Original Article

Pan-resistant *Acinetobacter* infection in neonates in Karachi, Pakistan

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Abstract

Background: Pan-resistant *Acinetobacter* infection has emerged as an important nosocomial pathogen in our inpatient neonates over the past few years.

Methodology: We performed a retrospective chart review during a five-year period (July 2003 – June 2008) of all neonates hospitalized in our neonatal intensive care unit (NICU) who developed *Acinetobacter* infection to identify mortality-associated risk factors in *Acinetobacter* neonatal infection.

Results: During the five-year study period, 122 cultures from 78 neonates grew *Acinetobacter*. Source sites of positive culture were in the following descending order: blood (n = 57), trachea (n = 55), tissue/wound/body fluids (n = 4), eye (n = 4), urine (n = 1), and cerebrospinal fluid (n = 1). Twenty-four (31%) patients had *Acinetobacter* isolated from more than one site. At the time of admission the mean age was 2.08 ± 4 days and mean weight was 1.77 ± 0.88 kg; 75% were premature. Pan-resistance (87/122; sensitive only to Polymyxin) was present in 71% of *Acinetobacter* isolates. Crude mortality rate of this cohort was 47%, while 70% of patients died within four days after positive *Acinetobacter* culture. We identified weight of less than 1 kg on admission (p 0.06, adjusted Odds Ratio (AOR) 1.53), gestational age 28 weeks or less (p 0.011, AOR 2.88), poor perfusion (p 0.007, AOR 2.4), thrombocytopenia (p 0.01; AOR 1.6) and metabolic acidosis (p 0.01; AOR 1.67) as predictors associated with poor outcome.

Conclusion: Pan-resistant *Acinetobacter* infection is exceedingly fatal in newborns, particularly in premature and very low-birth weight neonates. Rational antibiotic use and vigilant infection control in NICUs are key to controlling multi-drug resistant *Acinetobacter* infection and improving clinical outcome.

Keywords: Acinetobacter infection, neonate, mortality risk factors

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Introduction

Acinetobacter has emerged as an important nosocomial organism causing infectious outbreaks in critically ill patients leading to high mortality and morbidity [1,2]. It has become one of the top seven pathogens threatening the current health care delivery system, particularly the intensive care setting [3]. Because of its remarkable ability to colonize patients and the nosocomial environment, it causes hospital outbreaks due to cross-transmission between patients [4]. It is associated with ventilator acquired pneumonia (VAP), blood stream infection (BSI), urinary tract infection (UTI) and central nervous system (CNS) infection in neonates.

Acinetobacter spp. has become one of the greatest threats for our current health care system because of its resistance to most known drugs. It has emerged as a multi-drug resistant (MDR) organism moving towards pan-resistance [5]. In general *Acinetobacter* is considered as an organism with low virulence but issues such as critical illness/immunocompromised status, prematurity, low birth weight, endotracheal intubation, parenteral nutrition, intravascular catheterization and broad spectrum antibiotic therapy are known risk factors for *Acinetobacter spp.* septicemia [6]. The crude mortality (at any age) for *Acinetobacter spp.* ranges from 23 - 73% [7]. The association between MDR *Acinetobacter* (MDRAB) and mortality is increasingly established in literature; this is why it has become one of the most studied and reported organisms in health care institutes and also in public health [2]. There is a dearth of literature identifying factors related to high mortality in neonates with *Acinetobacter* infection requiring high-level care. We therefore attempt to identify important risk factors associated with increased mortality in neonates with

Acinetobacter spp. infection in our intensive care unit.

Materials and methods

Study Population and Identification

We performed a retrospective chart review of all neonates with discharge diagnosis of *Acinetobacter* infection from the NICU at Aga Khan University Hospital, Karachi, from July 2003 to June 2008. As there is no International Classification of Disease (ICD – 2008) available for *Acinetobacter spp.* infection, we identified the cases by using two mechanisms: filtering other Gram-negative organism-related infections in discharged patients, and using the log book of our neonatal intensive care unit (NICU) which records all discharge diagnoses.

Upon filtering, we identified 187 cases, which were narrowed down to 78 cases with *Acinetobacter* infection only on file review. These 78 cases were later included in the final analysis. We enrolled cases who acquired *Acinetobacter* infection after 48 hours in the NICU. Those with pre-existing culture-proven *Acinetobacter* infection at the time of admission in NICU or incomplete medical records were excluded from the study.

