<td>28.4</td>
<td>21</td>
<td>50.0</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Nitrofurantoin</td>
<td>9</td>
<td>12.2</td>
<td>13</td>
<td>31.0</td>
<td>23</td>
</tr>
</tbody>
</table>

E. coli: Escherichia coli; K. pneumoniae: Klebsiella pneumoniae; P. aeruginosa: Pseudomonas aeruginosa; S. aureus: Staphylococcus aureus; N: number, Nt: Not tested.
The antibiotic resistance pattern of Gram-negative bacilli and Gram-positive coccus is shown in Tables 1. The overall sensitivity was high to an excellent pattern for Carbapenems, Nitrofurantoin, Amikacin and Piperacillin-Tazobactam. Among Quinolones Gram-negative bacilli, isolates showed a high resistance rate range (74.3% to 97.1%) to Nalidixic acid, and reach to 88.1% for Ciprofloxacin, and Norfloxacin. On other hand, a good sensitivity about (67%, 61% and 56%) for Klebsiella pneumoniae, Escherichia coli and Pseudomonas aeruginosa was observed against Ofloxacin, Levofloxacin and Moxifloxacin. Staphylococcus aureus was more vulnerable to all Quinolones except Nalidixic acid. Escherichia coli shows an excellent sensitivity (88%) for Nitrofurantoin and Imipenem, followed by (85%) Ertapenem, and moderate to high sensitivity (72%, 77% and 80%) for Chloramphenicol, Amikacin and Piperacillin-Tazobactam respectively. Similar to Escherichia coli findings were seen for Klebsiella pneumoniae sensitivity in relation to Carbapenems and Amikacin. However, Pseudomonas aeruginosa expresses a high resistant pattern against almost all examined antibiotics except for Carbapenems, Piperacillin-Tazobactam, Moxifloxacin, Amikacin, and Chloramphenicol that shows intermediate resistant pattern against them. On the other side, Staphylococcus aureus displays a high sensitivity pattern, 90% for both Nitrofurantoin and Gentamicin, 83% for Penicillin, 80% for both Minocycline and Moxifloxacin and 75% for Lemeofloxacin and a very high resistant pattern (90%) was detected against Azithromycin.

UTI is the most common community and nosocomial infections and the second most common reason for empirical antibiotic treatment [19]. Continuous extensive surveys are required to eradicate the pathogen and to cut complicated consequences due to these infections [20].

In the present study, 170 urine samples yielded a significant growth of four species of bacteria. Gram-negative isolated bacteria in this study were more accountable for UTI than Gram-positive bacteria and this result is in agreement with the conclusions of earlier studies [1,3,6,9, 14,15,19,21–25,25]. Conversely, Kyabaggu, et al. [5] reported a high incidence if Gram-positive among UTI patients in Uganda compared to Gram-negative bacteria [5].

In this study, the most frequently isolated microorganism was Escherichia coli with a rate of (43.5%), followed by Klebsiella pneumoniae with (24.7%) and this result is consistency with other studies from other Arabic and non-Arabic countries across the world such Egypt, Sudan, Libya, Ethiopia, Nepal, India, China and Turkey [1,3,6,19,21–26,26–29]. Alkhayat and Al. Maqtari (2014) previously published similar finding to our result in Yemen [13]. On contrary regarding the second most common uropathogenic bacteria in Yemen, Gondos, et al. [14], on his study, of UTIs among renal transplants patients, and Mohanna, and Raja'a [9], in their study about urinary tract infection in children, were documented that Staphylococcus saprophyticus was the second most commonly isolated bacteria [9,14]. Staphylococcus saprophyticus and Staphylococcus aureus were also reported as the second uropathogenic other studies carried out in Bangladesh by Haque, Akter and, Salam [4] and in Nigeria by (Oli et al) [4,6]. The present result stated that Pseudomonas aeruginosa and Staphylococcus aureus were the subsequent predominant (20% and 11.8%) uropathogenic isolated bacteria after Escherichia coli and Klebsiella pneumoniae. Variance in identification techniques may affect the relative occurrence of bacteria, which makes a difficult comparison [30]. In addition to that, geographic variations were shown to make an impact on different results [2].

