Hospital Antibiogram: A Necessity in Monitoring Sensitivity of Isolates and Rationale Use of Antibiotics’

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Authors’ contributions

This work was carried out in collaboration between all authors. Author IA provoked the idea of manuscript and wrote introduction, results and discussion. Author HZ wrote the abstract, methodology and conclusion. Author NKL summarized the results and did data analysis. Authors SI, KT, MZ and AK collected the data. All authors read and approved the final manuscript.

ABSTRACT

Background: The laid protocols by CDC (center for disease control) narrated the dire need of local anti-biograms. Therefore the current study had been planned to acquire the knowledge about sensitivity pattern of various isolates in different specimens.

Objectives: To identify the local antibiotic sensitivity data against various isolates from different specimens.

Materials and Methods: A descriptive cross sectional study was conducted at the Pathology...
department of Al Nafees Medical College & Hospital, Islamabad, Pakistan. The duration of study was 04 months i.e. 01st June to 01st Oct. 2015. Frequencies and percentages were the numerical variables extracted by using the SPSS version 16.

**Results:** A total of 336 different specimens were received during study period. *E. coli* is the commonest organism isolated from urine, high vaginal swabs (HVS) and pus i.e. 60.60%, 100% and 25% respectively. Klebsiella species is the second most common organism (12.12%) followed by *Pseudomonas* (9.09%) isolated from urine. *E. coli*, *Klebsiella*, *Pseudomonas* and *Staphylococcus aureus* were isolated at same frequency (25%) from pus. *Salmonella typhi* was isolated from blood (100%).

The drugs of choice for *E. coli* are quinolones and aminoglycosides by showing the sensitivity of about 75% each. For *Klebsiella pneumoniae*, the ideal antibiotics are aminoglycosides (85.1%) and 2nd generation cephalosporins (85%). For *Pseudomonas aeruginosa*, extended spectrum penicillin, quinolones, 2nd and 3rd generation cephalosporins are the most suitable ones showing the sensitivity of 100% each.

**Conclusion:** Quinolones, aminoglycosides, 2nd and 3rd generation cephalosporins are the drugs of choices for the treatment of many gram positive and gram negative infections.

**Keywords:** Antibiogram culture and sensitivity; quinolones; aminoglycosides; 2nd and 3rd generation cephalosporins.

1. **BACKGROUND AND INTRODUCTION**

1.1 **Antibiogram and Its Necessity**

The antibiogram of a hospital is a periodic summary of antimicrobial sensitivity of local microbial isolates submitted to the hospital's microbiology laboratory [1,2]. This antibiogram is useful to the clinicians to judge the local susceptibility rates, which is helpful in selecting empiric antibiotic therapy, and in monitoring the bacterial resistance patterns over time within an institution. In addition, the antibiograms are also used to evaluate the susceptibility rates and resistance trends of micro-organisms with other institutions [3]. On the basis of antibiograms, the antibiotic policy of a hospital is formulated which is one of the essential requirements for accreditation [4]. The antibiograms are also helpful and reliable in predicting outbreaks of infectious diseases by the further incorporation of patient related data [1]. The antibiogram also helps in monitoring antimicrobial resistance trends over different periods, intensive care unit (ICU) or ward specific data and inpatient versus outpatient data, etc. Interestingly, even different departments of a hospital can have different patterns of antibiotic use and resistance. Binkley et al. compared a unit specific antibiogram with that of the hospital antibiogram in his study and reported that the ICUs organisms are 5-25% more resistant than that otherwise reported by the overall antibiogram [5].

1.2 **Antibiogram and Empirical Therapy**

The main use of a cumulative antibiogram is to identify appropriate empiric therapy. The antibiograms are developed and presented by the microbiology laboratory in collaboration with pharmacists, physicians and infection control committee [6]. Hospital laboratories evaluate the antimicrobial susceptibilities of bacterial isolates and summarize the susceptibility pattern during a specified period in its antibiogram. This data can be compiled to measure the regional susceptibility pattern, to observe trends over time and to judge the effects of interventions formulated to reduce antibiotic resistance through judicious use of antibiotic [3].

