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Antimicrobial Resistance among *Acinetobacter* species and Evaluation of Risk Factors

Raminder Sandhu[1*] and Kanwardeep Singh[2]

[1]Department of Microbiology, BPS Government Medical College for Women, Khanpur Kalan, Sonepat, Haryana, India.
[2]Department of Microbiology, Government Medical College, Amritsar, Punjab, India.

Authors' contributions

This work was carried out in collaboration between both authors. Author RS designed the study, wrote the protocol and the first draft of the manuscript. Author KS managed the literature searches, analyses of the study and performed the statistical analysis. Both authors read and approved the final manuscript.

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ABSTRACT

Background: *Acinetobacter* has gained importance as an emerging multi drug resistant nosocomial pathogen among non fermenting aerobic gram negative bacteria, especially in intensive care units. This organism is contributing to increased morbidity and mortality with strong propensity to colonize and disseminate among humans and environmental sources.
Materials and Methods: A retrospective observational study was conducted from February 2013 to December 2013. Various clinical specimens received in microbiology laboratory from inpatients and outpatients were studied including their antimicrobial resistance pattern. A total of 111 *Acinetobacter species* isolates were included in the study. Associated risk factors were recorded from the clinical data which included demographic characteristics of the patient along with the indoor department, period of stay in ICU and hospital, presence of indwelling devices, antimicrobial therapy, surgical interventions, focal or generalized infections and underlying chronic morbid diseases.

**Corresponding author: Email: sandhuraminder19@yahoo.com;*

Results: In current study maximum number of *Acinetobacter* was from urine specimen (57.66%) followed by blood (25.23%). Among inpatients highest percentage of isolates was recovered from general surgical ward (26.88%) followed by intensive care units (24.73%). The number of MDR & XDR isolates recovered was 21(18.92%) & 11(10%) respectively. Imipenem, Meropenem and Doxycycline remained efficacious drugs against *Acinetobacte*r infections with resistance rates of 18.02%, 30.63% and 36.94% respectively. The study revealed focal/generalized infections, indwelling devices, duration of stay in ICU & hospital, mechanical ventilation as significant risk factors in decreasing order for acquisition of MDR and XDR *Acinetobacter* but according to the statistical analysis only Diabetes mellitus was found to be significant (*p* value 0.019) whereas all other factors remained insignificant (*p* value > 0.05).

Conclusion: Prolonged usage of indwelling devices & medical equipments in critically ill patients along with longer duration of hospitalization can facilitate colonization and infection with *Acinetobacte*r which is otherwise a low virulence pathogen. Strict compliance of disinfection policy and infection control programme with rational use of antibiotics especially carbapenems in *Acinetobacte*r infections shall help in curtailing drug resistant strains from further dissemination.

Keywords: Acinetobacter species; multi drug resistant; risk factors; intensive care unit.

1. INTRODUCTION

Occurrence of multidrug resistant pathogens in hospital environment is increasing worldwide and limiting the therapeutic options for clinicians. Reason underlying development of resistance among pathogenic organisms against antibiotics may be non judicious and overuse of many antibiotics which has the roots in inherent inclination of clinicians towards prescribing the potent antibiotics [1]. *Acinetobacter* spp. is Gram Negative, strictly aerobic, non-fastidious, non-fermenting encapsulated coccobacilli causing mostly nosocomial infections. According to most recent scientific literature, *Acinetobacter* spp. are the second most common non fermenting Gram negative pathogen isolated from clinical samples after *Pseudomonas aeruginosa* [2]. There are many species in this genus, but only three species i.e. *A. baumanni, A. caloaceticus* and *A. lowffii* appear to be of clinical importance. These species have been included under the term *A. calcoacetius-A. baumanni complex* & are usually reported as *Acinetobacter*. The resistance mechanisms in Acinetobacter are multiple. They include production of beta-lactamases, alteration in cell wall channels and efflux pumps by which the organism becomes resistant to beta-lactam antibiotics; production of aminoglycoside modifying enzymes and mutations in genes gyrA and parC mediate resistance to aminoglycosides and quinolones respectively [3]. Interest in *Acinetobacter* spp. has been growing for the past 30 years. One of the main reasons for the present increased interest in this genus is the emergence of multiresistant strains, some of which are pan-resistant to antibiotics that suddenly cause an outbreak of infection involving several patients in a clinical unit. In hot and humid areas, e.g., in tropical countries, *Acinetobacter* infections can be community-acquired, and generally manifest as bacteremia or pulmonary infections. These bacteria have already been compared to methicillin-resistant *Staphylococcus aureus* (MRSA) and have even been termed the 'Gram negative MRSA' [4]. Infection is facilitated by the ability of the bacterium to colonize hospital equipment and to persist on inanimate surfaces for prolonged periods of time ranging from 3 days to 5 months, and *Acinetobacter* spp. can be detected on various equipments including bedrails, curtains, ventilation equipments (e.g. AMBU bags, Ventilation filter). Colonization of patients, health care workers and healthy individuals occurs frequently. Several virulence factors like lipases and Siderophores have been studied [5]. Quorum-sensing might be a central mechanism for auto induction of multiple virulence factors in an opportunistic pathogen such as *Acinetobacte*r, and this process should be studied for its clinical implications [4]. *Acinetobacter* spp. are important causes of device-related infections and urinary tract infections, but in recent years have also been isolated from bloodstream and other sites, and are notorious for resistance to Beta-lactam antibiotics. The spread of Multidrug resistant *Acinetobacter* strains among hospitalized patients has become an increasing cause of concern [6]. The advent of carbapenems in the 1980s heralded a new treatment option for serious bacterial infections. However resistance to carbapenems has been frequently observed in Gram negative bacilli such as *Pseudomonas aeruginosa* and *Acinetobacter baumanii*. The common form of resistance is mediated by lack