Study Setting

We have a 13-bed, level III NICU (with 12 ventilators) providing all neonatal services except Extra Corporeal Membrane Oxygenation (ECMO) and hemodialysis. We provide care to more than 450 neonates annually. Premature births make up approximately 15-20% of cases, while 15% of the premature were extremely low birth weight. Our NICU is divided into four levels of care: level 1, six beds for inborn neonates; level 2, five beds for neonates admitted through ER or other hospitals; levels 3 and 4, single beds, for septic neonates requiring isolation. Our NICU admissions during the study period were from two sources: (i) patients born at our hospital and (ii) those admitted through the emergency room or directly transferred to NICU from local hospitals. The unit's antibiotic policy recommends initial empiric cover of ampicillin + gentamycin for neonates born at our institute requiring admission in NICU, and cefotaxime + amikacin for neonates admitted from the ER and other institutes.

Organism Identification

Acinetobacter spp. were identified by Gram stain and colony morphology as well as by setting up sulphide-indole-motility test medium, citrate utilization test, urea hydrolysis test and triple sugar iron agar. API 20NE was set up for cases where the above tests were inconclusive. For the determination of drug susceptibility, the disk diffusion method was used according to Clinical and Laboratory Institute (CLSI) guidelines [8], which were used previously [9]. Polymyxin disks of 300 units were used for susceptibility testing. We were unable to have complete subspecies data for *Acinetobacter;* therefore, we are reporting all *Acinetobacter* as the *Acinetobacter spp.*

Pan-sensitive *Acinetobacter* was defined as sensitive to all first-line drug classes, while multi-drug resistant *Acinetobacter* was resistant to more than two of the following five drug classes: antipseudomonal cephalosporin, antipseudomonal carbapenems, ampicillin - sulbactam, fluoroquinolones, and aminoglycosides. "Pan-resistant *Acinetobacter*" was defined as resistant to all antimicrobials undergoing first-line susceptibility testing with therapeutic potential against *Acinetobacter spp*. [5].

Statistical analysis

The retrieved data was analyzed on SPSS version 16. Demographic features included age in days, weight, gender, year of admission, gestational age, antibiotics history, deteriorating signs, site of culture, length of hospitalization, and discharge disposition. Continuous variables (age, weight, and length of stay and discharge disposition) were dealt with mean and standard deviation, while categorical variables such as gender, poor perfusion (3-5 seconds), metabolic acidosis (pH < 7.2), low platelets (< or equal to 50,000), and duration of culture positivity after hospitalization were analyzed by frequency and percentage. To identify risk factors associated with high mortality in *Acinetobacter spp.* infection in neonates, we compared the discharge disposition, dead with alive. We set the level of significance at 0.05. Univariate analysis was performed, and Chi-square value, Odds ratios and p-values were calculated between independent variables and outcome variable individually. A p-value of 0.10 was considered significant at the Univariate level and a cut-off of 0.10 was taken for the multivariate model. Interaction was checked among variables with biological plausibility and a p-value of 0.1 was considered as having a positive interaction and therefore kept in the final model. Finally, a multiple regression model was applied for all variables in such

a way that the variable with the most significant p-value was entered first in the final model to calculate the adjusted odds ratio.

Ethical approval

The study was approved by the Ethical Review Board (ERB) of Aga Khan University, Karachi (1187-Ped/ERC-09).

Results

During the study period of five years, 122 cultures from 78 neonates were positive for *Acinetobacter spp.* The majority of patients (62%) were males. The maximum number of patients with *Acinetobacter* infection was reported in 2006 (n = 25), followed by 2004 (n = 18). Eight percent of patients were on antibiotics at the time of admission. Tracheal cultures (6.7 ± 7 days) were positive earlier than blood cultures (7.4 ± 10 days), pinpointing the narrow time margin between colonization and infection. Antibiotics started at the time of admission in NICU, in descending order, were ampicillin (n = 45, 58%), followed by cephalosporins (n = 28, 35%) and carbapenems (n = 5, 6%). More than 95% of our cohort required ventilatory support and umbilical arterial and venous catheterization.

Mortality among our *Acinetobacter spp*. infected cohort was 47%, and of these, 70% died within four days of culture positivity (table 1). The cohort with combined trachea and blood culture positivity for *Acinetobacter* had the highest mortality followed by single site culture positivity in tissue/wound, tracheal secretions and blood (table 2). Pan-resistance was extremely common (table 3). Mortality association with other bacterial and/or fungal isolates grown on culture was not found.

Crude and adjusted OR was calculated (table 4). We identified weight (< 1 kg), preterm with gestational age 28 weeks or less, poor perfusion, low platelets, metabolic acidosis and shorter length of stay as predictors associated with high mortality in our neonatal cohort who developed *Acinetobacter spp*. infection during NICU stay. Twenty-three percent (n = 18) of the neonates received Polymyxin during the stay (10 ± 5 days), and 33% (n = 6) of them were expired (p = 0.17, OR 0.468 (0.155 – 1.409).

