

Antibiotic resistance pattern in an intensive care unit of a tertiary care hospital in Pakistan

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ABSTRACT

Introduction: Since antibiotic is the most successful medical development, its resistance is a global health issue. The incidence of antibiotic resistance is around seven times higher in Intensive care units (ICU) than in general hospitals. Failure of antibiotic therapy can be due to a number of factors such as frequent and widespread use of prophylactic and therapeutic antimicrobial. This calls for prompt preventive measures that should be observed in all health care facilities. We performed this survey to have an idea about the most common microorganisms found in patients admitted in our ICU so that more specific antibiotics can be selected.

Methods: This cross-sectional study performed in the medical ICU of Jinnah Postgraduate Medical Centre, Karachi, Pakistan, included all patients irrespective of gender being admitted in the ICU from January to February 2019. 95 specimens were collected from blood, endotracheal secretions, central catheter tips, and urine. Antibiotic sensitivity was tested by disk diffusion method. Interpretation was done as susceptible, resistant, or intermediate. The statistical analysis was performed using the SPSS version 23.0.

Results: Out of the total of 95 patients, 69.5% were males and mean age of individuals was found to be 27.37 + 10 years. All patients had positive cultures, 98 of which were bacterial and one was of Candida. Bacteria were mostly gram-negative and the most frequently encountered bacteria were Pseudomonas (34.7%), Klebsiella (16.8%), Acinetobacter (16.8%), and Staphylococcus (10.5%). For Pseudomonas, polymixin was found to be the most sensitive antibiotic followed by piperacillin/tazobactam, amikacin, and ceftazidime. For Acinetobacter, colistin followed by cefoperazone/sulbactam; for Klebsiella, amikacin and imipenem had equally highest sensitivity frequencies. For Staphylococcus, amikacin sensitivity was found in seven patients while five patients were found susceptible each for vancomycin, chloramphenicol, clindamycin, and cotrimoxazole.

Conclusion: Microorganisms with multidrug resistance especially gram-negative ones are increasing day by day and this can be one reason of the increasing mortalities in the intensive care setup. High percentage of resistance to the frequently used antibiotics was found in this study. It is inferred that antibiotics prescribed empirically should be according to the locally made and regularly updated antibiogram.

KEYWORDS: culture; antibiotic; antibiotic resistance; multidrug resistance; antibiogram; intensive care units

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INTRODUCTION:

Antibiotic resistance is an emerging problem globally resulting in widespread public health issues. From being the most successful medical development of human health, antibiotics have been extensively used for various infections. Ever since their discovery, antibiotics have been known to increase the life expectancy of patients all over the world. William Stewart, a general surgeon in America proudly stated “the time has come to close the book on infectious diseases”. Little did he know about the emergence and spread of antimicrobial resistance. Lack of therapeutic agents to cope up with this increasing resistance is another big challenge for physicians^{1,2}.

The use of antibiotics is pivotal in critical care setting³. A combination of such drugs is used empirically to cover various microorganisms in intensive care units (ICU) particularly for critically ill patients suffering from sepsis and septic shock, which are the major cause of mortality and morbidity in these patients⁴. Unfortunately, several studies have shown that the use of broad-spectrum empiric antibiotics among these patients is one of the major factor that contributes to antibiotic resistance. Approximately 25% of all patients treated in the ICU contribute to nosocomial infections. The incidence of antibiotic resistance is around seven times higher in ICU than in general hospitals⁵. An international study conducted in 2007 demonstrated that patients with longer ICU stay were more likely to develop infections. A large proportion of these infections were contributed by resistant species of Staphylococci, Acinetobacter, Pseudomonas, and Candida⁶. Patients in ICU have an increased risk of acquiring infections from antibiotic-resistant microorganisms. The global incidence rate is 23.7 infections per 1000 patient days⁷.

Failure of antibiotic therapy can be due to a number of factors such as empiric therapy not specific to the organism, inadequate source control, severity of illness, immunocompromised patients, susceptibility to nosocomial infections, cross transmission of pathogens, breach of skin and membranes due to use of invasive devices, increased

patient and healthcare personnel contact, and most importantly frequent and widespread use of prophylactic and therapeutic antimicrobial^{5,7,8}. This calls for prompt preventive measures that should be observed in all health care facilities, particularly ICUs, such as maintaining hand hygiene, decolonization of skin using antiseptics and proper screening for multidrug-resistant microorganisms⁹. To make sure that effective antibiotic treatment is initiated; choice of empirical treatment should be optimized using the pharmacokinetic-pharmacodynamics (PK-PD) characteristics of the drugs and minimizing the frequency of patients treated unnecessarily. Furthermore, shortening the duration of therapy and de-escalating once the culture reports are available, can help to optimize and rationalize antibiotic therapy in the ICU¹⁰.