of drug penetration (i.e., porin mutations and efflux pumps) and/or carbapenem hydrolyzing betalactamase enzymes including the metallo betalactamases (MBL) [7,8]. Microbiology laboratories can provide frontline surveillance for antibiotic resistance and are therefore useful in combating nosocomial infections [9]. Rapid, accurate analysis of antimicrobial susceptibility will be useful in determining the precise use of antimicrobial agents. Hence, clinical input from a microbiologist is necessary to keep one step ahead in controlling nosocomial infections. Periodic surveillance by molecular typing of isolates from patients is recommended for early detection of an epidemic strain, which consequently serves as an effective control measure [10]. The present study was undertaken to focus on antimicrobial resistance pattern of *Acinetobacter species* isolated from various clinical specimens of patients admitted and attending the various clinical departments of a tertiary care institute and evaluation of associated risk factors for acquisition of these pathogens, in the advent of rapidly emerging multi drug resistant isolates of *Acinetobacter* species worldwide.

2. MATERIALS AND METHODS

2.1 Study Design

A retrospective observational study was conducted from February 2013 to December 2013. Purulent wound and skin ulcer samples, blood, urine, tracheal aspirate, BAL fluid, pleural fluid, sputum, endotracheal tube tip and intravenous catheter tip samples collected from patients admitted in various wards, intensive care units as well as outdoor departments of a tertiary care institute of North-West India, were considered to be eligible.

2.2 Identification and Antimicrobial Susceptibility Testing

Various samples received in microbiology laboratory were inoculated on blood agar and MacConkey agar and incubated at 37ºC as per standard operative guidelines. After 24 hours of incubation, non-lactose fermenting gram negative cocco-bacilli which were Catalase positive, oxidase negative, and produced an alkaline reaction on Triple Sugar Iron Agar were provisionally considered to be NFGNB. Colonies of *Acinetobacter* spp. on Blood Agar were cream colored with no pigmentation and on MacConkey agar showed a pinkish tint. Further identification and confirmation of *Acinetobacter* spp. was done using bio-chemical tests as per standard operating procedures which included hanging drop preparation, utilization of 10% glucose with Oxidation-Fermentation medium and citrate utilization test. Isolates of *Acinetobacter* spp. were differentiated from other oxidase negative, non motile, non fermenting bacilli like *Bordetella holmesii* and CDC group1 by nitrate reduction test and urease test [11]. Susceptibility testing of *Acinetobacter* isolates for various antimicrobials was performed by Kirby Bauer disk diffusion method [12]. The test organism was picked up with the a sterile loop, suspended in peptone water and kept for incubation at 37ºC for 2 hours. The turbidity of the suspension was adjusted to 0.5 McFarland's standard. Then the adjusted suspension was spread on the surface of a Mueller's-Hinton agar plate with a sterile cotton swab. The following antibiotic discs were then placed on the Mueller Hinton agar plate: Cotrimoxazole (25 µg), Cefuroxime (30 µg), Cefepime (30 µg), Ciprofloxacin (5 µg), Gentamicin (10 µg), Amikacin (30 µg), Doxycycline (30 µg), Imipenem (10 µg), and Meropenem (10 µg), Ampicillin-Sulbactam (10/10 µg). In addition Nitrofurantoin (300 µg) was used exclusively in urine samples. All dehydrated media and antibiotic disks were procured from HiMedia Labs Ltd (Mumbai India). The sensitivity and resistance of isolates was reported as per Clinical and Laboratory Standard Institute guidelines [13]. Multi drug resistant (MDR) isolates were defined as those which depicted resistance to Penicillins & cephalosporins, beta-lactamase inhibitors, aminoglycosides and fluoroquinolones and extensively drug resistant (XDR) isolates were those which remained resistant to carbapenems apart from resistance to penicillins & cephalosporins, beta- lactamase inhibitors, aminoglycosides and fluoroquinolones [14].

