British Microbiology Research Journal
13(3): 1-8, 2016, Article no.BMRJ.23795
ISSN: 2231-0886, NLM ID: 101608140

SCIENCEDOMAIN *international*
www.sciencedomain.org

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

Ishtiaq Ahmend[1], Humaira Zafar[2*], Noor Khan Lakhnana[3], Sundas Ishtiaq[4], Kiran Tauseef[5], Mudassira Zahid[6] and Ahsan Kazmi[7]

[1]Department of Surgery, Al Nafees Medical College, Islamabad, Pakistan.
[2]Department of Microbiology, Al Nafees Medical College, Islamabad, Pakistan.
[3]Department of Pathology, Al Nafees Medical College, Islamabad, Pakistan.
[4]Department of Surgery, Fauji Foundation Hospital, Rawalpindi, Pakistan.
[5]Department of Haematology, Al Nafees Medical College, Islamabad, Pakistan.
[6]Department of Histopathology, Al Nafees Medical College, Islamabad, Pakistan.
[7]Department of Chemical Pathology, Al Nafees Medical College, Islamabad, Pakistan.

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.

Article Information

DOI: 10.9734/BMRJ/2016/23795
Editor(s):
(1) Luis Martinez-Sobrido, University of Rochester, School of Medicine and Dentistry, NY, USA.
(2) Hung-Jen Liu, Distinguished professor, Director, Institute of Molecular Biology, National Chung Hsing University, Taiwan.
Reviewers:
(1) Maria Manuel Azevedo, University of Porto, Portugal.
(2) Anonymous, Universiti Sultan Zainal Abidin, Malaysia.
Complete Peer review History: http://sciencedomain.org/review-history/13580

Original Research Article

Received 22nd December 2015
Accepted 12th February 2016
Published 7th March 2016

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

**Corresponding author: E-mail: dr.humairazafar@yahoo.com;*

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 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 continues 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℃ 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

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

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

Organisms	Urine % (n=33)	HVS % (n=03)	PUS % (n=04)	Sputum % (n=03)	Blood % (n=02)
E. coli	60.60	100	25	-	-
Klebsiella species	12.1	-	25	33.33	-
Pseudomonas species	9.09	-	25	-	-
Proteus species	6.06	-	-	33.34	-
Morganella species	6.06	-	-	-	-
Staphylococcus saprophyticus	6.06	-	-	-	-
Staphylococcus aureus	-	-	25	33.33	-
Salmonella typhi	-	-	-	-	100

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 Oxazoladine (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* speies 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].

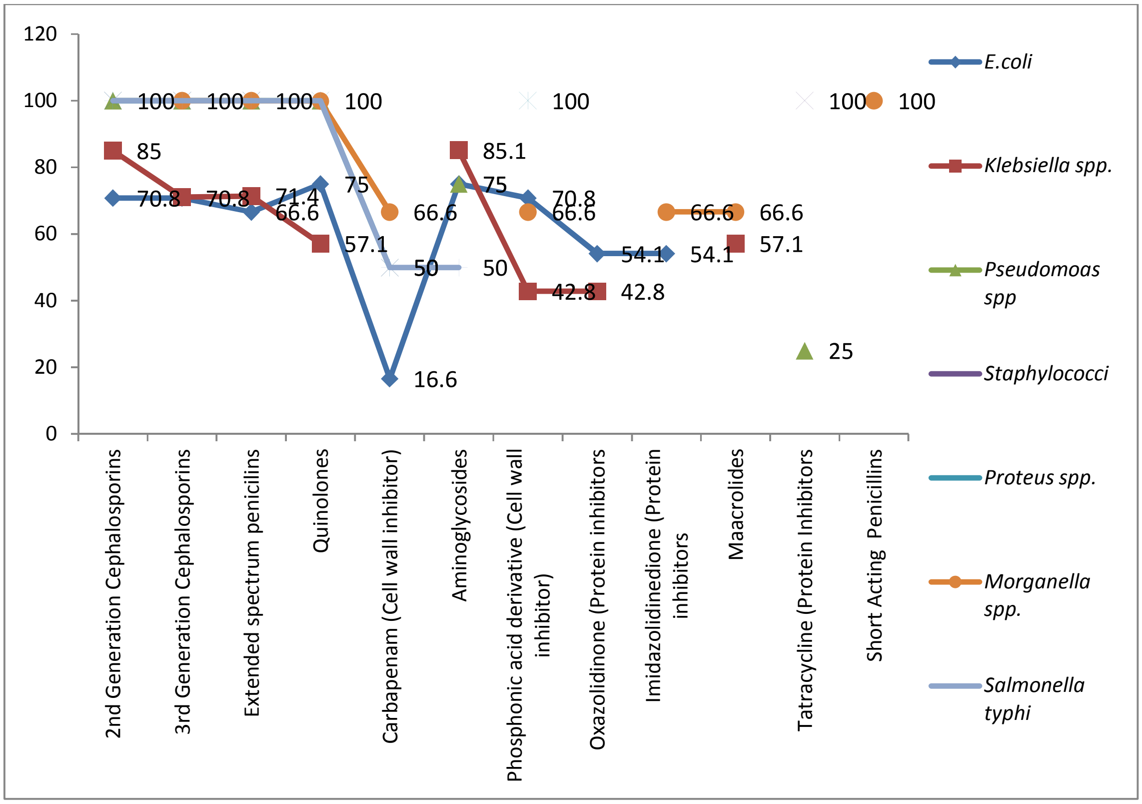

Fig. 1. Percentage susceptibility of bacterial isolates in various specimens

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. All *Haemophilus influenzae* were sensitive to

