ANTIMICROBIAL SENSITIVITY OF MULTIDRUG-RESISTANT ACINETOBACTER BAUMANNII IN A TERTIARY CARE HOSPITAL OF PATNA

Keshav Kumar Bimal[1], Suprakash Das[2], Shashi Kishore[3], Archana[4], S. K. Shahi[5]

[1]Junior Resident, Department of Microbiology, Indira Gandhi Institute of Medical Sciences, Sheikhpura, Patna.
[2]Junior Resident, Department of Microbiology, Indira Gandhi Institute of Medical Sciences, Sheikhpura, Patna.
[3]Tutor, Department of Microbiology, Sri Krishna Medical College and Hospital, Muzaffarpur.
[4]Junior Resident, Department of Microbiology, Indira Gandhi Institute of Medical Sciences, Sheikhpura, Patna.
[5]Professor and Head, Department of Microbiology, Indira Gandhi Institute of Medical Sciences, Sheikhpura, Patna.

ABSTRACT

BACKGROUND

Acinetobacter spp. has emerged as an important nosocomial pathogen especially in ICU settings. Acinetobacter baumannii is the most commonly isolated species among different Acinetobacters and is associated with variety of human infections. A. baumannii exhibits resistance not only to beta-lactams and cephalosporins, but also to other groups of antibiotics including carbapenems and this has resulted in the emergence of multidrug-resistance A. baumannii species, which is now widespread. To know the prevalence and antimicrobial susceptibility pattern of A. baumannii is crucial for the optimal antimicrobial therapy and to resist the spread of MDR Acinetobacter spp.

The aim of the study is to study the antimicrobial susceptibility pattern of A. baumannii isolated from various clinical specimens and to explore the risk factors for multidrug-resistant A. baumannii infections.

MATERIALS AND METHODS

The present study was conducted from August 2015 to July 2016 at Indira Gandhi Institute of Medical Sciences, Patna. Antimicrobial susceptibility testing was done by Kirby-Bauer's disc diffusion method. The zones of inhibition were interpreted for antibiotic sensitivity as per the CLSI guidelines 2014. Data regarding patients demographic and clinical status was obtained from medical records and possible risk factors for multidrug-resistant A. baumannii infections was evaluated for their statistical significance.

Statistical analysis used- Microsoft excel sheet 2007 and Epi Info software (version 7.2.0.1) was used for different statistical analysis including Pearson's x^2 test and simple logistic regression.

RESULTS

A. baumannii was isolated predominantly from respiratory samples (35.3%). Majority of the isolates were from different inpatient departments (59.1%), followed by different ICUs (40.9%). The A. baumannii isolates showed most sensitivity to colistin (100%) followed by polymyxin B (90.20%) and least sensitive to ampicillin (5.19%). Most of the isolates (60.66%) were multidrug resistant.

CONCLUSION

A. baumannii is emerging as a predominant healthcare associated multidrug-resistant pathogen, especially in the ICUs. This is a major challenge to the current era as untreatable infections by this organism may contribute to increased morbidity and mortality.

KEYWORDS

Acinetobacter baumannii, Nosocomial Infection, Multidrug Resistance, Risk Factors.

HOW TO CITE THIS ARTICLE: Bimal KK, Das S, Kishore S, et al. Antimicrobial sensitivity of multidrug-resistant Acinetobacter baumannii in a tertiary care hospital of Patna. J. Evid. Based Med. Healthc. 2017; 4(51), 3139-3144. DOI: 10.18410/jebmh/2017/622

BACKGROUND

Acinetobacter baumannii (A. baumannii) is an opportunistic gram-negative pathogen, which has implicated in a wide range of infections, particularly in critically-ill patients with impaired immune response.[1,2] In addition to hospitalised patients, community-acquired Acinetobacter infection is increasingly reported these days.[3]