2.3 Clinical Data

Associated risk factors were recorded from the clinical data which included demographic characteristics of the patient along with the indoor department, provisional diagnosis, period of stay in ICU, duration of stay in the hospital, presence of indwelling devices (include central line catheters, mechanical ventilators, urinary catheters, nasogastric tubes), antimicrobial therapy, surgical intervention ,underlying chronic diseases (Diabetes mellitus, carcinoma, granulocytopenia, chronic renal failure),focal or generalized infections (skin and soft tissue infections, ventilator associated pneumonia,

wound infections, endocarditis, urinary tract infections, blood stream infections, osteomyelitis, intra-abdominal infections, meningitis).

2.4 Statistical Analysis

All data were analyzed using the computerized statistical analysis (SPSS, version 17). P value <0.05 was considered statistically significant

3. RESULTS

A total of 111 *Acinetobacter* spp. were isolated from various samples including blood (28), urine (64), purulent wound samples (7), endotracheal tube aspirate (6), bronchoalveolar lavage fluid (2), pleural fluid (3), and sputum (1). Out of 111 isolates, 93 (83.78%) were from inpatients and remaining 18 (16.22%) from patients attending various outdoor departments as shown in Table 1. As regards the specimen, highest number of isolates were recovered from urine 64 (57.66%), followed by blood 28 (25.23%), purulent wound samples 7(6.31%), endotracheal aspirates 3(2.70%), endotracheal tube tip 3(2.70%), pleural fluid 3(2.70%), BAL fluid 2(1.80%). Among inpatients most of the isolates were obtained from surgical ward 25 (26.88%), followed by intensive care units which included MICU 6(6.45%), SICU 4(4.30%) and NICU 13(13.98%) whereas lowest number of isolates from orthopedics ward 2(2.15%) & respiratory medicine ward 4(4.30%) as shown in Table 2. Majority of isolates depicted high resistance to Cefuroxime (90.09%), Nitrofurantoin (79.69%), Cotrimoxazole (75.68%), Ciprofloxacin (69.37%), Gentamicin (63.06%) and Cefepime (61.26%), Ampicillin/Sulbactam (54.95%) whereas lower rate of resistance was shown against Amikacin (41.44%) and Doxycycline (36.94%). Among carbapenems, Imipenem followed by Meropenem remained most efficacious against *Acinetobacter* spp. with resistance rates of 18.02% and 30.63% as shown in Table 3. In the present study MDR and XDR isolates were 21 (18.92%) and 11 (10%) respectively, out of which highest number was recovered from urine samples (MDR 12 & XDR 7), followed by blood (MDR 4 & XDR 2) and endotracheal tube tip samples (MDR 2& XDR 2) as shown in Table 4. Assessment of risk factors for infection with MDR (multi drug resistant) & XDR (Extensively drug resistant) *Acinetobacter* species, reflected highest risk for those who were suffering from focal/generalized infections (MDR 85.71%; XDR 72.73%; *P =0.371*), patients with indwelling devices (MDR 76.19%; XDR 54.55%; *P =0.210*), followed by prolonged stay in ICU ≥5 days (MDR 61.90%; XDR 63.64%; *P =0.923*); hospital ≥7 days (MDR 61.90%; XDR 54.55%; *P =0.687*) and surgical intervention (MDR 61.90%; XDR 72.73%; *P =0.540*) as shown in Table 5. Antibiotic administration as a risk factor variable, indicated that highest risk was involved with intake of combination therapy (47.62%) (Aminoglycosides, fluoroquinolones, beta lactams and carbapenems) as regards MDR isolates whereas for XDR isolates risk remained similar with usage of aminoglycosides (27.27%), fluoroquinolones (27.27%) and combination therapy (27.27%) followed by beta –lactams (18.18%) as mentioned in Table 5 and statistical analysis depicted *P =0.685* which was not significant .