1.3 **CLSI Guidelines**

In 2006, the Clinical and Laboratory Standards Institute (CLSI) provides recommendations for the analysis and presentation of cumulative antibiogram data in his guideline document [7]. It defines a cumulative antibiogram as “the report generated by analysis of isolates from a particular institution(s) during a defined period of time that reflects the percentage of first isolates per patient of a given species that is susceptible to each of the antimicrobial agents routinely tested.” The challenge for it to develop a comprehensive antibiogram displaying recent, precise and clinically useful data in a systematic way on annual basis [6].

Due to the significance of antibiogram, all health care institutions should develop a useful and precise antibiogram based on the principles given in CLSI recommendations [7]. This warrants that microbiologists, physicians, infection control committees, pharmacists and other health care workers have accurate
information. Moreover, it is imperative for the clinicians to be acquainted with antibiogram issues and should know how to apply the data in clinical practice. The main emphasis is the need for a precise institutional antibiogram which is standardized and can direct empiric therapy and prevent antibiotic resistance. Antibiotic resistance monitoring is continue to remain important as microbial pathogens develop antibiotic resistance [4,6,8].

1.4 Study Rationale

In our institution, infection control committee regularly review the antibiogram on quarterly basis and recommendations were made regarding use of antibiotic therapy for indoor and outdoor patients. The objective of our study is to review the antibiogram of our institution and compared the trend with the national and international literature.

2. MATERIALS AND METHODS

This descriptive cross sectional study was conducted at the Department of Pathology, Al Nafees Medical College & Hospital, Islamabad, Pakistan from 1st June to 30th September 2015. Al nafees Medical College Hospital is a 600 bed teaching hospital, which providing medical services mainly to rural areas and peripheral areas of Islamabad and Rawalpindi city, Murree district and Kashmir.

Data was gathered from all indoor and outdoor specimens received for culture and sensitivity and presented in quarterly antibiogram meeting which is regularly conducted in collaboration with Department of Surgery and Allied. The identity of all specimens and their results were kept anonymized for confidentiality.

2.1 Sample Processing

At first day the specimens were inoculated at Blood agar, MacConkey’s agar and for urine CLED agar. They were than incubated at 37°C for 24 hours. For urine specimens, after inoculation they were transferred in a test tube and centrifuged at 3000 rpm for 05 minutes. Direct microscopy was done from the deposits to see the number of pus cells.

On second day gram staining followed by biochemical tests were done. On the same day application of drug sensitivity on Mueller Hinton agar was also done. On third day the reports were finalized. For all the blood cultures recommended serial sub culturing was done. All data was saved carefully and kept anonymized. SPSS Version was used for statistical inference. Frequencies and percentages were the numerical variables extracted by using the SPSS version 16.

3. RESULTS

3.1 Samples Distribution

A total of 336 different specimens were received during study period and among them 82.5% (n= 277) were indoor departments and 17.5% (n= 59) were from outpatient departments. Majority of specimens were urine (n=159, 47.32%), followed by HVS (n=118, 35.12%) and blood (n=33, 9.82%). Among urine 20.75% (n=33), HVS 0.02% (n=3), blood 0.06% (n=2), pus 36.36% (n=4) and sputum 42.85% (n=3) were positive (Table 1).

Table 1. Percentages of positive specimens received in microbiology laboratory

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Total specimens n (%)</th>
<th>Positive specimens n</th>
<th>% among groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urine</td>
<td>159 (47.32%)</td>
<td>33</td>
<td>20.75</td>
</tr>
<tr>
<td>HVS</td>
<td>118 (35.12%)</td>
<td>03</td>
<td>0.02</td>
</tr>
<tr>
<td>Blood</td>
<td>33 (9.82%)</td>
<td>02</td>
<td>0.06</td>
</tr>
<tr>
<td>Pus</td>
<td>11 (3.27%)</td>
<td>04</td>
<td>36.36</td>
</tr>
<tr>
<td>Stool</td>
<td>08 (2.38%)</td>
<td>00</td>
<td>00</td>
</tr>
<tr>
<td>Sputum</td>
<td>07 (2.09%)</td>
<td>03</td>
<td>42.85</td>
</tr>
<tr>
<td>Total</td>
<td>336 (100%)</td>
<td>45</td>
<td>13.39</td>
</tr>
</tbody>
</table>

E. coli is the most commonest organism isolated from urine, HVS and PUS i.e. 60.60%, 100% and 25% respectively. Klebsiella (12.12%) and Pseudomonas (9.09%) are the second and third commonest organisms for urine. For all the pus specimens, E. coli, Klebsiella, Pseudomonas and Staphylococcus aureus were isolated at same frequency (25%). All the positive blood cultures yielded the growth of Salmonella typhi (100%). (This is shown in Table 2).