This short survey will give us an idea of the most common organisms encountered in patients admitted in the intensive care unit of the largest tertiary care setup of Karachi, Pakistan. Knowing about the antibiotic sensitivity levels of these organisms will help in selecting the more specific antibiotics for empirical treatment. This can also serve as a baseline for larger prevalence studies in this hospital or multiple tertiary care setups in this country so that unnecessary administration of less-specific antibiotics can be avoided.

MATERIALS AND METHODS:

This is a cross-sectional study, performed at the medical ICU of Jinnah Postgraduate Medical Centre (JPMC), Karachi, Pakistan. Data was collected from all patients admitted to the ICU from January 2019 to February 2019 after approval from the ethical review board at JPMC. All patients irrespective of gender after taking informed consent were included in the study. Pediatric patients were excluded. Specimens were collected from blood, endotracheal secretions, central catheter tips, and urine. Inoculation and incubation was done for 24-48 hours and gram staining was done separating the gram-positive and negative organisms. Antibiotic sensitivity was tested by disk diffusion method based on the guidelines of National Committee for Clinical Laboratory Standards [11]. The antibiotics used were ampicillin, cloxacillin,

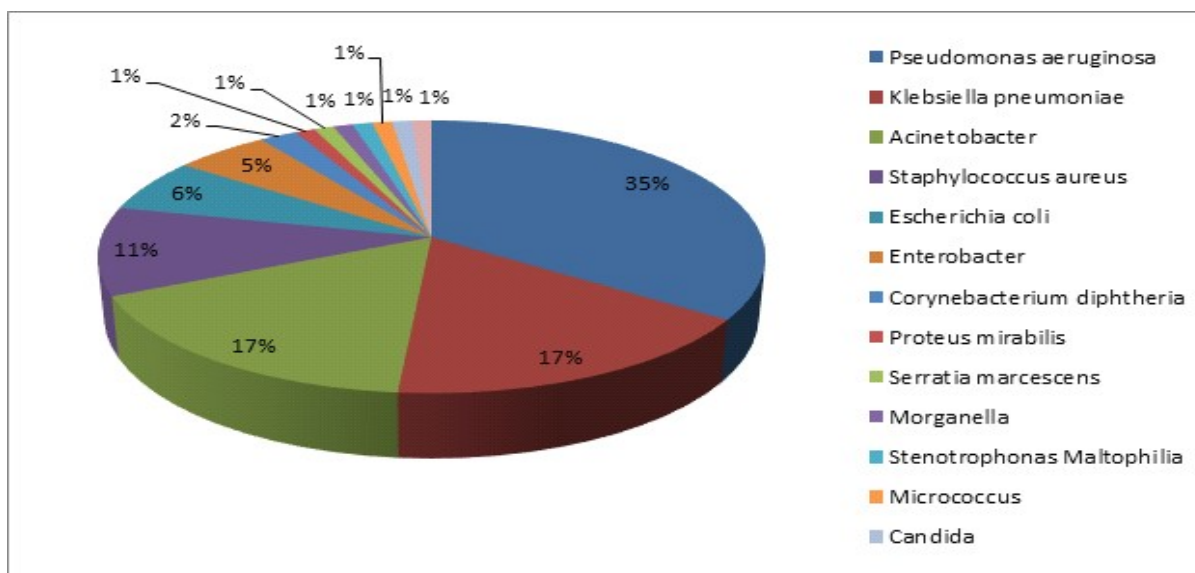


Figure 1: Organisms distribution in intensive care unit patients

amoxicillin/clavulanic acid, aztreonam. Aminoglycosides (amikacin, gentamicin, and tobramycin), ceftazidime, cefixime, cefipime, ceftriaxone, cephadrine, cefoperazone/sulbactam, quinolones (ciprofloxacin, levofloxacin, and norfloxacin), carbapenems (imipenem and meropenem), tetracycline, piperacillin/tazobactam, polymixin, tigecycline, colistin, fosfomycin, co-

trimoxazole, chloramphenicol, cefaclor, minocycline, clindamycin, linezolid, fusidic acid, doxycycline, nalidixic acid, piperidic acid, nitrofurantoin, and vancomycin. Interpretation was done as susceptible, resistant, or intermediate. The testing technique randomly gave these results and a single patient sample was not tested for all antibiotics.