The current study also detects that Gram-negative bacteria were very good sensitivity to Carbapenems (mainly Imipenem) except for Pseudomonas aeruginosa that show an intermediate susceptibility which was consistent with many previously reported studies by Indian researchers [7,20,22,23]. This finding was confirmed also by recent Elzayat et at. an Egyptian researcher [29] and Yemini study by AIZubiery et al. [7] which declared that Carbapenems were highly active against Gram-negative bacteria which are highly resistant to the 1st, 2nd and slightly 3rd generations Cephalosporins and Penicillins. Therefore, doctors to be guided to discontinue prescription Cephalosporins and Penicillins as an empiric therapy for UTIs. The incidence of Carbapenems resistance is low in our situation in contrasting to increasing trends of Carbapenems resistance revealed lately by Sudanic investigator [19].

Concerning Nitrofurantoin, it has been recommended for the treatment of UTI that caused by MDR strains [31]. High sensitivity pattern (72.4%) among our bacterial isolates suggested its inclusion in the empirical treatment strategy as well as it is the most suitable first-line
antibiotic for UTI therapy. Our finding was in agreement with that reported by other studies from Egypt, China, Ethiopia, Uganda, Bangladesh and India [4,5,22 and 25], and it is comparable with recent guidelines on the antibiotic recommendation for UTI by Infectious Diseases Society of America guidelines [32]. Locally, Al-Haddad et al. [10] documented similar report to our finding. In contrast, Mohanna and Raja’a (2005) detect a very low sensitivity for Nitrofurantoin (15.9%) [9]. Nevertheless, there may be non-compliance to Nitrofurantoin because of its bitterness and there have been worries over its possible effects on the fetus [24]. Alternatively, an intermediate to low sensitivity pattern to Nitrofurantoin has been reported from an earlier study in Ethiopia and Nigeria that could be because of the previous exposure to these antibiotics [33,34].

Enterobacteriaceae are well known vulnerable to Amikacin [8]. A good sensitivity pattern for Amikacin and Piperacillin-Tazobactam was seen in the current study particularity among the most common isolated Escherichia coli strains (79.7% and 77% respectively). Our result was in alignment line with recent studies in India [22–24], and in Egypt for Amikacin only [29]. In Yemen, similar and an excellent finding was observed by Gondos et al., Al-Haddad [10,14] for Amikacin since Piperacillin-Tazobactam antibiotic was not tested in the later study, Subedi N et al. (2014) noted moderate sensitivity pattern for Amikacin with a high pattern of sensitivity to Piperacillin-Tazobactam in Nepal [21]. On other hand, Badri and Mohamed Sudanese researchers reported a very high resistance pattern against Amikacin [19].

The frightening finding in the existing study is the decreased sensitivity of isolated uropathogens to Quinolones mainly for Nalidixic acid followed by Ciprofloxacin. This finding is consistent with that previously published in Yemen by Al-Haddad et al., AlZubiery et al. [7,12] Similar finding were observed in southeastern Nigeria among female patients to Levofloxacin [6]. On the contrary, Wariso KT et al. [34] in Nigeria stated, that Quinolones still principally efficient for empirical therapy in UTIs except for Nalidixic acid [34]. The long period of using Quinolones without a proper restriction is the possible reason for this condition [26].

Multidrug-resistant pathogen (MDR) like Pseudomonas aeruginosa causing various chronic biofilm-associated infections including UTI [31]. The Pseudomonas aeruginosa showed moderate sensitivity to Carbapenems, Moxifloxacin, and Piperacillin-Tazobactam in this study. Recently, researchers from India documented extensive very high resistance pattern [22,23]. On other hand, a lower resistant rate was documented in India [20]. Selective stress due to extreme exposure of bacteria to antibiotics is usually the source of such high incidence of resistance especially in the hospitals setting [31].

