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Risk Factors Associated with MDR and CR *Acinetobacter baumannii* Carriage among ICU Patients Hospitalized at Hospitals in Pakistan

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Abstract | **Original Research Article**

Background: In hospital intensive care units (ICUs) around the world, multidrug-resistant and carbapenem-resistant Acinetobacter baumannii (CRAB) infections pose a serious concern, and this is especially true in developing nations like Pakistan. There is insufficient comprehensive evidence on the parameters linked to MDR and CR Acinetobacter baumannii carriage among hospitalized intensive care unit (ICU) patients, despite the limited treatment choices. In order to close this gap, our study identified risk variables for MDR and CR Acinetobacter baumannii carriage in intensive care unit patients at Police Services Hospital and Holy Family Hospital in Pakistan. ***Methods***: Between July 2019 and July 2020, 132 ICU-admitted patients were purposefully enrolled in this study using a cross-sectional study design. Using a standardized questionnaire, demographic data and risk variables related to MDR and CR Acinobacter baumannii were gathered. The data was analyzed using bivalent analysis and descriptive statistics. For every analysis, the 95% confidence interval (CI) was the level of statistical significance. ***Results:*** Employed participants had a 3.4-fold higher risk of having A. baumannii than jobless participants, according to bivariable analysis (cOR = 3.38, 95%, CI: 1.09 - 10.43, p = 0.035). Compared to patients with normal or low BMI, individuals with high BMI had a higher chance of contracting A. baumannii (aOR = 11.2, 95%, CI: 3.57 - 21.11, p = 0.004). The likelihood of having carbapenem-resistant Acinetobacter baumannii was 21 times higher in those over 50 (COR = 21.0, 95% CI: 1.83 - 240.52, p = 0.011). Carbapenem-resistant Acinetobacter baumannii was 16 times more common in patients who remained in the intensive care unit (ICU) for longer than 30 days than in those who had been hospitalized (COR = 16.0, 95% CI: 1.45 - 176.45, p = 0.019). ***Conclusion***: Among patients admitted to intensive care units, A. baumannii infections were shown to be substantially correlated with length of hospital stay, weight, and marital status. However, it was discovered that among patients admitted to the intensive care unit, there was no significant correlation between A. baumannii infections and gender, age, occupation, level of education, referral status, or the presence of infection. Given the poor treatment results linked to the carriage of this multidrug-resistant bacterium, screening for colonization with A. baumannii should be performed on all patients admitted to intensive care units. To reduce the spread of A. baumannii in intensive care units, proper infection control measures should be maintained.

Keywords: MDR, Carbapenem Resistant Acinetobacter baumannii, ICU.

INTRODUCTION

Acinetobacter baumannii has become a major and worrisome cause of infections linked to healthcare in many nations, especially in intensive care units (ICUs) and other medical facilities. Its reputation as a problematic nosocomial infection is influenced by its capacity to proliferate in healthcare settings and endure on a variety of surfaces. However, published prevalence rates may be underestimated or vary depending on the disparity in data reporting standards among Asian nations and the absence of uniform surveillance systems. Therefore, gathering precise and thorough epidemiological data on the incidence of Acinetobacter baumannii in Asia becomes a constant issue, impeding the creation of focused treatments and infection control strategies.

The evidence that is currently available indicates a significant increase in Acinetobacter baumannii infections in Asian hospital settings, despite these obstacles. For instance, a study conducted in a large West Asian tertiary hospital found that Acinetobacter baumannii, which makes up around 40% of all gram-negative bacteria, was the prevalent pathogen found in the majority of specimens from clinical settings [1].

Acinetobacter baumannii infection was shown to be 24.5% common in the intensive care unit (ICU) of a referral hospital in another East Asian investigation. A significant percentage of the isolates exhibited resistance to several medicines, including carbapenems [2].

Prior exposure to antibiotics is the main risk factor for the establishment of drug-resistant Acinetobacter baumannii (Ab) strains in Pakistan and many other regions. Individuals who have previously been exposed to carbapenem are more likely to develop multidrug-resistant strains of Ab. Furthermore, the continuous exposure of Ab to antimicrobial medications in the hospital setting fosters the emergence of mutant forms, which result in infections that present significant difficulties for patient care [3].