The sensitivity pattern of different isolates to different antimicrobial agents. E. coli are most sensitive to Quinolones and Aminoglycosides (75%) followed by Phosphonic Acid derivatives, 2nd and 3rd generation Cephalosporin (70.8%) and least sensitive to Carbapenam (16.6%). Klebsiella spp were highly sensitive to 2nd generation Cephalosporin’s and...
Table 2. Percentages of bacterial isolates from various specimens

<table>
<thead>
<tr>
<th>Organisms</th>
<th>Urine % (n=33)</th>
<th>HVS % (n=03)</th>
<th>PUS % (n=04)</th>
<th>Sputum % (n=03)</th>
<th>Blood % (n=02)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>E. coli</em></td>
<td>60.60</td>
<td>100</td>
<td>25</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><em>Klebsiella species</em></td>
<td>12.1</td>
<td>-</td>
<td>25</td>
<td>33.33</td>
<td>-</td>
</tr>
<tr>
<td><em>Pseudomonas species</em></td>
<td>9.09</td>
<td>-</td>
<td>25</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><em>Proteus species</em></td>
<td>6.06</td>
<td>-</td>
<td>-</td>
<td>33.34</td>
<td>-</td>
</tr>
<tr>
<td><em>Morganella species</em></td>
<td>6.06</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><em>Staphylococcus saprophyticus</em></td>
<td>6.06</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td>-</td>
<td>-</td>
<td>25</td>
<td>33.33</td>
<td>-</td>
</tr>
<tr>
<td><em>Salmonella typhi</em></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>-</td>
</tr>
</tbody>
</table>

Aminoglycosides (85%) followed by 3rd generation Cephalosporin’s and Extended Spectrum Penicillin’s (71.4% and 71.1% respectively). They are least sensitive to Phosphonic Acid derivatives and Oxazolidine (42.8%). *Pseudomonas* are 100% sensitive to Quinolones, Extended Spectrum Penicillin’s, 2nd and 3rd generation Cephalosporin. Their sensitivity to Aminoglycosides is 75% and Tetracyclines were 25%. *Staphylococci* is 100% sensitive to Extended Spectrum Penicillin’s, Tetracyclines, 2nd and 3rd generation Cephalosporin. *Proteus* and *Salmonella typhi* are also 100% sensitive to Quinolones, Extended Spectrum Penicillin’s, 2nd and 3rd generation Cephalosporin. *Morganella species* is mostly sensitive (100%) Quinolones, Extended Spectrum Penicillin’s, 3rd generation Cephalosporin and short acting Penicillin (this is shown in Fig. 1).

4. DISCUSSION

As per the recommended protocols by CDC (center for disease control), the adequate information regarding the sensitivity pattern of various isolates in specific localities is necessary for initial prescription. Therefore the current study had been planned to acquire the knowledge about sensitivity pattern of various isolates in urine.

*Escherichia coli* was the commonest organism isolated from all specimens in our study and different studies nationally and internationally has also reported the same trend. Other commonest organisms isolated in our study are *Klebsiella, Pseudomonas* and *Staphylococci*. Irrespective to other studies reported nationally and internationally our results shows sensitivity to almost all commonest antibiotics like 2nd, 3rd generation Cephalosporin’s, extended spectrum Pencillin, Quinolones and Aminoglycosides. National literature also shows that from superficial surgical site infections, *E. coli* is the most common organism followed by *Klebsiella* whereas the *Staphylococcus epidermidis* is the least common (0.9%). All isolates were sensitive to Penicillin derivatives and Carbapenem whereas the Quinolones, Aminoglycosides and Monobactum showing some sensitivity. However, Cephalosporin’s were ineffective against majority of the important isolates [9]. Another study by Sheikh et al. [10] has reported that the commonest isolates in ICU are *Escherichia coli* (46.21), *Pseudomonas* (17.64%), *Staph aureus*, Methicillin Resistant *Staphylococcus aureus* (13.42%), *Klebsiella* (8.46%), *Proteus* (8.46%), *Candida* (4.21%), *Acinetobacter* (2.52%) and Beta-hemolytic *Streptococci* (1.26%). These isolates are sensitive to Meropenem, Imipenem, Cefoperazone/Sulbactam, Piperacillin/Tazobactam, Amikacin, Ceftriaxone/Ceftazidime and Ciprofloxacin in descending order.