Organisms	Total Sample (n=95)	Tracheal Secretions	Blood	Urine	Catheter tip
Pseudomonas aeruginosa	33	28	4	0	1
Proteus mirabilis	1	0	1	0	0
Klebsiella pneumoniae	16	13	3	0	0
Acinetobacter	16	13	3	0	0
Serratia marcescens	1	0	1	0	0
Candida	1	0	0	1	0
Staphylococcus aureus	10	4	3	0	3
Escherichia coli	6	1	0	3	2
Enterobacter	5	0	2	0	3
Morganella	1	1	0	0	0
Stenotrophomonas maltophilia	1	0	1	0	0
Micrococcus	1	0	1	0	0
Corynebacterium diphtheria	2	0	1	0	1
Streptococcus pneumoniae	1	0	1	0	0

Table 1: Sources of cultured sample and organisms

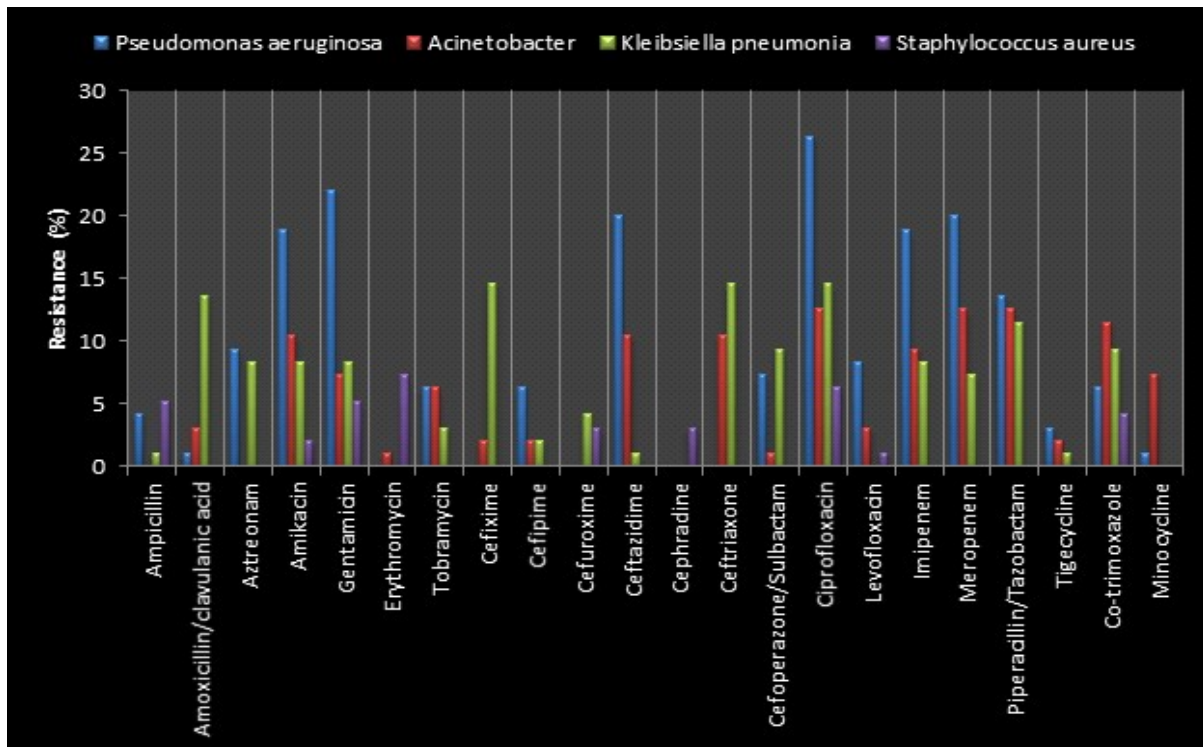


Figure 2: Distribution of resistance percentage to antibiotics

95 patients were gathered in the assigned duration. Limited information was collected i.e. their age, gender, and the parameters of their culture and sensitivity report

The statistical analysis was performed using the SPSS version 23.0. Mean and standard deviations were recorded for age, while frequency and percentages for categorical variables including isolated organisms, site of collection, and sensitivity distribution.