Table 1. Distribution of *Acinetobacter* isolates in various clinical specimens

Specimen	Isolates (% age)	In patients	Out patients
Blood	28(25.23)	27	01
Urine	6457.66)	47	17
Purulent wounds	7(6.31)	7	0
Endotracheal aspirate	3(2.70)	3	0
Endotracheal tube tip	3(2.70)	3	0
BAL fluid	2(1.80)	2	0
Pleural fluid	3(2.70)	3	0
Sputum	01(0.90)	1	0
Total	111	93	18

Table 2. Profile of *Acinetobacter* isolates among inpatients

Department	Number of isolates	Percentage
MICU	6	6.45%
SICU	4	4.30%
NICU	13	13.98%
General medicine	10	10.75%
General surgery	25	26.88%
Gynae/obstetrics	20	21.51%
Pediatrics	9	9.68%
Orthopedics	2	2.15%
Respiratory medicine	4	4.30%
Total	93	100

4. DISCUSSION

In health care centers, patients of various ages stand a higher chance for development of an infection. Various invasive procedure and devices, drugs that suppress the immune system, increased use of blood products and inhalation therapy add to the potential threat [15].

Besides this, uses of poor aseptic protocols by health care service providers also increase the risk of infections [16]. In the present study, majority of *Acinetobacter* isolates 93 (83.78%) were from inpatients and remaining 18 (16.22%) from outdoor patients, supporting the survival of pathogen in hospital settings. These findings are similar to those of Dash M et al. 2013 and Park SY et al. 2013 who also reported 124 (90.5%) and 114 (92.68%) isolates as nosocomial while 13 (9.5%) and 9(7.32%) community acquired [17,18]. In current study maximum number of isolates were from urine specimen 64(57.66%) which is similar to Lahiri KK et al. [19] who reported 51.97% isolates from urine sample [19]. Blood 28(25.23%), remained the second important specimen, followed by purulent wound 7(6.31%), endotracheal tube tip 4 (3.60%) and pleural fluid 3(2.70%) for isolation of *Acinetobacter* spp. Interpreting the significance of these isolates from clinical specimens is often difficult, because of the wide distribution of Acinetobacter in nature and its ability to colonize healthy or damaged tissue. Upto 25% of healthy ambulatory adults exhibit cutaneous colonization and are the most common Gram negative bacilli carried on the skin of hospital personnel [19]. The infections were more frequent in the surgical unit 25(26.88%) that is in concordance with findings of Dash M et al 2014 who quoted 26.3% of infections in surgical unit, followed by ICU (including MICU, SICU & NICU) 23 (24.73%) which was similar to findings of Mohammadtaheri Z et al. 2010 who reported 22.4% of *Acinetobacter* spp. from ICU [17,20]. Out of 111 isolates, 21 (18.92%) were MDR which is similar to findings of Bhattacharya S et al. [21] who observed 29% of isolates to be MDR whereas Sivaranjani V et al. [22], and Shrivastva G et al. [23] mentioned 71.31% and 3.6% MDR isolates respectively. This wide variation can be due to interplay of factors which include the underlying condition of patients, compliance of infection control programs, type of strains along with antibiotic resistance pattern that is effective in increasing their survival in the environment and further colonization of the patients. In our study highest number of MDR isolates were obtained from urine (57.1%), followed by blood (19%), and endotracheal tube tip (9.5%) whereas Sivaranjani V et al. [22] isolated maximum from pus samples (38.52%), followed by endotracheal aspirates (20.49%) and urine (19.67%). The sites of MDR *Acinetobacter* isolation in surgical patients mentioned by Dent et al. [24] was from sputum (31%), urine (16%), extremity wounds (13%), blood (10%) and CVP catheter (9%). In our hospital setting urine samples were received predominantly as compared to respiratory secretions, hence the high number *Acinetobacter spp* isolated from this particular specimen. The number of XDR isolates was 11(10%) as analyzed from antimicrobial susceptibility pattern which were low in comparison to study done in Iran by Hossein Fazeli el al. [25] in which 60 (86.95%) isolates of *Acinetobacter* were XDR. Presence of focal or generalized infection (MDR 85.71%; XDR 72.73%), indwelling devices (MDR 76.19%; XDR 54.55%), duration of stay in ICU ≥5 days (MDR 61.90%; XDR 63.64%), prolonged stay in hospital ≥7 days (MDR 61.90%; XDR 54.55%) and surgical intervention (MDR 61.90%; XDR 72.73%) were the risk factors in decreasing order for acquisition of infection with multidrug resistant and extensively drug resistant *Acinetobacter* species. These findings were statistically insignificant with *P>0.05*. These risk factors have been documented by other workers as well [24,26,27]. These factors might be portraying severity of underlying conditions & accompanied focal or generalized infections that required critical care with usage of indwelling devices and surgical interventions. The present study identified indwelling devices as a potential source for infection with *Acinetobacter* spp. The standard protocol is removal of these indwelling devices following an episode of gram negative bacteremia but compliance to this could not be assessed as a limitation of retrospective study. Antibiotic administration as a risk factor for acquiring MDR infections depicted highest risk with combination therapy 47.62% (aminoglycosides, fluoroquinolones, beta-lactams and carbapenems) whereas for XDR infection risk remained similar with usage of aminoglycosides (27.27%), fluoroquinolones (27.27%) & combination therapy (27.27%). Underlying morbid conditions such as Diabetes mellitus (36.36%) remained significant risk factor for acquisition of XDR organisms ($p < 0.05$) whereas neutropenia (9.09%) remained insignificant as risk factor for XDR pathogens. Wareham et al. 2008 , Jung et al. 2010, Zakuan Zainy Deris et al. 2009 mentioned Diabetes mellitus as co-morbidity factor for *Acinetobacter* blood stream infection in 1.9% ,29.6% and 10.3% cases respectively [28-30]. Hsieh TC et al. [31] reported Diabetes mellitus as a risk factor for pneumonia and airway colonization to be 45.6%; 47.5% in extensively drug-resistant *Acinetobacter baumanii* (XDRAB). In clinical practice, *Acinetobacter* infections are associated closely with surgery or the use of artificial devices. Patients become infected following