Co-amoxiclave and Cefixime, 97% to Ampicillin, 98% to Clarithromycin and 99% to Levofloxacin. They concluded that *Streptococcus pneumonia* and *Haemophilus influenzae* resistance rate was high for Macrolide whereas the *Streptococcus pneumonia* and *Haemophilus influenzae* remain susceptible to ß-lactams as well as to Levofloxacin [15]. Most common organisms 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 is 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 Entero-bacteriaceae 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

1. Joshi S. Hospital antibiogram: A necessity. Indian J Med Microbiol. 2010;28(4):277-80.
2. Paryani JP, Memon SR, Rajpar ZH, Shah SA. Pattern and sensitivity of microorganisms causing urinary tract infection at teaching hospital. J Liaquat Uni Med Health Sci. 2012;11(2):97-100.
3. Stein CR, Weber DJ, Kelley M. Using hospital antibiogram data to assess regional pneumococcal resistance to antibiotics. Emerging Inf dise 2003;9(2):231-35.
4. Zapantis A, Lacy MK, Horvat RT. Nationwide antibiogram analysis using NCCLS M39-A guidelines. J Clin Microbiol. 2005;43(6):2629-34.
5. Horva RT. Review of antibiogram preparation and susceptibility testing systems. Hosp Pharm 2010;45(11 Suppl 1):S6–S9.
6. Hindler JF, Stelling J. Analysis and presentation of cumulative antibiograms: A new consensus guideline from the Clinical and Laboratory Standards Institute. Clin Infect Dis. 2007;44(6):867-73.
7. Clinical and Laboratory Standards Institute (CLSI). Analysis and presentation of cumulative susceptibility test data: Approved guideline. Wayne, Pennsylvania: CLSI. CLSI document M39-A2; 2006.
8. Boehme MS, Somsel PA, Downes FP. Systematic review of antibiograms: A national laboratory system approach for improving antimicrobial susceptibility testing practices in Michigan. Pub Health Rep. 2010;125(S2):63-72.
9. Ali SA, Tahir SM, Memon AS, Shaikh NA. Pattern of pathogens and their sensitivity isolated from superficial surgical site infections in a tertiary care hospital. J Ayub Med Coll Abottabad. 2009;21(2):80-82.
10. Sheikh NA, Bashir K, Shafique AA, Khawaja S. An audit for microbiological surveillance and antimicrobial susceptibility in the intensive care unit. Pak J Med Health Sci. 2010;4(2):93-96.
11. Najeeb S, Gillani S, Ullah R, Rehman A. Causative bacteria and antibiotic resistance in neonatal sepsis. J Ayub Med Coll Abottabad. 2012;24(3):131-34.
12. Javeed I, Hafeez R, Anwar S. Antibiotic susceptibility pattern of bacterial isolates from patients admitted to tertiary care hospital in Lahore. Biomedical 2011;27(1):19-23.
13. Babar N, Usman J, Munir T, Gill MM, Anjum R, Gilani M, et al. Frequency and antibiogram of Vancomycin resistant enterococcus in a tertiary care hospital. J Coll Physicians Surg Pak. 2014;24(1):27-29.
14. Gill MM, Usman J, Kaleem F, Hassan A, Khalid A, Anjum R, et al. Frequency and antibiogram of multi-drug resistant *Pseudomonas aeruginosa*. J Coll Physicians Surg Pak. 2011;21(9):531-34.
15. Zafar A, Hussain Z, Lomama E, Sibille S, Irfan S, Khan E. Antibiotic susceptibility of pathogens isolated from patients with community-acquired respiratory tract infections in Pakistan—the active study. J Ayub Med Coll Abottabad. 2008;20(1):7-9.
16. Mumtaz S, Akhtar N, Hayat A. Antibiogram of aerobic pyogenic isolates from wounds and abscesses of patients at Rawalpindi. Pak J Med Res. 2002;41(1):16-18.
17. Rashid A, Naeem MA. Cutaneous bacterial infections: Antimicrobial susceptibility pattern. Professional Med J 2006;13($):591-95.
18. Varghese GK, Mukhopadhya C, Bairy I, Vandana KE, Varma M. Bacterial organisms and antimicrobial resistance patterns. J Assoc Physicians India. 2010;58(Suppl):23-4.
19. Gopalakrishnan R, Sureshkumar D. Changing trends in antimicrobial susceptibility and hospital acquired infections over an 8 year period in a tertiary care hospital in relation to introduction of an infection control programme. J Assoc Physicians India. 2010;58 Suppl:25-31.

20. Lo WT, Lin WJ, Chiueh TS, Lee SY, Wang CC, Lu JJ. Changing trends in antimicrobial resistance of major bacterial pathogens, 1985-2005: A study from a medical center in northern Taiwan. J Microbiol Immunol Infect. 2011;44(2):131-38.

21. Alagesan M, Gopalakrishnan R, Panchatcharam SN, Dorairajan S, Mandayam Ananth T, Venkatasubramanian R. A decade of change in susceptibility patterns of gram-negative blood culture isolates: A single center study. Germs. 2015;5(3):65-77.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/13580