Acinetobacter spp. are relatively common colonisers of hospitalised patients, their clinical significance when found in patient specimens can be difficult to establish. When infection does occur, it usually is seen in debilitated patients such as those in burn or intensive care units and those who have undergone medical instrumentation and/or have received multiple antimicrobial agents.[4] A variety of human infections are caused by Acinetobacter spp., such

Financial or Other, Competing Interest: None.
Submission 03-05-2017, Peer Review 10-05-2017,
Acceptance 09-06-2017, Published 26-06-2017.
Corresponding Author:
Dr. Shashi Kishore,
Tutor, Department of Microbiology,
Sri Krishna Medical College and Hospital, Muzaffarpur.
E-mail: drshashikishore@gmail.com
DOI: 10.18410/jebmh/2017/622

as pneumonia (most often related to endotracheal tubes or tracheostomies), endocarditis, meningitis, skin and wound infections, peritonitis (in patients receiving peritoneal dialysis) and urinary tract infections. They have been implicated in a variety of nosocomial infections including bacteraemia, urinary tract infections and secondary meningitis, but their predominant role is as agents of nosocomial pneumonia, particularly ventilator-associated pneumonia in patients confined to hospital intensive care units.[5]

The usages of medical devices, such as vascular catheters or endotracheal tube for airway failure become the most frequent sources of Acinetobacter infections.[6] A. baumannii causing a serious clinical problem in hospital-acquired infection, which is leading to an increased mortality with crude mortality rates parallel to those attributed to other gram-negative bacilli (28%-32%).[7] Acinetobacters are extremely difficult to treat because of the widespread resistance of these bacteria to major groups of antibiotics. Knowledge of the distribution of various species in relation to the variety of infection in hospital setup and their antimicrobial profile is of utmost importance for effective treatment of infection caused by the pathogen.[8,9] The information of this organism and antibiotic susceptibility pattern among hospitalised patients in Patna is hard to find. This study was designed to determine the prevalence of MDR- A. baumannii, its antibiotic susceptibility pattern and associated risk factors in hospitalised patients from a teaching hospital in Patna, Bihar.

MATERIALS AND METHODS

This is a hospital-based prospective study conducted over a duration of 1 year (August 2015 to July 2016) in the Department of Microbiology, IGIMS, Patna, a tertiary care centre of Bihar. Samples like pus/swab, urine, sputum, blood, tracheal aspirate, endotracheal tube, IV catheter tips and body fluids were collected from different inpatient wards and ICUs of both sexes and all age groups and transferred to laboratory without delay for further processing. All the samples were inoculated onto blood agar, MacConkey agar and incubated at 37°C for 24-48 hours. Urine was plated on to CLED medium. For the blood samples, brain heart infusion broth was used as a primary culture medium. All non-lactose fermenting colonies were subjected to Gram staining, oxidase test, hanging drop and catalase test. Gram-negative bacilli or coccobacilli that were oxidase negative, nonmotile and catalase positive were identified as Acinetobacter species.[10] Characterisation of the isolates was done using standard methods.[11] Antimicrobial susceptibility testing of the isolates were performed by the standard Kirby-Bauer's disc diffusion method with commercially available discs (Hi-Media, Mumbai) on Muller-Hinton Agar (MHA) plates and the zones of inhibition measured and interpreted for antibiotic sensitivity as per the Clinical Laboratory Standards Institute (CLSI) guidelines 2014.