initial colonization. This process is influenced by various risk-factors, particularly in ICUs, where multiple manipulations following surgery, as well as the use of endotracheal tubes and intravascular, ventricular or urinary catheters, can result in colonization by opportunistic bacteria such as *Acinetobacter*. The presence and duration of invasive procedures, as well as exposure to broad-spectrum antibiotics, have been identified as risk-factors for acquisition of *Acinetobacter* in numerous studies. As *Acinetobacter* is often transmitted via the hands of hospital staff, the care workload score, 'the omega score', could serve as a good marker for estimating the importance of these risk-factors [4]. *Acinetobacter* spp. isolates remained highly resistant to Cefuroxime (90.09%), Cotrimoxazole (75.68%), Ciprofloxacin (69.37%), Cefepime (61.26%), Gentamicin (63.06%) and Ampicillin/Sulbactam (54.95%). High resistance pattern depicted to these antibiotics by the isolates may be related to selective pressure of extensive usage of these agents in our hospital settings. Urinary isolates remained highly resistant to Nitrofurantoin (79.69%) which is similar to study done by Sanjeev H et al. [32] who reported 87% nitrofurantoin resistant isolates. As regards treatment of infection with *Acinetobacter spp.* is concerned attempt must be made to distinguish colonization from frank clinical signs and symptoms before initiation of antimicrobial therapy. The present study revealed Imipenem to be the most potent antibiotic in vitro against *Acinetobacter* spp. infections with low resistance rate of 18.02% which is comparable with findings of other workers [17,21,22,33]. Other antibiotics which exhibited efficacy in vitro were Meropenem and Doxycycline with resistance of 30.63% & 36.94% respectively. The growing menace of carbapenems resistance is a serious concern as it may limit therapeutic options. Antibiotic usage in ICUs whether needed or not in sepsis and pneumonias may be guided by the estimation of procalcitonin levels which is highly specific for bacterial sepsis [34]. Reducing intrinsic contamination and colonization of medical equipment or devices used for monitoring and therapy of patients, and decreasing contamination through airborne or direct contact with patients must be the primary measure used to control the infection of MDR *Acinetobacter* in the ICU. Furthermore, attention to various guidelines for the use of care bundles in critical care, such as ventilator bundles, central line bundles, and severe sepsis bundles is important for the prevention of bacteremia in clinical practice, especially for patients colonized with MDR *Acinetobacter*. Moreover, efforts to remove invasive devices and equipment such as endotracheal tube or central venous catheter as soon as possible are needed to prevent development of MDR *Acinetobacter* bacteremia among the colonized patients [29]. There are few limitations of the present study. First of all study was retrospective observational, so inclusion and exclusion criteria could not be laid out uniformly. Secondly active surveillance culture for presence of *Acinetobacter* spp. was not routinely carried out during stay in ICU. Thirdly resistance to antibiotics could not be ascertained by determining minimum inhibitory concentration (MIC) for the drugs tested.