Najeeb and his colleagues reported that in neonatal sepsis, the Gram negative bacteria were found in 54.6%. Other than that the *Acinetobacter species, Staphylococcus epidermidis, Klebsiella, Streptococci, Enterobacter cloacae* and *Moraxella species* were also isolated. Mostly these organisms were resistant to commonly used antibiotics like Ampicillin, Amoxicillin, Cefotaxime, and Ceftriaxone (77.7%, 81.5%, 63.1%, and 66.9% respectively). They were comparatively less resistance to Ceftazidime and Gentamicin, while Amikacin, Tobramycin, Quinolones and Imipenem were relatively less resistant. Vancomycin was effective in 100% cases of *Staphylococcus group*. Resistance to commonly used antibiotics in institutions is alarmingly high requiring continuous surveillance to assess the sensitivity and resistance pattern at a certain levels [11].
In another study about antibiotic susceptibility pattern of bacterial isolates from patients admitted to a tertiary care hospital in Lahore shows E. coli and Klebsiella were the most prevalent isolates followed by Pseudomonas and Staphylococcus spp. High degree of resistance was observed among gram negative organisms to all groups of antibiotics. Resistance to Amikacin ranged from 12 – 18% among different species of Gram negative isolates whereas the range of Carbapenem resistance was 1.4 – 9.5%. Oxacillin resistance among Staph isolates was 33.1%, but all were sensitive to Vancomycin. This study observe high frequency of resistance and shows that this antibiotic resistance among nosocomial isolates is a serious problem. They also recommended continuous need of surveillance of sensitivity patterns of antimicrobial agents to know about the trend of this problem [12].

Nazish et al. from tertiary care hospital Rawalpindi has reported 11.57% of Vancomycin resistant Enterococcus (VRE) from all isolates and their antimicrobial sensitivity pattern revealed maximum resistance against Ampicillin (86.36%) followed by Erythromycin (81.81%) and Gentamicin (68.18%), while all the isolates were 100% susceptible to Chloramphenicol and Linezolid [13]. The frequency of multi drug resistant (MDR) Pseudomonas aeruginosa among all the Pseudomonas aeruginosa strains isolated was found to be 22.7% as reported by Gill and colleagues [13,14]. These isolates were most sensitive to Colistin followed by Piperacillin-Tazobactam and Cefoperazone-Sulbactum. This trend shows that the infections due to MDR Pseudomonas aeruginosa is an emerging threat which can be prevented by prescribing antibiotics judiciously and by adopting proper disinfection measures [14]. None of the MDR Pseudomonas were isolated from our hospital specimens which favor the concept of judicious use of antibiotics which is strictly observed in our hospital.

In community acquired respiratory tract infections, Zafar and colleagues has observed that all Streptococcus pneumoniae are susceptible to Amoxicillin, Co-amoxiclave and Cefixime, whereas 72% of isolates were sensitive to Macrolide and 97% to Levofloxacin.
were 3.6%.

(Methicillin Resistant Tetracycline (34.1%). Frequency of MRSA Cotrimoxazole (31.7%), Cephradine (30.4%) and Penicillin (97.5%), Erythromycin (37.8%), the cases isolated from cutaneous lesion (52%) whereas Staph. aureus was the most common organism isolated from pus and wounds were Staphylococcus aureus (49%) followed by E. coli (25.9%) Klebsiella (9.5%), Pseudomonas aeruginosa (8.6%), Proteus species (4%) and Acinetobacter species (2.7%) as reported by Mumtaz in his study. They observed that the Quinolones, Aminoglycosides and Cephalosporins were the most effective antimicrobial in vitro while Amoxicillin, Minocycline and Trimethoprim-Sulphamethaxazole were least effective [2,16].