RESULTS:

Out of the total of 95 patients, 66 (69.5%) were males and 29 (30.5%) were females. Mean age of individuals was found to be 27.37 + 10 years. All patients had positive cultures, 98 of which were bacterial and one was of *Candida*. Bacteria were mostly gram-negative (85.3%) and the most frequently encountered bacteria were *Pseudomonas aeruginosa* (34.7%), *Klebsiella pneumoniae* (16.8%), *Acinetobacter* (16.8%), and *Staphylococcus aureus* (10.5%), while the less common ones are shown in figure 1.

Organism frequency according to the site of collection is presented in table 1.

On sensitivity analysis comparison; for *Pseudomonas*, polymixin was found to be the most sensitive (17.8% sensitive), followed by piperacillin/tazobactam (15.7% sensitive), amikacin (14.7% sensitive), and ceftazidime (13.6% sensitive); for *Acinetobacter*, colistin (10.5%) followed by cefoperazone/sulbactam (5.2%); for *Klebsiella*, Amikacin and Imipenem had equal sensitivity frequencies (8.4%), while similar sensitivities were found for cefoperazone/sulbactam and tigecycline (7%). For *Staphylococcus*, amikacin sensitivity was found in seven patients while five patients were found susceptible each for vancomycin, chloramphenicol, clindamycin, and co-trimoxazole. The resistance percentages for the four most common organisms in this study are presented in figure 2.

DISCUSSION:

In the antibiogram made in this study, most of the microorganisms were gram-negative and four

most frequently encountered organisms were *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Acinetobacter*, and *Staphylococcus aureus*.

It is a worldwide practice to use antibiogram for determining an appropriate empirical antibiotic against a suspected microorganism. But unfortunately, in developing countries like Pakistan, no good local data is available, and antibiotics are prescribed inappropriately in up to 90% patients in the hospital^{12,13}. However, a similar and helpful study was done in Islamabad, Pakistan in 2016⁴. Although gram-positive infections are increasing day by day, higher prevalence of gram-negative organisms in a hospital environment and their increasing resistance to antibiotics is a well-known fact as seen in works done by Al-jawady et al., Vinent et al., and Mohammadi-mehr et al.^{6,14,15}.

In almost all the reviewed literature, *Pseudomonas* was the most common microorganism isolated from samples collected from patients in the hospitals and also the one with highest prevalence of multidrug resistance. The most commonly found gram-negative organisms here in our ICU were *Pseudomonas*, *Klebsiella*, and *Acinetobacter*. Similar results were obtained by Ziab et al. and Radji et al., while Al-Jawady et al. and Morfin-Otero et al. showed that to be *Escherichia Coli* (*E. coli*)^{5,14,16–18}. In samples collected from trachea and blood in our study, *Pseudomonas* was the predominant organism. While Pradhan et al. and Rajan et al. found *Acinetobacter* and *Klebsiella* as the most frequent organisms in respiratory tract secretions respectively^{19,20} and Patel et al. and Mohammadi-mehr et al. supported the results of latter^{15,21}. In urine, *E. coli* dominated, this is similar to what other authors found^{15,19,22}.

Cephalosporins are amongst the most widely used antibiotics globally²³. Moreover, there is an extensive usage of cephalosporins and quinolones in our hospital and throughout Pakistan, which might be one reason why there is an increasing pattern of resistance to these drugs. Same applies to carbapenems which is alarming. As mentioned in our results, *Pseudomonas* showed highest prevalence of resistance to ciprofloxacin (26.3% resistant) and gentamicin (22.1% resistant), while

Polymixin was considered as the most sensitive antibiotic in this case. Qadeer et al. concluded colistin as the most sensitive antibiotic and carbapenems and cefoperazone/sulbactam as the most resistant ones for *pseudomonas*⁴. On the other hand, a study done in 2011 reported amikacin as the most sensitive and ceftriaxone as the most resistant antibiotic for this microbe⁵.

One of the second most common gram-negative organism of our collected samples i.e. *Klebsiella* showed highest resistance to 3rd generation cephalosporins and ciprofloxacin (each 14.7% resistant) while amikacin and imipenem had the highest sensitivity profile. This is contradicting to the results computed by Qadeer et al., and Gunjal et al., showing high resistance to carbapenems and aminoglycosides^{4,24}. Sheth et al., Al-lawati et al., and Rajan et al. on the other hand gave high sensitivities to carbapenems in their results^{19,25,26} while Radji et al. had similar observations to our study about cephalosporins and quinolones⁵.