Table 3. Antibiogram of *Acinetobacter* isolates

Antibiotic	Sensitive (% age)	Intermediate (% age)	Resistant (% age)
Cotrimoxazole	27 (24.32)	0	84(75.68)
Cefuroxime	11(9.91)	0	100(90.09)
Cefepime	33(38.74)	0	68(61.26)
Ciprofloxacin	34(30.63)	0	77(69.37)
Gentamicin	41(36.94)	0	70(63.06)
Amikacin	65(58.56)	0	46(41.44)
Doxycycline	70(63.06)	0	31(36.94)
Imipenem	85(76.58)	6(5.41)	20(18.02)
Meropenem	71(63.96)	6(5.41)	24(30.63)
Ampicillin /Sulbactam	50(45.05)	0	61(54.95)
Nitrofurantoin	12(18.75)	1(1.56)	51(79.69)

Table 4. Specimen-wise distribution of multidrug and extensively drug resistant *Acinetobacter* isolates

Specimens	MDR isolates	Non-MDR isolates	XDR isolates
Blood	04(19.0%)	22	02(18.18%)
Urine	12(57.1%)	45	07(63.64%)
Purulent fluid	01(4.8%)	06	00(00)
ET aspirate	01(4.8%)	01	00(00)
ET tip	02(9.5%)	00	02(18.18%)
BAL fluid	00 (00)	02	00(00)
Pleural fluid	00(00)	03	00(00)
Sputum	01(4.8%)	00	00(00)
Total	21	79	11

Table 5. Associated risk factors for MDR & XDR *Acinetobacter* isolates

Risk factors	MDR isolates n=21	XDR isolates n=11	*Chi square*(X^2)	*P* value	Significance
1.Indwelling devices					
a. Arterial/urinary catheter	16(76.19%)	6(54.55%)	1.57	0.210	NS**
b.No indwelling device	5(23.80%)	5(45.45%)			
2.Duration of stay in ICU					
a. ≥5 days	13(61.90%)	7(63.64%)	0.009	0.923	NS
b. ≤5 days	8(38.10)	4(36.36%)			
3. Duration of stay in hospital					
a. ≥7 days	13 (61.90%)	6 (54.55%)	0.162	0.687	NS
b. ≤7 days	8(38.10)	5 (45.45%)			
4.Mechanical ventilation					
a. Yes	6(28.57%)	3(27.27%)	0.006	0.938	NS
b.No	15 (71.43%)	8 (72.73%)			
5. Neutropenia/ Granulocytopenia					
a. Present	0(00)	1(9.10%)	1.971	0.160	NS
b. Not seen	21(100%)	10 (90.91%)			
6. Diabetic mellitus					
a. Diabetic	1(4.76%)	4(36.36%)	5.468	0.019	S***
b.Non- diabetic	20 (95.24%)	7(63.64%)			
7. Surgical intervention					
a. Yes	13(61.90%)	8(72.73%)	0.375	0.540	NS
b. No	8 (38.10%)	3(27.27%)			
8. Antibiotic administration					
a.Aminoglycosides	3(14.28%)	3 (27.27%)	1.490	0.685	NS
b.Fluoroquinolones	5 (23.81%)	3 (27.27%)			
c.Beta- lactams	3 (14.28%)	2 (18.18%)			
d.Combinations	10 (47.62%)	3 (27.27%)			
9.Focal /Generalized infection*					
a. Present	18 (85.71%)	8 (72.73%)	0.799	0.371	NS
b.Absent	3 (14.29%)	3 (27.27%)			
Total	21	11			

Focal/generalized infections include skin and soft tissue infections, ventilator associated pneumonia, wound infections, endocarditis, urinary tract infections, blood stream infections, osteomyelitis, intra-abdominal infections, meningitis;Not significant;*** Significant*

5. CONCLUSION

The present study concludes that early removal of various indwelling devices and life saving equipments in patients admitted to ICUs can curtail colonization and further infection with MDR and XDR *Acinetobacter* isolates. As acquisition of MDR pathogens prolongs the duration of stay in hospital settings that adds to health care cost. Moreover *Acinetobacter* spp. are robust survivors with great propensity to disseminate and colonize human as well as environmental surfaces as they can withstand desiccation. Microbiological surveillance can

serve as an important tool in combating the further dissemination of these MDR and XDR isolates. MDR and XDR *Acinetobacter* spp. is an emerging threat in hospital settings along with their growing resistance to carbapenems worldwide. The present study reflected lower prevalence of MDR & XDR *Acinetobacter* isolates, with low resistance to carbapenems which may be because of compliance of infection control programmes and more prudent use of these agents in our institute. At present remaining alternate therapeutic options include Colistin, Polymyxin B and Tigecycline but these have dreaded complications. Under such circumstances constant monitoring of resistant pathogens, strict compliance to infection control practices by heath care workers and evaluation of risk factors responsible for harboring these pathogens shall go a long way in combating war against them.

CONSENT

It is not applicable.