Discussion

Acinetobacter spp. has the reputation of causing outbreaks in intensive care units. Resistances to major antimicrobial drugs as well as resistance to desiccants and disinfectants are the major factors that make it a successful and persistent hospital pathogen [5]. Multidrug-resistant *Acinetobacter baumannii* has been reported worldwide and is now recognized as one of the most difficult health care-associated infections to control and treat. Burn ward and intensive care unit (ICU) patients and those with central intravenous catheters are the main targets of this organism [10,11]. Several outbreaks in ICUs, burns units [12-15] and NICUs [10,16-18] have been reported previously. We also noticed outbreak patterns during our specified study period.

Von-Dolinger [19] has identified very young neonatal age at admission (age < 7 days) as a risk factor for *Acinetobacter* neonatal infection in his MDRAB series. Approximately 87% of our study cohort admitted in NICU on the first day of life later developed *Acinetobacter spp.* infection.

Surveillance data illustrates increasing resistance trends since 2002 in *A. baumannii*, with more than 30% of bacteremic isolates in 2005 being resistant to gentamycin and piperacillin/tazobactam and with non-bacteremic isolates being even more resistant [8]. Carbapenems were previously known to be effective against MDRAB but since the emergence of pan-resistant *Acinetobacter spp*. it is even more difficult to treat this organism. The Centers for Disease Control and Prevention (CDC) reports an increasing rate of carbapenems resistant *A. baumannii* from 9% in 1995 to 40% in 2004 [11,20]; however; the drug resistance and organism virulence is different in different parts of the world. The majority of *Acinetobacter spp.* isolated from our patients showed MDRAB and pan-resistant patterns. Drug susceptibility testing in our cohort revealed resistance to all first-line drugs (Table 3), and as colistins were not used in first-line susceptibility testing[21], we used the term pan-resistant *Acinetobacter spp.* for the *Acinetobacter spp.* sensitive only to polymyxin. Approximately 70% of our blood and tracheal isolates showed pan-resistant patterns. This may explain why more than two thirds of mortalities were within four days (2 ± 3.6 days) of culture positivity. These resistance patterns of *Acintobacter sp.* were also reported from our institute but the data was from the adult ICU [9.22].

Clinical signs associated with deterioration and poor outcomes in our study patients were the same as those for any severe bacterial sepsis. Huang [23] described neonatal manifestations in *Acinetobacter* infection, which are similar to our cohort. Certain factors such as prematurity [10,24] and low birth

Table1. Demographic features of study population.

Variables	**n (%)**
Age (on admission)	**2.08 ± 4 Days**
First day of life	**68 (87)**
2 – 30 days of life	**10 (13)**
Gender	
Males	**49 (62)**
Year of admission	
2003 (July – Dec)	**5 (6)**
2004	**18 (23)**
2005	**8 (10)**
2006	**25 (32)**
2007	**13 (17)**
2008 (Jan – Jun)	**10 (13)**
Weight (on admission)	**1.77 ± 0.88 Kgs**
1 Kg or less	**20 (26)**
> 1 Kg	**58 (74)**
Gestational age	
Term	**19 (23)**
Preterm	**59 (75)**
Gestational age category	
28 Weeks or less	**23 (39)**
> 28 Weeks of gestation	**36 (61)**
Antibiotics history	
Yes	**6 (8)**
Deteriorating sign	
Poor perfusion	**34 (44)**
Low platelets	**25 (32)**
Metabolic Acidosis	**25 (32)**
Days of hospitalization at first* Acinetobacter *isolation	
Blood	**7.4 ± 10 days**
Tracheal	**6.7 ± 7 days**
Eye	**10.3 ± 8 days**
Tissue / Body fluids	**21 ± 11 days**
Urine	**20 days**
CSF	**33 days**
Discharge disposition	
Recovered	**41 (53)**
Died	**37 (47)**
Duration between culture positivity and death	**2 ± 3.6 Days**
1 – 3 days	**26 (70)**
> 3 days	**11 (30)**
Length of hospital stay	**20 ± 20 Days**

Table2. Number and site of *Acinetobacter spp.* isolates.

Site	Total Number (%)	Expired (%)
Blood	35 (44)	15 (43)
Trachea	17 (22)	8 (47)
Blood + Trachea	18 (23)	12 (67)
Tissue	2 (3)	1 (50)
Trachea + Eye	2 (3)	0 (--)
Urine	1 (1)	0 (--)
Urine + Trachea	1 (1)	0 (--)
Blood + Tissue + CSF	1 (1)	0 (--)
Blood + Trachea + Eye	1 (1)	1 (100)
Eye	1 (1)	0 (--)
Tissue + Trachea	1 (1)	0 (--)

Table3. *Acinetobacter spp*. and their sensitivities in neonatal cohort.