Even though it's critical to comprehend and deal with this problem, Pakistan still lacks adequate knowledge about the risk variables that lead to CRAB carriage in ICU patients. Implementing focused treatments to slow the emergence of drug-resistant A. baumannii and enhance patient outcomes in Pakistani healthcare settings requires gaining thorough understanding of these factors. Thus, risk factors for MDR and CR Acinetobacter baumannii carriage in intensive care unit patients at Police Services Hospital and Holy Family Hospital in Pakistan were identified in this study.

MATERIALS AND METHODS

Study Area

This study was conducted in the intensive care unit (ICU) of Holy Family Hospital and Police Services Hospital. Both the Holy Family Hospital and the Police Services Hospital were open at the time of this study. In addition to specialized care services like the intensive care unit, it provides inpatient and outpatient treatment [4]. At the time of the study, the intensive care unit could accommodate 20 beds. The hospital was more suited for the current investigation because of these demographics.

Study Design

This study adopted a cross-sectional descriptive study design among patients admitted to the ICU at POLICE SERVICES HOSPITAL AND HOLY FAMILY HOSPITAL between January and December, 2020.

Study Population

The study population consisted of patients who were hospitalized to the intensive care unit (ICU) at POLICE SERVICES HOSPITAL AND HOLY FAMILY HOSPITAL between July 2019 and July 2020. This group is considered to be at high risk for A. baumannii co-infection in hospital settings, including intensive care units [5]. The study involved the recruitment of 132 participants.

Sample Size Determination

The Chow *et al*., 2007 [6] formula was used to determine the study sample size. The study's sample size consisted of 132 patients, and the prevalence rate that was employed was 9.5% [7].

Sampling Technique

Participants in the study were adult patients (≥18 years) who had been hospitalized to the intensive care unit for at least 48 hours and gave their consent through close family members or legal representatives. According to Palinkas *et al*., 2013 [8], the purposeful sampling technique was employed to choose participants who met the inclusion requirements. Given that the sample size is n (132) and that POLICE SERVICES HOSPITAL AND HOLY FAMILY HOSPITAL contains intensive care units (ICUs) with an annual capacity of 1500 patients, the sampling interval Kth was determined to be 12. For the duration of the trial, subjects were sampled daily at 12-hour intervals. 132 study participants were eventually found through a continual recruitment effort.

Data Collection

A standardized questionnaire was used to gather demographic information, including treatment outcomes, comorbidities, gender, age, and length of hospital stay. The questionnaire's design and standardization were intended to collect key variables, clinical data, and factors related to MDR and CR Acinetobacter baumannii in intensive care unit patients.

Data Analysis

Data were displayed in tables using mean values and standard deviations. SPSS Statistics version 25.0 was used to perform the statistical analysis [9]. The individuals' socioeconomic and clinical demographics were described using percentages and proportions. Furthermore, odds ratios (aORs) were calculated to determine if Acinetobacter baumannii carriage was present or not. Additionally, to investigate and find noteworthy correlations between these variables, multivariate logistic regression analysis was utilized. The threshold for statistical significance was $p < 0.05$.

RESULTS

Socio-Demographic and Clinical Characteristics of the Study Population

The study had 132 patients in total. Males made up the majority of participants (51.5%, 68/132). Of the participants, 38.6% (51/132) were between the ages of 45 and 59, with a median age of 52 (IQR = 36 - 58). Married people made up the majority of participants (74.2%, 98/132). Of those surveyed, 39.4% (52/132) had only completed primary school, while the same proportion had completed secondary school. Nearly half of the participants worked for themselves (44.7%, 59/132). According to Table 1, every participant had at least one comorbidity with respiratory (42.4%, 56/132) and renal (50.8%, 67/132) disorders.