ETHICAL APPROVAL

The Ethical Committee of our institute deals only with the research projects approved by the Government of India .Moreover the present study in a retrospective observational study in which neither the name nor the photograph of the patient was mentioned. Hence it is hereby declared that all the experiments have been performed in accordance with the ethical standards laid down in the Declaration of Helsinki, 1964.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Tiwari P, Kaur S. Profile and sensitivity pattern of bacteria isolated from various cultures in a tertiary care hospital in Delhi. Indian J Public Health. 2010;54(4):213-15. DOI:10.4103/0019-557X.77264. [PMID: 21372371].
2. Gautam V, Singhal L, Ray P. Burkholderia cepacia complex: Beyond Pseudomonas and Acinetobacter. Ind J Med Microbiol. 2011;29:4-12. DOI:10.4103/0255 0857.76516. [PMID: 21304187].
3. Munoz-Price LS, Winstein RA. Acinetobacter infection. N Engl J Med. 2008;358(12):1271-81. DOI:10.1056/NEJMra070741] [PMID:18354105].
4. Joly-Guillou ML. Clinical impact and pathogenicity of *Acinetobacter*. Clin Microbiol Infect. 2005;11:868–73. [PMID:16216100]
5. Govan JRW. Pseudomonas and Non-fermenters. In: Greenwood D, Slack R, Peutherer J, Barer M, editors. Medical Microbiology. A Guide to Microbial infections: Pathogenesis, Immunity, Laboratory Diagnosis and Control. Churchill Livingstone Elsevier: 17th ed. London. 2007;298.
6. Dijkshoorn L, Nemec A, Seifert H. An increasing threat in hospitals: multi-drug resistant *Acinetobacter baumannii*. Nat Rev Microbiol. 2007;5(12):939-51. DOI:10.1038/nrmicro1789. [PMID:18007677]
7. Hemalatha V, Sekar U, Kamat V. Detection of metallo betalactamases producing *Pseudomonas aeruginosa* in hospitalized patients. Indian J Med Res. 2005;122:148-52. [PMID:16177473].
8. Walsh TR, Toleman MA, Poirel L, Nordmann P. Metallo-β- Lactamases: The quiet before the storm? Clin Microbiol Rev. 2005;18(2):306-25. DOI: 10.1128/CMR.18.2.306-325.2005. [PMID:16177473]
9. Hawkey P. The enemy within: Hospital-acquired, antibiotic resistant bacteria. Microbiol Today. 2001;28:7-9.
10. Wu TL, Ma L, Chang JC, Su LH, Chu C, Leu HS et al. Variable resistance patterns of integron-associated multidrug- resistant *Acinetobacter baumannii* isolates in a surgical intensive care unit. Microb Drug Resist. 2004;10(4):292-99. DOI:10.1089/mdr.2004.10.292. [PMID:15650373].
11. Collee JG, Miles RS, Watt B. Tests for the identification of bacteria. In: Collee JG, Fraser AG, Marmion BP, Simmons A (eds). Mackie and McCartney practical medical microbiology. 14th edn. Edinburgh: Churchill Livingstone. 1996;131–52.
12. Bauer AW, Kirby WM, Sherris JC, Turck M. Antibiotic susceptibility testing by a standardized single disc method. American Journal of Clinical Pathology. 1966;45: 493–496. [PMID: 5325707].