The following standard antibiotic disks were placed on the MHA plate- ampicillin (10 mcg), amikacin (30 mcg), tobramycin (10 mcg), piperacillin/tazobactam (100/10 mcg), imipenem (10 mcg), meropenem (10 mcg), levofloxacin (5 mcg) and colistin (10 mcg). The results were further confirmed by using VITEK 2 Compact (Biomerieux, France). In the present study, MDR A. baumannii shall be defined as the isolate resistant to at least three classes of antimicrobial agents- All penicillins and cephalosporins (including inhibitor combinations), fluoroquinolones and aminoglycosides.[11] The categorical data and antimicrobial susceptibility were presented as number and percentage. The demographic data of the admitted patients were collected from medical records and was used to determine whether patient received antibiotics or high-risk medications (including chemotherapeutic agents, immunosuppressants and anti-inflammatory drugs) at least 24 hours before infection, duration of ICU stay, prior antibiotics use, site of infection and associated medical co-morbidities (including diabetes mellitus, chronic obstructive pulmonary disease, asthma, neurological impairment, congestive cardiac failure, end-stage renal disease, cancer, hepatitis and HIV). A healthcare-associated infection or nosocomial infection is defined as a localised or systemic condition resulting from an adverse reaction to the presence of an infectious agent (s) or its toxin (s) that was not present on admission to the hospital. An infection is considered as nosocomial if all the elements of a site-specific infection criterion of Centre of Disease Control and Prevention (CDC) were first present together on or after the third hospital day (day of hospital admission is day 1).[12] To explore risk factors for hospital-acquired infections caused by A. baumannii strains, bivariate analysis between infection and possible predictors were conducted using Pearson's x^2 test for independence (categorical variables) and simple logistic regression for continuous variables was done.

RESULTS

A total of 122 A. baumannii isolates were obtained from 2085 clinical samples processed. Among the 122 isolates obtained, predominant isolation was from the respiratory samples consisting of tracheal aspirates and sputum (43, 35.3%) followed by urine (33, 27.1%), pus (22, 18%), blood (15, 12.3%) and other samples (9, 7.4%). Majority of the isolates were from different inpatient departments 72 (59.02%), mostly from the surgical wards (38, 31.2%) followed by different ICUs 50 (40.9%). In general, the isolates showed high resistance to cell wall acting antibiotics like ampicillin (94.81%) and cephalosporins like cefazolin (86.79%) and ceftazidime (82.54%). They were also resistant to aminoglycosides like gentamicin (62.50%), amikacin (46.6%) and commonly used fluoroquinolones like ciprofloxacin (79.65%) and levofloxacin (68.52%) and to newer antibiotics like aztreonam (90.57%), doripenem (86.54%) and minocycline (45.90%). Most of the isolates were sensitive to polymyxin B (90.20%) and colistin showed 100% sensitivity. There were 74 (60.66%)

multidrug-resistant isolates, which were resistant to at least three different groups of antibiotics like penicillin and cephalosporins, aminoglycosides and fluoroquinolones. Most of the multidrug-resistant isolates were from different ICUs (45, 60.8%) followed by surgical wards (17, 22.97%) and they were isolated mainly from lower respiratory tract samples (40, 54.1%). We have analysed various factors that may be associated with healthcare associated MDR A. baumannii isolates and four of them have been identified with statistical significance (P <0.05). These risk factors are- (1) Admission in ICUs prior to infection; (2) Mean duration (days) stay in hospital prior to infection; (3) Respiratory infections; and (4) Antibiotics used prior to infection.

Clinical Samples	Number of Acinetobacter Isolates (n=122)	Number of MDR Isolates (n=74)
1. Respiratory isolates (tracheal aspirate + sputum)	43 (35.3%)	40 (54.1%)
2. Urine	33 (27.1%)	9 (12.2%)
3. Pus	22 (18.0%)	15 (20.3%)
4. Blood	15 (12.3%)	10 (13.5%)
5.Others (body fluids)	9 (7.4%)	0 (0%)

Table 1. Isolation of A. baumannii From Different Clinical Samples

Sources	Number of Isolates Percentage (n=122)	Number of MDR isolates Percentage (n=74)
ICUs	50 (40.9%)	45 (60.8%)
Surgical departments	38 (31.2%)	17 (22.97%)
Medicinal departments	34 (27.9%)	12 (16.22%)

Table 2. Source of A. baumannii Isolates

Months	Number of Cases (n=122)
January	6
February	8
March	9
April	16
May	15
June	10
July	8
August	7
September	8
October	16
November	11
December	8

Table 3. Seasonal Variations in A. baumannii Infections

	Growth at		Haemolysis	Gelatin Hydrolysis	Of Dextrose	Citrate	Arginine	Malonate	C
	37°C	44°C							
A. baumannii	+	+	-	-	+	+	+	+	-