Another study from a tertiary care hospital shows Staph. aureus is the most common organism isolated from cutaneous lesion (52%) whereas the Strept. pyogenes were found in only 18% of the cases. Staph. aureus were resistance to Penicillin (97.5%), Erythromycin (37.8%), Cotrimoxazole (31.7%), Cephradine (30.4%) and Tetracycline (34.1%). Frequency of MRSA (Methicillin Resistant Staphylococcus aureus) were 3.6%. Strept. pyogenes were found completely sensitive to Penicillin’s but resistant to Tetracycline, Cotrimoxazole, Erythromycin and Gentamicin. They observed that all isolates were sensitive to Vancomycin [17]. The comparison of this study with previous studies indicates that problem of bacterial resistance amongst common cutaneous pathogens is increasing. The situation calls for creating awareness regarding dangers of indiscriminate use of antibiotics.

International literature review also shows increasing resistance to commonly used antibiotics, Lambke et al. reported that E. coli is the commonest pathogens in healthy young women and resistance rates are about 25% for Fluoroquinolones and 4% for Cephalosporin’s [13]. They observed that this resistance pattern are similar to many other hospitals of their country and literature shows escalating Fluoroquinolone resistance. They recommended an alternative approach and emphasized the significance of relying on local hospital antibiogram patterns which allows the appropriateness of different types of antibiotics. By this the quality of care is improved by reducing the likelihood of inappropriate prescription and poor stewardship of antibiotics.

[1] We are also following the same approach in our hospital and due to this all isolates from our hospital are sensitive to even commonly used antibiotics whereas this pattern is not seen in other hospitals of our city [13].

In India, the commonest cause of infections at all sites are Gram negative bacilli as reported by Varghese et al. [17,18]. They observed considerable degree of resistance to both 1st and 2nd line gram negative organisms. The gram positive cocci are less of a problem as compared to gram negative bacilli and MRSA prevalence is also not insignificant [18]. Another study from India by Gopalakrishnan and colleagues reported that the antimicrobial drug resistance patterns in Indian hospitals is different from that reported from the Western hospitals in having a high resistance prevalence in Gram negative bacteria and having significantly low resistance in Gram positive bacteria. They also observe that the resistance among Gram negative pathogens (especially ESBL production in Enterobacteriaceae and Carbapenem resistance in Pseudomonas and Acinetobacter) is a main concern in their tertiary care hospitals [19].

From Taiwan, a study has reported that the resistance to antimicrobial drugs has rapidly increased during last two decades especially among the major bacterial pathogens. To limit the use of antimicrobial agent’s continuous enforcement of policies and active surveillance of antibiotic resistance through a nationwide system were suggested [20]. Similarly, Alagesan et al. [21] has also reported a progressive rise in antimicrobial drug resistance especially to E. coli, Klebsiella pneumoniae and Pseudomonas Aeruginosa. They observe ESBL production in the majority of isolates of Klebsiella and E. coli isolates. They reported increasing resistance to Carbapenem among Klebsiella pneumoniae and E. coli and these organisms are even resistant to Tigecycline and Polymyxin E which are the antibiotics of last resort. They recommend an urgent need for antimicrobial drug stewardship and other measures to limit the gram-negative resistance.

5. CONCLUSION
The study concluded the drugs of choice for E. coli are quinolones and aminoglycosides by showing the sensitivity of about 75% each. For Klebsiella pneumoniae, the ideal antibiotics are aminoglycosides (85.1%) and 2nd generation cephalosporins (85%). For
Pseudomonas aeruginosa, extended spectrum penicillin, quinolones, 2nd and 3rd generation cephalosporins are the most suitable ones showing the sensitivity of 100% each.

Acquiring knowledge about the specific locality antibiogram will be helpful to reduce the infection rate just like it is in our hospital.

COMPETING INTERESTS
Authors have declared that no competing interests exist.

REFERENCES


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