The isolated uropathogenic Staphylococcus aureus in this study was found extremely resistant to Azithromycin (90.0%) and Roxithromycin (80.0%) but highly sensitive for Penicillin (83.0%), and moderate sensitivity to both aminopenicillins Ampicillin (55.0%) and Amoxicillin (60.0%). Gentamicin shows an excellent sensitivity (90.0%) against uropathogenic isolates. This was similar to the result documented recently in Yemen by AL-Kadassy et al. [15] except for Amoxicillin, hence it is not included in her study. Our results about Ampicillin and Gentamicin were similar to previously reported studies in Nigeria [35]. Kotigire Santosh et al. and Derese et al. in their studies in India and Ethiopia showed that a comparable finding for Gentamicin [23,33] however, Wariso KT et al. in Nigeria reported a high resistance rate against Gentamicin [34]. In Yemen, AL-Kadassy et al. documented similar finding for Gentamicin (100.0%) but high sensitivity pattern for Ampicillin (75.0%) [15]. Our result concerning Gentamicin was in accordance with the previous recommendation [30].

4. CONCLUSION

Although Gram-negative bacilli were the most common isolated uropathogens, the majority of them was Escherichia coli. There is a decrease in sensitivity pattern that was observed in our study with an increased resistance against the commonly used UTI antibiotics. Therefore, antibioticograms establishment for uropathogenic isolates introduce a guide to the doctors starting proper empirical antibiotic treatment.

5. RECOMMENDATION

Individual antibioticograms to detect trends are useless unless they are done at a fixed interval at least one each year. An antibiotic strategy is one of the obligatory necessities for accreditation, and creation of an antibiotic is the first stage before bordering the antibiotic
strategy. Reference strains such as ATCC should be included in the future study for antibiogram detection based on Clinical and Laboratory Standards Institute.

CONSENT

It is not applicable.

ETHICAL APPROVAL

As per international standard or university standard, written approval of Ethics committee has been collected and preserved by the authors. The data that support the findings of this study are available from the hospitals or clinics of Sana’a city but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of the hospitals or clinics of Sana’a city.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

16. CLSI. Performance Standards for Antimicrobial Disk Susceptibility Tests. Jean B. Patel and Linda A. Miller and Franklin R, Cockerill and David P. Nicolau and Patricia A. Bradford and Mair Powell and George M. Eliopoulos and Jana M.
and antibiotic susceptibility pattern
Patel P, Garala R. Bacteriological profile
2017;146:21

Patients Attending Tertiary Care Hospital:
Antibio
Santosh K, Siddiqui S. Prevalence and
2017;4(2):46

from a tertiary care centre in Tumkur,
profile and antibiogram of uropathogens
Sankarankutty J, Kaup S. Microbiological
urinary tract infection in tripu
susceptibility pattern in patients with
KK. Aetiological profile and antibiotic
Debnath J, Das PK, Debnath M, Haldar

Antimicrobial Susceptibility Testing. Janet
B. Patel, Franklin R. Cockerill III, Patricia
A. Bradford, George M. Eliopoulos, Janet
A. Hindler, Stephen G. Jenkins, James S.
Lewis II, Brandi Limbago, Linda A. Miller,
David P. Nicolau, Mair Powell, Jana M.
Swenson, Maria M. Traczewski, John D.
Turnidge, Melvin P. Weinstein, Barbara L.
Zimmer, editor. CLSI document M100-S25.
Wayne, PA: Clinical and Laboratory Standards
Institute; 2015;35(3).

Antimicrobial Susceptibility Testing. Jean
B. Patel, Franklin R. Cockerill III, Patricia
A. Bradford, George M. Eliopoulos, Janet
A. Hindler, Stephen G. Jenkins, James S.
Lewis II, Brandi Limbago, Linda A. Miller,
David P. Nicolau, Mair Powell, Jana M.
Swenson, Maria M. Traczewski, John D.
Turnidge, Melvin P. Weinstein, Barbara L.
Wayne, PA: Clinical and Laboratory Standards
Institute; 2015;35(1).