Table 4. Acinetobacter Identification Scheme

Antibiotic	Sensitive Percentage	Resistant Percentage	Intermediate Percentage
Colistin	122 (100.0)	0	
Polymyxin B	46 (90.20)	5 (9.80)	
Tobramycin	32 (62.75)	19 (37.25)	
Imipenem	74 (61.67)	46 (38.33)	
Nitrofurantoin	20 (60.61)	13(39.39)	0
Amikacin	62 (53.4)	54 (46.65)	
Meropenem	58 (48.33)	62 (51.67)	
Minocycline	28 (45.90)	28 (45.90)	5 (8.20)
Piperacillin-Tazobactam	41 (42.71)	54 (56.25)	1 (1.04)
Gentamycin	32 (36.36)	55 (62.50)	1 (1.14)
Levofloxacin	15 (27.78)	37 (68.52)	2 (3.70)
Nalidixic acid	18 (25.71)	50 (71.43)	2 (2.86)
Ciprofloxacin	23 (20.35)	90 (79.65)	
Ofloxacin	11 (19.30)	44 (77.19)	2 (3.51)
Ceftazidime	11 (17.46)	52 (82.54)	
Doripenem	7 (13.46)	45 (86.54)	
Cefazolin	6 (11.32)	46 (86.79)	1 (1.89)
Aztreonam	5 (9.43)	48 (90.57)	
Ampicillin	3 (5.19)	73 (94.81)	

Table 5. Antibiotic Susceptibility Pattern of A. baumannii Isolates

Resistant to ampicillin/cephalosporins, amikacin/gentamicin and ciprofloxacin/ofloxacin	Yes, N (%)	No, N (%)	P-value
1. ICU Prior to infection			
Yes	68 (91.89%)	4 (8.33%)	< 0.05
No	6 (8.11%)	44 (91.67%)	
2. Mean (range) days of stay	28.45 (21 - 35)	4.5 (3 - 5)	<0.05
3. Respiratory infections	40 (54.1%)	3 (6.3%)	<0.05
4. Antibiotic used prior to infection			
Yes	67 (90.54%)	9 (18.75%)	<0.05
No	7 (9.46%)	39 (81.25%)	
Total	74 (60.66%)	48 (39.34%)	

Table 6. Factors Associated with Healthcare Associated Infection Caused by Multidrug Resistant Versus Susceptible A. baumannii

DISCUSSION

Acinetobacter is an important nosocomial pathogen with a rising prevalence of hospital-acquired infection.[13] Acinetobacter isolation from all infective samples was 5.85% (122 out of 2085) in our study indicating its importance as a nosocomial pathogen. The results also go with the study done by Suresh G Joshi et al in which they found an isolation rate of 9.5% from clinical samples from different inpatient departments.[14]

Most of the isolates were obtained from male patients 82 (67.2%), which is similar to others Indian studies showing slightly higher incidence in male compared to female patients.[14,15]

We found a seasonal variation of A. baumannii infections with higher rate of incidence during the months of April-May and October and lower rate in January, which may correlate with atmospheric temperature changes. Study done by Suresh J Joshi et al and Christie C et al also showed similar seasonal variations in incidence rates of Acinetobacter infections.[14,16]

In our present study, most of the patients belong to the age group of 16-65 years of age, which correlates with study done by Jean Uwingabiye et al showing most patients belonging to age group of 18-64 years[17] and study by Cucunawangsih et al.[18]

In the present study, most of the A. baumannii isolates were isolated from respiratory samples. Most of the respiratory samples were from ICUs. This may probably be related to the advanced invasive diagnostic and therapeutic procedures adopted in the present days ICUs as emphasised in various studies.[15,19] This result of the present study is similar to studies done by Jean Uwingabiye et al[17] and Rekha S et al[20] in which both the authors found respiratory samples as major source of A. baumannii isolates (44.67% and 73%, respectively). In their studies pus (12.47% and 12%, respectively) and blood samples (14.51% and 9%, respectively) are next to respiratory samples. In contrast to our study, study done by Muktikesh Dash et al found pus/swab samples (56.9%) to be the major source of Acinetobacter isolates.[21]