13. Clinical and Laboratory Standards Institute. Performance standards for antimicrobial susceptibility testing; 22nd informational supplement. CLSI Document M-100 S22. Wayne, Pennsylvania. Clinical and Laboratory Standards Institute. 2012;32(3).
14. Manchanda V, Sanchaita S, Singh NP. Multidrug resistant *Acinetobacter*. J Glob Infect Dis. 2010;2(3):291-304. DOI: 10.4103/0974-777X.68538. [PMCID: PMC2946687].
15. Geffers C, Sohr D, Gastmeier P. Mortality attribute to hospital acquired infections among surgical patients. Infect Control Hosp Epidemiol. 2008;29(12):1167–70. DOI: 10.1086/592410] [PMID:19014317.
16. Aranaz-Andrés JM, Aibar-Remón C, Vitaller-Murillo J, Ruiz- Lopez P, Limon-Ramirez R, Terol-Garcia E, et al. Incidence of adverse events related to health care in Spain: results of the Spanish National Study of Adverse Events. J Epidemiol Community Health. 2008;62(12):1022–29. DOI: 10.1136/jech.2007.065227. [PMID:19008366].
17. Dash M, Padhi S, Pattnaik S, Mohanty I, Misra P. 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. DOI:10.4103/2231-0770.120501. [PMID:24327968].
18. Park SY, Choo JW, Kwon SH, et al. Risk Factors for Mortality in Patients with *Acinetobacter baumannii* Bacteremia. Infect Chemother 2013;45(3):325-330. DOI: 10.3947/ic.2013.45.3.325.
19. Lahiri KK, Mani NS, Purai SS. *Acinetobacter* spp. as Nosocomial Pathogen. Clinical Significance and Antimicrobial Sensitivity. MJAF. 2004;60(1):7-10.
20. Mohammadtaheri Z, Pourpaki M, Mohammadi F, Namdar R, Masjedi MR. Surveillance of antimicrobial susceptibility among bacterial isolates from intensive care unit patients of a tertiary care university hospital in Iran: 2006-2009. Chemotherapy. 2010;56(6):478-84. DOI: 10.1159/000321032. [PMID:21099220].
21. Bhattacharyya S, Bhattacharyya I, Rit K, Mukhopadhyay PK, Dey JB, Ganguly U, et al. Antibiogram of *Acinetobacter* spp. isolated from various clinical specimens in a tertiary care hospital in West Bengal, India. Biomed Res. 2013;24(1):43-46.
22. Sivaranjani V, Umadevi S, Srirangaraj S, Kali A, Seetha KS. Multi drug resistant Acinetobacter species from various clinical samples in a tertiary care hospital from South India. AMJ. 2013;6(12):697-700. DOI:10.4066/AMJ.2013.1901. [PMID:24391681].
23. Shrivastava G, Bhatambare GS, Bajpai T, Patel KB. Sensitivity profile of multidrug resistant *Acinetobacter* spp. isolated at ICUs of tertiary care hospital. Int J Health Syst Disaster Manage. 2013;1:200-3. DOI: 10.4103/2347-9019.130731.
24. Dent LL, Marshall DR, Pratap S, Hulette RB. Multidrug resistant *Acinetobacter baumannii*: A descriptive study in a city hospital. BMC Infect Dis. 2010;10:196. DOI:10.1186/1471-2334-10-196. PMCID: PMC2909240].
25. Hossein Fazeli, Tahere Motallebi Rad, Bahram Nasr Esfahani, Arezoo Pourdad, Mojtaba Akbari. Risk factors and prevalence of high resistant *Acinetobacter* spp. among hospitalized patients. J Res Med Sci. 2014; 19(5):480–81. [PMCID: PMC4116585].
26. Lone R, Shah A, Kadri SM, Lone S, Faisal S. Nosocomial Multi-Drug-Resistant *Acinetobacter* Infections – Clinical Findings, Risk Factors and Demographic Characteristics. Bangladesh J Med Microbiol. 2009;3:34-8.
27. Agoda A, Zarrelli R, Barllitta M, Anzaldi A, Di Popolo A, Mattaliano A, et al. Alert surveillance of intensive care unit acquired *Acinetobacter* infection in a Sicillian hospital. Clin Microbiol Infect. 2006; 12(3):241-7. [PMID:16451411]
28. Wareham DW, Bean DC, Khanna P, Hennessy EM, Krahe D, Ely A, Millar M. Bloodstream infection due to *Acinetobacter* spp: epidemiology, risk factors and impact of multi-drug resistance. Eur J Clin Microbiol Infect Dis. 2008;27(7):607-12. DOI: 10.1007/s10096-008-0473-y. [Epub 2008 Feb 19].
29. Jung, et al. Risk factors for multi-drug resistant *Acinetobacter baumannii* bacteremia in patients with colonization in the intensive care unit. BMC Infectious Diseases. 2010;10:228. DOI: 10.1186/1471-2334-10-228.
30. Zakuan Zainy Deris, Azian Harun, Mahamarowi Omar, Md Radzi Johari. The prevalence and risk factors of nosocomial

Acinetobacter blood stream infections in tertiary teaching hospital in north-eastern Malaysia. Tropical Biomedicine. 2009; 26(2):123–129.

31. Hsieh T-C, et al. Role of aerosolized colistin methanesulfonate therapy for extensively-drug-resistant *Acinetobacter baumannii* complex pneumonia and airway colonization.J Microbiol Immunol Infect 2014 Oct31.piiS1684-1182 (14) 001789-9. DOI:10.1016/j.jmii.2014.08.009. [Epub Ahead of print].
32. Sanjeev H, Swathi N, Asha Pai, Rekha R, Vimal K, Ganesh HR. Systematic review of urinary tract infection caused by *Acinetobacter* species among hospitalized patients .NUJHS. 2013;3(4):7-9.
33. Lautenbach E, Synnestvedt M, Weiner MG, Bilker WB, Vo L, Schein J, et al. Epidemiology and impact of imipenem resistance in *Acinetobacter baumannii*. Infect Control Hosp Epidemiol. 2009; 30(12):1186-92. DOI: 10.1086/648450. [PMID:19860563].
34. Rekha S, Gokul BN. Beena PM, Prasad SR. Multidrug resistant *Acinetobacter* Isolates from patients admitted at Kolar. J Clin Biomed Sci. 2011;1(1):3-7.

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