CLSI. Performance Standards for
Antimicrobial Susceptibility Testing. Jean
B. Patel, Franklin R. Cockerill III, Patricia
A. Bradford, George M. Eliopoulos, Janet
A. Hindler, Stephen G. Jenkins, James S.
Lewis II, Brandi Limbago, Linda A. Miller,
David P. Nicolau, Mair Powell, Jana M.
Swenson, Maria M. Traczewski, John D.
Turnidge, Melvin P. Weinstein, Barbara L.
Zimmer, editor. CLSI document M100-S25.
Wayne, PA: Clinical and Laboratory Standards
Institute; 2015;35(3).

CLSI. Performance Standards for
Antimicrobial Susceptibility Testing. Janet
A. Hindler, Michael Barton, Sharon M.
Erdman, Alan T. Evangelista, Stephen G.
Jenkins, Judith Johnston, James S. Lewis
II, Dyan Luper, Ronald N. Graeme Nimmo,
John Stelling, MD, editor. CLSI document
M39-A4. Fourth. Wayne, PA: Clinical and
Laboratory Standards Institute; 2014;34(2).

Badri A, Mohamed S. Clinical
Epidemiology and Antibiogram of UTI
Patients Attended Different Hospital in
2017;6(301):2.

Benachinmardi K, Padmavathy M, Malini J,
Navaneeth B, others. Microbiological
profile and antibiogram of uropathogens
in pediatric age group. International Journal
of Health & Allied Sciences. Medknow

Debnath J, Das PK, Debnath M, Haldar
KK. Aetiological profile and antibiotic
susceptibility pattern in patients with
urinary tract infection in tripura. J Clin

Sankarankutty J, Kaup S. Microbiological
profile and antibiogram of uropathogens
from a tertiary care centre in Tumkur,

Santosh K, Siddiqui S. Prevalence and
Antibiogram of Uropathogens from
Patients Attending Tertiary Care Hospital:

Patel P, Garala R. Bacteriological profile
and antibiotic susceptibility pattern
(antibiogram) of urinary tract infections
in paediatric patients. Journal of Research in

Wong CKM, Kung K, Au-Doung PLW, Ip
M, Lee N, Fung A, Wong SYS. Correction:
Antibiotic resistance rates and physician
antibiotic prescription patterns of
uncomplicated urinary tract infections in
southern Chinese primary care. PLoS
ONE. 2018;13(2):e0192466.

Mohammed MA, Alnour TMS, Shakurfo
OM, Aburass MM. Prevalence and
antimicrobial resistance pattern of bacterial
strains isolated from patients with urinary
tract infection in Messalata Central
Hospital, Libya. Asian Pac J Trop Med.

Isikgoz Tasbakan M, Durusoy R, Pullukcu
H, Sipahi OR, Ulusoy S. Hospital-acquired
urinary tract infection point prevalence in
Turkey: differences in risk factors among
patient groups. Ann Clin Microbiol

Dabobash MD, Attla MF, Elgarba M,
Menshawy AS. Antibiogram Sensitivity in
Urinary Tract Infections (UTI) at El Batan
Medical Center- Tobruk - Libya. Urol
Nephrol Open Access J. 2017;4(3).

Elzayat MA-A, Barnett-Vanes A, Dabour
MFE, Cheng F. Prevalence of
undiagnosed asymptomatic bacteriuria and
associated risk factors during pregnancy:
A cross-sectional study at two tertiary
centres in Cairo, Egypt. BMJ open. British
Medical Journal Publishing Group;
2017;7(3):e013198.

Leegaard TM, Caugant DA, Frøholm LO,
Høiby EA. Apparent differences in
antimicrobial susceptibility as a
consequence of national guidelines. Clin

Johansen TEB, Naber KG. Antibiotics and
Urinary Tract Infections. First. Martyn
Rittman, editor. Basel, Switzerland: Shu
Kun Lin; 2015.

Gupta K, Hooton TM, Naber KG, Wullt B,
Colgan R, Miller LG, Moran GJ, Nicolle LE,
Raz R, Schaef fer AJ, Soper DE. International clinical practice guidelines for
the treatment of acute uncomplicated
cystitis and pyelonephritis in women: A
2010 update by the Infectious Diseases
Society of America and the European
Society for Microbiology and Infectious
e103–20.