In the present study, 50 cases (41%) were from different ICUs and rest were from different wards in which surgical wards contribute for majority of them (38, 31.2%). This is almost similar to results of other studies done by Muktikesh et al (45.2% cases were from ICUs and 26.3% from surgical wards) and Rani S et al and Gupta N et al (47.14% and 38% cases were from ICUs, respectively).[22,23]

A. baumannii are notorious for their ability to acquire antibiotic resistance.[24] Antimicrobial resistance among this species has increased substantially in the past decade and has created a major public health dilemma. The most potent antibiotic drug class currently available are the carbapenems, but resistant strains have emerged.[25] Most of the patients who were admitted in our hospital had previously attended primary and secondary care hospitals and usually received combination of β-lactam antibiotics like second and third generation cephalosporins along with aminoglycoside or fluoroquinolones. Thus, majority of the isolates in our study were resistant to commonly used antibiotics. We found that polymyxin B and colistin were the most potent antibiotics against this pathogen with sensitivity of 90.5% and 100%, respectively. Other studies done by Muktikesh et al, Rani S et al and Shareek PS et al also showed a very high sensitivity of A. baumannii isolates to colistin (100%, 96.47% and 100%, respectively).[21,22,26]

Amikacin, ofloxacin, ciprofloxacin, meropenem and piperacillin-tazobactam were effective in some cases, although the resistance rates for these drugs were very high like 46.65%, 77.19%, 79.65%, 51.67%, 56.25%, respectively. In this study, maximum resistance was observed to ampicillin (94.81%), aztreonam (90.57%) and doripenem (86.54%). This result showed that A. baumannii isolates are now highly resistant to newer antibiotics also. In contrary to our study, studies done by Parween N et al, Goel N et al, Dash M et al and Tripathy et al reported also high resistance to amikacin, i.e. 88.95%, 87.2%, 61% and 55%, respectively.[27,19,21,28]

Carbapenems have been the drug of choice for treating Acinetobacter infections, but unfortunately, carbapenem-resistant Acinetobacter spp due to carbapenemase enzyme is becoming common worldwide. In our study, we found resistance to imipenem was 38.33%, which correlates with studies done by Tripathy C P et al (43%), Dash M et al (19%), Perween N et al (15.21%) and Rekha S et al (29.4%).[28,21,27,22]

In our study, 60.66% (74 out of 122) of the A. baumannii isolates were multidrug resistant. Different studies have found varying percentages of multidrug-resistant A. baumannii isolates (range=40-80%).[13,17,20] Most of the multidrug-resistant, A. baumannii isolates were isolated from ICUs (45, 60.8%) followed by surgical wards (17, 22.97%) and rest are from other inpatient wards (12, 16.2%). The difference in the prevalence of multidrug-resistant Acinetobacter-related infections between the ICUs and the other units was statistically significant ($p < 0.05$). Majority of the multidrug-resistant A. baumannii isolates were obtained from lower respiratory tract samples (40, 54.1%), followed by pus samples (15, 20.3%), blood (10, 13.5%) and urine (9, 12.2%). The results are similar to studies done by Jean Uwingabiye et al, Cucunawangsih et al and Rekha S et al in which they found respiratory samples or vascular catheters as the major source of multidrug-resistant Acinetobacter isolates and urine samples contributing the least.[17,18,20]

The high resistant pattern seen in our isolates maybe related to the selective pressure of extensive uses of third generation cephalosporins. It has been observed frequently that Acinetobacter spp. can develop resistance when the patient is on treatment. So, initially, the isolates may show a sensitive pattern, but subsequently may show resistance to the antibiotics they were previously susceptible.[1]