Table 1: Socio-demographic and clinical characteristics of the study population

Characteristic	Category	Frequency	Percentage (%)
Age (Median)	<24		
	25 - 44	42	31.8
	45 - 59	51	38.6
Marital Status	Single	34	25.8
	Married	98	74.2
Education Level	No formal education	17	12.9
	Primary level	52	39.4
	Secondary level	52	39.4
	Tertiary level	11	8.3
Occupation	Unemployed	50	37.9
	Self-employed	59	44.7
	Employed	23	17.4
Referral Status	Referral	116	87.9
	Non-referral	16	12.1
Comorbidities	Respiratory related conditions	56	42.4
	Renal related conditions	67	50.8
	CNS related conditions	10	7.6
	Autoimmune related conditions	14	10.6
	Metabolic disorder	11	8.3
	Asthmatic	10	7.6
	Burns	6	4.5
	Injuries	8	6.1
	Blood stream conditions	8	6.1
	Other Conditions	20	15.2

Factors Associated with *A. baumannii* Carriage among Patients

According to bivariable analysis, patients who were referred to the study site had an 83% lower risk of infection than those who were not (cOR = 0.17, 95%, CI: 0.06 - 0.51, p = 0.002), and employed participants had a 3.4-fold higher risk of having A. baumannii than those who were unemployed (cOR = 3.38, 95%, CI: 1.09 - 10.43, p = 0.035). According to multivariable analysis, there was an independent correlation between A. baumannii carriage and referral status and occupation. Patients who were employed had a 4.4-fold higher likelihood of harboring A. baumannii (aOR = 4.41, 95%, CI: 1.32 - 14.79, p = 0.016), while patients who were referred from other facilities had an 86% lower likelihood than patients who were not referred (aOR = 0.14, 95%, CI: 0.05 - 0.45, p = 0.001). Compared to patients with normal or low BMI, individuals with high BMI had a higher chance of contracting A. baumannii (aOR = 11.2, 95%, CI: 3.57 - 21.11, p = 0.004). However, among patients admitted to the intensive care unit, there was no significant correlation between A. baumannii carriage and characteristics such as gender, age, marital status, or educational attainment (Table 2).

Table 2: Factors associated with A. baumannii carriage among patients admitted to the ICU at POLICE SERVICES HOSPITAL AND HOLY FAMILY HOSPITAL

Factor	A. baumannii Present n (%)	A. baumannii Absent n (%)	cOR (95% CI)	p-value	aOR (95% CI)	p-value
Gender						
Male	16 (53.3)	52 (51.0)	1.10 (0.47 - 2.48)	0.839		
Female	14 (46.7)	50 (49.0)	Ref			
Age						
<24	2 (6.7)	8 (7.8)	1.27 (0.22 - 7.45)	0.789		
25 - 44	12 (40.0)	30 (29.4)	0.80 (0.27 - 2.35)	0.679		
45 - 59	9 (30.0)	42 (41.2)	1.49 (0.49 - 4.52)	0.487		
≥60	7 (23.3)	22 (21.6)	Ref			
Marital Status						
Single	10 (33.3)	24 (23.5)	1.63 (0.67 - 3.94)	0.343		
Married	20 (66.7)	78 (76.5)	Ref			
Education Level						
No formal	5 (16.7)	12 (11.8)	0.53 (0.08 - 3.40)	0.506		
Primary level	10 (33.3)	42 (41.2)	0.93 (0.17 - 5.01)	0.936		