	All cultures "n"
Blood culture (total)	**57**
Pan-sensitive	13
Pan-Resistant *Acinetobacter spp.**	38
Multi-Drug Resistant *Acinetobacter spp.*	6
Tracheal culture	**55**
Pan-sensitive	1
Pan-Resistant *Acinetobacter spp.**	42
Multi-Drug Resistant *Acinetobacter spp.*	12
Tissue / Body fluids culture	**4**
Pan-Resistant *Acinetobacter spp.**	3
Multi-Drug Resistant *Acinetobacter spp.*	1
Eye culture	**4**
Pan-Resistant *Acinetobacter spp.**	3
Multi-Drug Resistant *Acinetobacter spp.*	1
Urine culture	**1**
Pan-Resistant *Acinetobacter spp.**	1
CSF culture	**1**
Multi-Drug Resistant *Acinetobacter spp.*	1

*pan-resistant *Acinetobacter spp.* retains susceptibility to polymyxin.

Table 4. Mortality associated risk factors for neonates with *Acinetobacter spp.* infection.

Variables	Recovered	Expired	p – value	Crude OR (CI)*	Adjusted OR (CI)**
Age					
preterm	30	29	**0.726**	1.208 (0.418 – 3.49)	--
Gestational age					
28 Weeks or less	7	16	**0.011**	3.70 (1.306 – 10.486)	**2.88 (0.500 – 16.640)**
Gender					
Males	25	24	**0.726**	1.18 (0.470 – 2.970)	--
Weight					
Less than 1 Kg	7	13	**0.068**	2.63 (0.914 –7.7571)	**1.53 (0.239 – 9.800)**
Deteriorating sign					
Poor perfusion	12	22	**0.007**	3.54 (1.385 – 9.072)	**2.45 (0.426 – 14.046)**
Low platelets	8	17	**0.01**	3.50 (1.281 – 9.601)	**1.66 (0.378 – 7.290)**
Metabolic Acidosis	8	17	**0.01**	3.50 (1.281 – 9.601)	**1.67 (0.317 – 8.832)**
Sites of* Acinetobacter *cultures					
Blood	27	28	**0.342**	1.61 (0.599 – 4.343)	--
Trachea	20	22	**0.496**	1.36 (0.559 – 3.322)	--
Length of hospitalization					
1 – 7 Days	37	15	**<0.001**	8.47 (2.717 – 26.409)	**13.23 (3.481 – 50.303)**
>7 days	5	20			

*Crude Odds Ratio at Univariate analysis
**Adjusted OR, for only those variables which were found significant at Univariate analysis (Variables with p-value 0.1 were entered into Multivariate analysis).

weight (LBW) [22,25,26]were associated with increasing risk of *Acinetobacter* infection, probably due to increased likelihood of hospitalization in these patients. Prematurity and extremely low birth weight (ELBW) were 2.9 and 1.5 times associated with mortality in our infected neonatal cohort respectively. We were unable to find any significant association between *Acinetobacter* BSI and mortality in our study participants as reported earlier by Change *et al*. [27].

Patients with *Acinetobacter* colonization often have a history of prolonged hospitalization [19] or antimicrobial therapy (with antibiotics that have little or no activity against *Acinetobacter)* [11]/ We have identified an association of shorter duration of stay with higher mortality in MDRAB neonates. This observation may be due to higher virulence of nosocomial organisms, pan-resistance, lower immunity and birth weights of the affected patients. More studies are required to verify the association.

Limitations

There are certain limitations of our study. This was a single center study, and may not represent the findings at other centers in Pakistan. Furthermore, since this was a retrospective chart review, we werenot able to assess all the variables and were limited by the completeness of documentation by the treating physicians. Because of the constraints of the chart review, not all confounding variables could be dealt with, but we performed a logistic analysis to reduce the impact of these variables to the lowest levels possible. This one center study has a limited number of patients so results should be generalized with caution. We didn't perform any sub-analysis on the basis of *Acinetobacter* sub-species because of unavailability of complete data. The majority of our study cohort required ventilatory support along with central arterial and venous catheterization so we didn't perform any sub-categorical analysis. Study of temporo-spatial (extrinsic, ecologic characteristics) factors such as colonization pressure, nurse-to-patient ratio, and other ward characteristics were not within the scope of this study.

Conclusion

Pan-resistant *Acinetobacter* infection is life-threatening in neonates, particularly in premature and LBW babies. Struggling as we are with a neonatal mortality rate as high as 54/1000 [28], minimizing

poor hospital outcomes due to neonatal nosocomial infections is imperative. Though lack of standardized laboratory resources may make this an under-reported pathogen in developing country hospitals, stringent infection control is the most cost effective preventive measure.

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