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Multi-drug resistant *Acinetobacter*: Risk factors and Outcomes in Veterans with Spinal Cord Injuries & Disorders

Swetha Ramanathan, MPH¹, Katie J. Suda, PharmD, MS^{1,2}, Margaret Fitzpatrick, MD, MS^{1,3}, Linda Poggensee, MS¹, Sherri L. LaVela, PhD, MPH, MBA^{1,4}, Stephen P. Burns, MD^{5,6}, Charlesnika T. Evans, PhD, MPH^{1,7}

¹Center of Innovation for Complex Chronic Healthcare (CINCCCH), Department of Veterans Affairs, Edward Hines Jr. VA Hospital, Hines, Illinois

²University of Illinois-Chicago, College of Pharmacy, Department of Pharmacy, Systems, Outcomes, and Policy, Chicago, Illinois

³Loyola University Stritch School of Medicine, Department of Internal Medicine, Chicago, Illinois

⁴Center for Healthcare Studies, Institute for Public Health and Medicine, General Internal Medicine and Geriatrics, Feinberg School of Medicine, Northwestern University, Chicago, Illinois

⁵Spinal Cord Injury Service, Department of Veterans Affairs, VA Puget Sound Health Care System, Seattle, Washington

⁶University of Washington, Department of Rehabilitation Medicine, Seattle, Washington

⁷Northwestern University, Department of Preventive Medicine and Center for Health Care Studies, Institute for Public Health and Medicine, Feinberg School of Medicine, Chicago, Illinois

Abstract

Background: Multi-drug resistant (MDR) *Acinetobacter* is a growing concern and has been identified as a serious threat by the Centers of Disease Control and Prevention. However there is little information on MDR *Acinetobacter* in individuals with spinal cord injuries and disorders (SCI/D). Therefore, the objective of this study was to identify risk factors for, and assess outcomes of MDR *Acinetobacter* in Veterans with SCI/D.

Methods: This was a retrospective cohort study from January 1, 2012 to December 31, 2013 using national Veterans Affairs (VA) medical encounter and microbiology data.

Results: A total of 773 *Acinetobacter* cultures were identified in 571 patients, of which 58.9% were MDR. Inpatient culture, male gender, sputum and other specimen type, receipt of antibiotics within 90 days before culture date, and pressure ulcers were identified as independent predictors of MDR *Acinetobacter*. Highest odds of MDR *Acinetobacter* was seen with previous antibiotic use (OR=7.27; 95% CI: 2.59-20.54). 30-day mortality was 5.3% in this study. MDR, previous mechanical ventilation 90 days before the culture, and cancer were all independent risk factors for 30 day mortality.

Discussion: There should be increased efforts to highlight the importance of antimicrobial stewardship in order to improve infection control to help limit spread of *Acinetobacter* in healthcare settings.

Background:

Multi-drug resistant gram-negative organisms (MDRGNOs) have been an increasing concern in both healthcare and community settings.¹ Infections with MDRGNOs are associated with increased mortality, prolonged hospital length of stay, and higher healthcare costs.² The Centers of Disease Control and Prevention (CDC) estimate that at least 23,000 people die each year as a direct result of an antibiotic-resistant infection.¹ Among MDRGNOs, multi-drug resistant (MDR) *Acinetobacter* is of particular concern due to this organism's frequent role in severe hospital-acquired infections and nosocomial outbreaks.^{3;4} Approximately 63% of all *Acinetobacter* infections are considered multi-drug resistant (MDR), and MDR *Acinetobacter* has been highlighted as a 'Serious Threat' by the CDC.¹ Furthermore, approximately 2% of all healthcare-associated infections reported to the National Healthcare Safety Network (NHSN) in 2009-2010 were caused by *Acinetobacter baumannii*; of these, 68% of *A. baumannii* central-line associated bloodstream infections (CLABSI) and 78% of *A. baumannii* catheter associated urinary tract infections (CAUTI) were reported to be MDR.⁴

Individuals with spinal cord injuries and disorders (SCI/D) are at increased risk for infections due to frequent contact with the healthcare system and use of invasive devices such as vascular and urinary catheters.^{5;6} The increased and repeated use of antibiotics to treat infections in SCI/D may also increase the risk for MDR infections.⁶ MDR infections have ranged around 60% in those with SCI/D.⁷ Risk factors for MDR organisms in persons with SCI/D include catheterization, pressure ulcers, and previous antibiotic exposure.^{5;6;8;9} *Acinetobacter* infections range from 0.7-12.6% in persons with SCI/D^{9;10}, and *Acinetobacter baumannii* has been found to be more frequent in those with SCI/D versus those without SCI/D.⁷ Existing literature on *Acinetobacter* infections in patients with SCI/D is scarce, and are limited to urine cultures and urinary tract infections,^{9;10} are embedded within studies focusing on multiple organisms,^{5;7-10} and do not focus on outcomes.^{5;7-10}

While several studies have focused on risk factors and outcomes for MDR *Acinetobacter* infections, no studies have specifically evaluated this organism in SCI/D. Similar to other MDRGNOs, previous antibiotic use and specifically broad spectrum antibiotics such as carbapenems and fluoroquinolones are risk factors for MDR *Acinetobacter* in the general population.^{11;12} Other notable risk factors are mechanical ventilation,^{13;14} pressure ulcers,^{11;15} and male gender.¹⁶ MDR *Acinetobacter* infections are also associated with higher rates of mortality and longer hospital stays.^{16;17}

Therefore the objective of this study was to describe the burden of, identify risk factors for, and assess outcomes of MDR *Acinetobacter* in Veterans with SCI/D.