Secondary level	13 (43.3)	39 (38.2)	0.67 (0.13 - 3.49)	0.631		
Tertiary level	2 (6.7)	9 (8.8)	Ref			
Occupation						
Unemployed	8 (26.7)	42 (41.2)	Ref		Ref	
Self employed	13 (43.3)	46 (45.1)	2.28 (0.81 - 6.43)	0.121	2.66 (0.89 - 7.93)	0.080
Employed	9 (30.0)	14 (13.7)	3.38 (1.09 - 10.43)	0.035	4.41 (1.32 - 14.79)	0.016
BMI						
<18.5	4 (13.3)	8 (7.8)	0.44 (0.11 - 1.73)	0.237		
18.5 - 24.9	10 (33.3)	48 (47.1)	Ref			
25 - 29.9	16 (53.3)	46 (45.1)	0.65 (0.27 - 1.58)	0.345	0.004	
Referral Status						
Referral	21 (70.0)	95 (93.1)	0.17 (0.06 - 0.51)	0.002	0.14 (0.05 - 0.45)	0.001
Non-referral	9 (30.0)	7 (6.9)	Ref		Ref	
Sample Type						
Urine	16 (53.3)	44 (43.1)	1.51 (0.67 - 3.41)	0.405		
Tracheal aspirate	11 (36.7)	38 (37.3)	0.98 (0.42 - 2.27)	0.566		
Blood	3 (10.0)	20 (19.6)	0.46 (0.13 - 1.65)	0.282		
Outcome						
Discharged	24 (80.0)	69 (67.6)	1.91 (0.71 - 5.13)	0.256		
Died	6 (20.0)	33 (32.4)	Ref			
LOHS	41.8 ±21.3	38.1 ±23.0	0.99 (0.98 - 1.01)	0.421		

BMI: Body Mass Index, **LOHS**: Length of Hospital Stay, **Ref**: Reference, **CI**: Confidence Interval, **cOR**: crude Odds Ratio, **aOR**: adjusted Odds Ratio.

Factors Associated with Carbapenem Resistant *Acinetobacter baumannii* (CRAB) among ICU Patients Hospitalized.

Bivariable analysis established that those who were aged ≥ 50 years were 21 times more likely to be carbapenem-resistant Acinetobacter baumannii, COR = 21.0, 95% CI: 1.83 - 240.52, p = 0.011. Those who stayed in ICU for more than 30 days were 16 times more likely to be carbapenem-resistant Acinetobacter baumannii compared to those who had been admitted (COR = 16.0, 95% CI:1.45 - 176.45, p = 0.019). Those who had underlying comorbidity were 46 times more likely to be carbapenem-resistant Acinetobacter baumannii compared to those without underlying comorbidity, COR = 46.0, 95% CI:3.33 - 634.88, p = 0.003. Variables were subjected to multivariable model where none of the variables were statistically significant (Table 3).

Table 3: Factors associated with Carbapenem-Resistant Acinetobacter baumannii (CRAB) among ICU patients

Factor	CRAB Present n (%)	CRAB Absent n (%)	cOR (95% CI)	p-value	aOR (95% CI)	p-value
Age						
<50 years	4 (16.0)	4 (80.0)	Ref			
		1 (20.0)	21.0 (1.83 - 240.52)	0.011		
Gender						
Male	14 (56.0)	2 (40.0)	1.91 (0.27 - 13.50)	0.642		
Female	11 (44.0)	3 (60.0)	Ref			
Sample Type						
Blood	3 (12.0)	0				
Tracheal	8 (32.0)	3 (60.0)				
Urine	14 (56.0)	2 (40.0)				
Body Mass Index						
<18.5	3 (12.0)	1 (20.0)				
≥25	10 (40.0)	0				
Normal	12 (48.0)	4 (80.0)				
Marital Status						

Single	9 (36.0)	1 (20.0)	2.25 (0.22 - 23.32)	0.64		
Married	16 (64.0)	4 (80.0)	Ref			
Education Level						
Primary or lower	13 (52.0)	2 (40.0)	1.63 (0.23 - 11.46)	0.595		
Secondary or higher	12 (48.0)	3 (60.0)	Ref			
Employment Status						
Unemployed	7 (28.0)	1 (20.0)	1.56 (0.15 - 16.45)	0.595		
Employed	18 (72.0)	4 (80.0)	Ref			
Length of ICU Stay						
≤30 days	5 (20.0)	4 (80.0)	Ref			
>30 days	20 (80.0)	1 (20.0)	16.0 (1.45 - 176.45)	0.019	6.90 (0.23 - 211.55)	0.269
Presence of Comorbidity						
Yes	23 (92.0)	1 (20.0)	46.0 (3.33 - 634.88)	0.003	4.91 (0.12 - 205.73)	0.404
No	2 (8.0)	4 (80.0)	Ref			
ICU Admission Outcome						
Died	5 (20.0)	1 (20.0)	1.0 (0.09 - 11.03)	0.746		
Discharged	20 (80.0)	4 (80.0)	Ref			

CRAB: Carbapenem-Resistant Acinetobacter baumannii, **ICU**: Intensive Care Unit, **cOR**: Crude Odds Ratio, **aOR**: Adjusted Odds Ratio, **CI**: Confidence Interval.