Carbapenems are frequently used as a last choice in treating serious infections caused by multidrug-resistant gram-negative bacilli.[19] In this study, 38.33%, 51.67% and 86.54% of A. baumannii isolates were resistant to imipenem, meropenem and doripenem, which correlates with observations made by other authors.[21,22,27] These findings suggest that carbapenems should be used judiciously in Acinetobacter infections especially in ICU patients to prevent any further increase in resistance to these group of drugs as in such instances the only available alternative antimicrobials for treatment are colistin, polymyxin B and tigecycline.[1] In the present study, we found that A. baumannii isolates were very highly susceptible to colistin and polymyxin B. In the view of increasing resistance to carbapenems, the study also highlights the need to test for the presence of carbapenemases routinely in the laboratory by the modified Hodge test.[29] Due to the high incidence of multidrug-resistance A. baumannii strains, proper antimicrobial treatment should be determined by their antimicrobial susceptibility pattern.[19]

Acinetobacter could be endogenous, fomite associated or airborne. Though the organism has developed multidrug resistance, it has largely remains susceptible to disinfectants and antiseptics.[1] Thus, the prevention involves aseptic care of vascular catheters and endotracheal tubes, proper disinfection of the surfaces with which the patient comes in contact and thorough hand hygiene of the healthcare workers.

CONCLUSION

The present study denotes high prevalence of multidrug-resistant A. baumannii isolates in ICU settings and wards which is emerging as a predominant pathogen in our hospital. Emergence of carbapenem resistance is an alarming situation. In case of multidrug-resistant Acinetobacter infections, colistin and polymyxin B are some of the antibiotics available for effective treatment of serious infections.

The result of the present study points to the facts that the length of hospital stay and antibiotic use prior to infection are significantly associated with increased risk of multidrug-resistant A. baumannii infections and that resistance was more common in respiratory tract as compared to other body sites.

To prevent the imminent threat of untreatable A. baumannii infections, a proper hospital antimicrobial policy and strict compliance to appropriate infection control practices are needed so that spread of such multidrug-resistant isolates in the hospital could be prevented.

REFERENCES

[1] Munoz-Price LS, Weinstein RA. Acinetobacter infection. N Engl J Med 2008;358(12):1271-1281.
[2] Visca P, Seifert H, Towner KJ. Acinetobacter infection--an emerging threat to human health. IUBMB Life 2011;63(12):1048-1054.
[3] Leung WS, Chu CM, Tsang KY, et al. Fulminant community- acquired Acinetobacter baumannii pneumonia as a distinct clinical syndrome. Chest 2006;129(1):102-109.
[4] Bailey & Scott's diagnostic microbiology. 13thedn. St. Louis Mosby: Elsvier 2014:329-334.
[5] Winn WC, Allen S, Janda W, et al. Konemancolor atlas and textbook of diagnostic microbiology.6thedn. Philadelphia: Lippincott William & Wilkins 2006: p. 354.
[6] Cisneros JM, Rodriguez-Bano J. Nosocomial bacteremia due to Acinetobacter baumannii: epidemiology, clinical features, and treatment. Clin Microbiol Infect 2002;8(11):687-693.
[7] Dijkshoorn L, Nemec A, Seifert H. An increasing threat in hospitals: multidrug-resistant Acinetobacter baumannii. Nat Rev Microbiol 2007;5(12):939-951.
[8] Bergogne-Berezin E, Towner KJ. Acinetobacter spp. as nosocomial pathogen: microbiological, clinical and epidemiological features. Clin Microbiol Rev 1996;9(2):148-165.
[9] Anupurba S, Sen MR. Antimicrobial resistance profile of bacterial isolates from intensive care unit: changing trends. J Commun Dis 2005;37(1):58-65.
[10] Gerner-Smidt P, Tjernberg I, Ursing J. Reliability of phenotypic tests for identification of Acinetobacter species. J Clin Microbiol 1991;29(2):277-282.
[11] Manchanda V, Sanchaita S, Singh N. Multidrug resistant Acinetobacter. J Glob Infect Dis 2010;2(3):291-304.