Acinetobacter, the third important organism in our sample was found to be highly resistant to ciprofloxacin (12.6% resistant), carbapenems (12.6% for meropenem and 9.4% for imipenem), and piperacillin/tazobactam (12.6% resistant), while the most sensitive antibiotic for this organism was colistin. Similar resistance profile was found for carbapenems and ciprofloxacin in previous studies with *Acinetobacter* being highly resistant to both. Other studies also supported our finding on colistin^{4,19,27}, while tigecycline was finalized as the most sensitive antibiotic for this bacterium by Hasan et al.²⁸. High frequency of *Acinetobacter* isolated in our setup compared with those of developed countries emphasizes the role of gathering local data to decide the appropriate antibiotic and also stresses on the importance of local preventive measures. This is because *Acinetobacter* is commonly found in water supply of our hospitals and it is a common practice to use this water for flushing and washing hospital equipment being used for patients^{6,29}.

These results cannot be generalized since it's a short sample study conducted in a single tertiary

care setup in a short time period. The comorbidities were not taken into account which might be causing the difference in resistance. Other potential confounding factors like age was also not considered. Since this was a cross-sectional study, there was no follow-up of patients affected by different drug resistant organisms and their outcomes. We did not analyze and compare the organisms with resistance to multiple antibiotics and lack of resistance genotyping is also one of our limitations. A prospective cohort study with a larger sample size is required in our setup to have further conclusions.

CONCLUSION:

It was concluded here in this study that microorganisms with multidrug resistance especially gram-negative ones are increasing day by day. This can be one reason of the increasing mortalities in the intensive care setup. High percentage of resistance to the frequently used antibiotics (cephalosporins, quinolones, and carbapenems) was found in this study. It is inferred that antibiotics prescribed empirically should be according to the locally made and regularly updated antibiogram.

REFERENCES

1. Antibiotic resistance. *Br Dent J*. 2017;223(9):692.
2. Martinez JL, Baquero F. Emergence and spread of antibiotic resistance: setting a parameter space. *Ups J Med Sci*. 2014;119(2):68–77.
3. Luyt C-E, Brechot N, Trouillet J-L, Chastre J. Antibiotic stewardship in the intensive care unit. *Crit Care*. 2014;18(5):480.
4. Qadeer A, Akhtar A, Ain QU, Saadat S, Mansoor S, Assad S, et al. Antibiogram of Medical Intensive Care Unit at Tertiary Care Hospital Setting of Pakistan. *Cureus*. 2016;8(9):e809.
5. Radji M, Fauziah S, Aribinuko N. Antibiotic sensitivity pattern of bacterial pathogens in the intensive care unit of Fatmawati Hospital, Indonesia. *Asian Pac J Trop Biomed*. 2011;1(1):39–42.
6. Vincent J-L, Rello J, Marshall J, Silva E, Anzueto A, Martin CD, et al. International study of the prevalence and outcomes of infection in intensive care units. *JAMA*. 2009;302(21):2323–9.
7. Al Johani SM, Akhter J, Balkhy H, El-Saed A, Younan M, Memish Z. Prevalence of antimicrobial resistance among gram-negative isolates in an adult intensive care unit at a tertiary care center in Saudi Arabia. *Ann Saudi Med*. 2010;30(5):364–9.
8. Bayram A, Balci I. Patterns of antimicrobial resistance in a surgical intensive care unit of a university hospital in Turkey. *BMC Infect Dis*. 2006;6(1):155.
9. Plantinga NL, Wittekamp BHJ, van Duijn PJ, Bonten MJM. Fighting antibiotic resistance in the intensive care unit using antibiotics. *Future Microbiol*. 2015;10(3):391–406.
10. Campion M, Scully G. Antibiotic Use in the Intensive Care Unit: Optimization and De-Escalation. *J Intensive Care Med*. 2018;33(12):647–55.
11. CLSI. Procedures for the Handling and Processing of Blood Specimens for Common Laboratory Tests; Approved Guideline - Fourth Edition. CLSI document H18-A4. Wayne, PA; 2010.
12. Ansari F. Use of systemic anti-infective agents in Iran during 1997-1998. *Eur J Clin Pharmacol*. 2001;57(6–7):547–51.
13. Hu S, Liu X, Peng Y. Assessment of antibiotic prescription in hospitalised patients at a Chinese university hospital. *J Infect*. 2003;46(3):161–3.
14. Al-Jawady Z, Al-Habib H. Antibiogram profiles of bacterial isolates from intensive care units in Mosul Teaching Hospitals. *Raf J Sci*. 2012;23:52–9.
15. Mohammadi-Mehr M, Feizabadi M. Antimicrobial resistance pattern of Gram-negative bacilli isolated from patients at ICUs of Army hospitals in Iran. *Iran J Microbiol*. 2011;3(1):26–30.
16. Al-Ahmadey Z, Mohamed S. Antimicrobial susceptibility pattern of bacterial isolates in the intensive care unit of Al-Ansar Hospital, Saudi Arabia. *Eur J Adv Res Bio Life Sci*. 2013;1:17–26.
17. Morfin-Otero R, Tinoco-Favila JC, Sader HS, Salcido-Gutierrez L, Perez-Gomez HR, Gonzalez-Diaz E, et al. Resistance trends in gram-negative bacteria: surveillance results from two Mexican hospitals, 2005-2010. *BMC Res Notes*. 2012;5:277.
18. Zhanel GG, DeCorby M, Laing N, Weshnoweski B, Vashisht R, Tailor F, et al. Antimicrobial-resistant pathogens in intensive care units in Canada: results of the Canadian National Intensive Care Unit (CAN-ICU) study, 2005-2006. *Antimicrob Agents Chemother*. 2008;52(4):1430–7.
19. Rajan R, Rao A. Antibiogram of gram-negative bacterial isolates from intensive care unit at a tertiary care