DISCUSSION

Participants in this study who were working had a 4.4-fold increased risk of harboring A. baumannii, indicating that occupational exposure may play a component in colonization. Previous research using cross-sectional surveys and retrospective cohort methods in a variety of healthcare settings produced consistent results. The idea that occupation may affect colonization risk in hospital settings is supported by these studies, which consistently found higher A. baumannii colonization rates among healthcare workers [10, 11].

Compared to participants receiving initial treatment, those referred to POLICE SERVICES HOSPITAL AND HOLY FAMILY HOSPITAL had a decreased probability of colonization with A. baumannii. This is due to the fact that the majority of patients who were referred to the study's location had previously undergone antibiotic treatment without success, which made their referral to POLICE SERVICES HOSPITAL AND HOLY FAMILY HOSPITAL necessary. The likelihood of referral patients being colonized with bacteria like A. baumannii at the time of screening is reduced when antibiotics are administered beforehand. Furthermore, this could be explained by variations in patient demographics, infection prevention strategies, or colonization trends in various medical environments [12].

A. baumannii colonization was more common in patients with a high BMI than in those with a low or normal BMI. This is in line with the understanding that a person with a high body mass index is more likely to have a compromised immune system and common health issues like diabetes and hypertension, among many others. Given that A. baumannii is an opportunistic pathogen that will almost randomly colonize any suitable host, regardless of gender, age, marital status, or participant education level, it was discovered that these factors did not significantly correlate with carriage of the pathogen among patients admitted to the intensive care unit [13].

In terms of variables linked to carbapenem resistance in intensive care unit patients, this study found that individuals who had been in the ICU for more than 30 days had a 16-fold higher chance of colonizing with carbapenem-resistant A. baumannii than those who had only recently been admitted. Because the causative pathogens circulating within the hospital environment are better adapted for survival even against agents designed to eliminate them, patients who stay in the hospital for extended periods of time are generally more likely to develop hospital acquired infections that are resistant to treatment with commonly prescribed drugs [14].

Interestingly, those with underlying comorbidities were 46 times more likely to have carbapenem-resistant isolates of A. baumannii in their bodies than those without underlying comorbidities. This is due to the fact that underlying comorbidities make treating the target disease more difficult because the clinician must frequently take into account how the primary disease's medications interact with the underlying disorders, which frequently results in the

usage of better medications with higher critical activity. Frequent use of this, even under unworthy circumstances, contributes significantly to the rise in bacterial strains that are resistant to very effective antibiotics as carbapenems and colistin [15].

Limitations of the Study

Only patients who provided their informed consent were included in the study. Additionally, the study was purposefully restricted to patients hospitalized to the intensive care unit (ICU) of POLICE SERVICES HOSPITAL AND HOLY FAMILY HOSPITAL alone, rather than other institutions in the county where patients would have been admitted and possibly had access to alternative data.

CONCLUSION

Among patients admitted to intensive care units, A. baumannii infections were shown to be substantially correlated with length of hospital stay, weight, and marital status. However, it was discovered that among patients admitted to the intensive care unit, there was no significant correlation between A. baumannii infections and gender, age, occupation, level of education, referral status, or the presence of infection. Because of the poor treatment results linked to the carriage of this multidrug-resistant bacterium, screening for colonization with A. baumannii should be performed on all patients admitted to intensive care units. To reduce the spread of A. baumannii in intensive care units, proper infection control measures should be maintained. Patients who have risk factors that have been shown to have a substantial correlation with A. baumannii colonization in the intensive care unit should receive extra attention in order to improve treatment outcomes.

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