[12] Horan TC, Andrus M, Dudeck MA. CDC/NHSN surveillance definition of health care-associated infection and criteria for specific types of infections in the acute care setting. Am J Infect Control. 2008 Jun;36(5):309-32.
[13] Lahiri KK, Mani NS, Purai SS. Acinetobacter spp as nosocomial pathogen: clinical significance and antimicrobial sensitivity. Med J Armed Forces India 2004;60(1):7-10.
[14] Joshi SG, Litake GM, Satpute MG, et al. Clinical and demographic features of infections caused by Acinetobacter species. Indian J Med Sci 2006;60(9):351-360.
[15] Prashanth K, Badrinath S. Nosocomial infections due to Acinetobacter species: clinical findings, risk and prognostic factors. Indian J Med Microbial 2006;24(1):39-44.
[16] Christie C, Mazon D, Hierholzer W, et al. Molecular heterogeneity of Acinetobacter baumannii isolates during seasonal increase in prevalence. Infect Control Hosp Epidemiol 1995;16(10):590-594.
[17] Uwingabiye J, Frikh M, Lemnouer A, et al. Acinetobacter infections prevalence and frequency of the antibiotics resistance: comparative study of intensive care units versus other hospital units. Pan Afr Med J 2016;23:191.
[18] Cucunawangsih, Wiwing V, Lugito NPH. Antimicrobial susceptibility of multidrug-resistant Acinetobacter baumannii in a teaching hospital: a two year observation. Open Journal of Medical Microbiology 2015;5:85-89.
[19] Goel N, Choudhary U, Aggarwal R, et al. Antibiotic sensitivity pattern of gram-negative bacilli isolated from the lower respiratory tract of ventilated patients in the intensive care unit. Indian J Crit Care Med 2009;13(3):148-158.
[20] Rekha S, Gokol BN, Beena PM, et al. Multidrug resistant Acinetobacter isolates from patients admitted at Kolar. J Clin Biomed Sci 2011:(1):3-7.
[21] Dash M, Padhi S, Pattnaik S, et al. Frequency, risk factors, and antibiogram of Acinetobacter species isolated from various clinical samples in a tertiary care hospital in Odisha, India. Avicenna J Med 2013;3(4):97-102.
[22] Sahu R, Pradhan CS, Swain B, et al. Surveillance of Acinetobacter spp and drug sensitivity pattern in an Indian tertiary care teaching hospital. Int J Pharm Sci Rev Res 2016;39(1):203-207.
[23] Gupta N, Gandham N, Jadhav S, et al. Isolation and identification of Acinetobacter species with special reference to antibiotic resistance. J Nat Sci Biol Med 2015;6(1):159-162.
[24] Coelho JM, Turton JF, Kaufmann ME, et al. Occurrence of carbapenem-resistant Acinetobacter baumannii clones at multiple hospitals in London and southeast England. J Clin Microbiol 2006;44(10):3623-3627.
[25] Maragakis LL, Perl TM. Acinetobacter baumannii: epidemiology, antimicrobial resistance and treatment options. Clin Infect Dis 2008;46(8):1254-1263.
[26] Shareek PS, Sureshkumar D, Ramgopalakrishnan S, et al. Antibiotic sensitivity pattern of blood isolates of Acinetobacter species in a tertiary care hospital: a retrospective analysis. Am J Infect Dis 2012;8(1):65-69.
[27] Perween N, Sehgal S, Prakash SK. Geographical patterns in antimicrobial resistance of Acinetobacter in clinical isolates. J Clin Diagn Res 2014;8(4):10-12.
[28] Tripathi CP, Gajbhiye RS, Agarwal GN. Clinical and antimicrobial profile of Acinetobacter spp: an emerging nosocomial superbug. Adv Biomed Res 2014;3:13.
[29] CLSI. Performance standards for antimicrobial susceptibility testing; twenty-fourth informational supplement. CLSI document M100-S24. Wayne, PA: Clinical and Laboratory Standards Institute 2014.