- hospital. *Int J Adv Res.* 2016;6:344–7.
20. Pradhan NP, Bhat SM, Ghadage DP. Nosocomial infections in the medical ICU: a retrospective study highlighting their prevalence, microbiological profile and impact on ICU stay and mortality. *J Assoc Physicians India.* 2014;62(10):18–21.
 21. Patel B, Patel P, Raval P, Patel M, Patel P, Vengad M. Bacteriological profile and Care, antibiogram of gram negative organisms isolated from medical and neurology intensive Organisms, units with special reference to multidrug resistant. *Natl J Med Res.* 2012;3:335–7.
 22. Panta K, Ghimire P, Rai S, Mukiya R, Singh R, Rai G. Antibiogram typing of gram negative isolates in different clinical samples of a tertiary care hospital. *Asian J Pharm Clin Res.* 2013;6:153–6.
 23. Jean S-S, Teng L-J, Hsueh P-R, Ho S-W, Luh K-T. Antimicrobial susceptibilities among clinical isolates of extended-spectrum cephalosporin-resistant Gram-negative bacteria in a Taiwanese University Hospital. *J Antimicrob Chemother.* 2002;49(1):69–76.
 24. Gunjal P, Gunjal S, Kher S. A cross-sectional study to determine the profile and antibiotic resistance pattern of gram negative bacilli isolated from intensive care unit patients in a tertiary care hospital in Ahmednagar, Maharastra. *Int J Biomed Adv Res.* 2012;3:281–4.
 25. Al-Lawati AM, Crouch ND, Elhag KM. Antibiotic consumption and development of resistance among gram-negative bacilli in intensive care units in Oman. *Ann Saudi Med.* 2000;20(3–4):324–7.
 26. Sheth K, Patel T, Malek S, Tripathi C. Antibiotic sensitivity pattern of bacterial isolates from the intensive care unit of a tertiary care hospital in India. *Trop J Pharm Res.* 2012;11:991–9.
 27. Khan M. Bacterial spectrum and susceptibility patterns of pathogens in ICU and IMCU of a Secondary Care Hospital in Kingdom of Saudi Arabia. *Int J Pathol.* 2012;10:64–70.
 28. Hasan B, Perveen K, Olsen B, Zahra R. Emergence of carbapenem-resistant *Acinetobacter baumannii* in hospitals in Pakistan. *J Med Microbiol.* 2014;63(Pt 1):50–5.
 29. Barchitta M, Cipresso R, Giaquinta L, Romeo MA, Denaro C, Pennisi C, et al. Acquisition and spread of *Acinetobacter baumannii* and *Stenotrophomonas maltophilia* in intensive care patients. *Int J Hyg Environ Health.* 2009;212(3):330–7.