Methods:

Study Design, Setting, & Population

This was a retrospective cohort study from January 1, 2012 to December 31, 2013 using national Veterans Affairs (VA) medical encounter and microbiology data. Data were included for 110 VA facilities. The sample included all Veterans with SCI/D seen at a VA medical center during the study period. We excluded Veterans with multiple sclerosis and amyotrophic lateral sclerosis as individuals with stable non-progressive spinal cord neurological deficits are the focus of the VA SCI/D system of care. Veterans with SCI/D were included in the sample if they had a positive culture for *Acinetobacter* spp. within the study period.

Only those cultures with associated antibiotic sensitivity testing performed were included in this study. Cultures were identified as MDR if they were resistant to at least 1 agent in at least 3 or more antimicrobial categories tested, as defined by Magiorokos et al.³ These antimicrobial categories were aminoglycosides, antipseudomonal carbapenems, antipseudomonal fluoroquinolones, antipseudomonal penicillins + β -lactamase inhibitors, extended-spectrum cephalosporins, folate pathway inhibitors, penicillins + β -lactamase inhibitors, polymyxins, and tetracyclines.⁵ All isolates not meeting the MDR criteria were categorized as non-MDR. Duplicate cultures, defined as *Acinetobacter* cultures with the same antibiotic susceptibility profile, were excluded if the duplicate culture occurred within 30 days of a previous culture.¹⁸ This study was approved by the Edward Hines Jr VA Hospital Institutional Review Board.

Data Sources & Definitions

Patient demographics, healthcare utilization, facility characteristics, microbiology, and pharmacy data were collected from the VA Corporate Data Warehouse (CDW). The CDW is a national repository that includes clinical and administrative data from the Veterans Health Administration (VHA) and is updated daily. Mortality data was obtained from the VA Vital Status File which contains dates of death combined from the Veterans Benefits Administration (VBA) Beneficiary Identification and Records Locator System (BIRLS) Death file, the VA Medicare Vital Status File, and the Social Security Administration Death Master File. SCI/D characteristics such as duration and level of injury were obtained from the VA SCD Registry, a national database containing information on spinal cord characteristics derived from patient registries.

Demographic data such as age, sex, race/ethnicity, and comorbidities were identified 365 days prior to and during the visit or admission where the culture was identified. Specimen type was categorized into four categories including urine, blood, sputum and other. Other specimen type included wound, tissue, body fluid, and bone cultures. Comorbidities were identified using ICD-9 codes of conditions from the Deyo-Charlson comorbidity index, including pressure ulcer which is a common condition in patients with SCI/D.¹⁹ 30-day and 1-year mortality was defined as death of the patient within 30 days and 1 year from the date of the culture collected. 30-day hospital readmission was defined as patient readmission

within 30-days of the positive culture date and was only applicable for those patients with an initial culture collected in an inpatient setting.

The VA SCI/D system of care includes 24 regional SCI Centers, called ‘hubs’, which provide comprehensive care delivered by interdisciplinary teams. These ‘hub’ SCI/D centers are connected to ‘spoke’ facilities that provide community-based care for SCI/D patients. Data was analyzed to assess whether there were differences in MDR *Acinetobacter* in ‘hub’ versus ‘spoke’ facilities. Region was defined using the U.S. Census Bureau regions. San Juan, Puerto Rico, and Manilla were grouped into the ‘South’ region.²⁰

Statistical Analysis

Bivariate analysis using chi-square tests were conducted and unadjusted odds ratios (OR) and 95% confidence intervals (95% CIs) were calculated to identify potential risk factors and outcomes of MDR *Acinetobacter*. A multivariable regression model, cluster adjusted by patient to account for multiple cultures per patient, was utilized to identify independent predictors. Variables that were significant in the unadjusted results were included in the multivariable model. Bivariate analysis was also utilized to identify risk factors related to 30-day mortality. Only the first culture of *Acinetobacter* per patient during the study period was included for mortality analysis. Poisson regression was used to identify independent risk factors for 30-day mortality and the most parsimonious model was selected. Incidence rate ratios (IRRs) and 95% CIs were reported for the Poisson regression. A p-value 0.05 was considered statically significant. All statistical analyses were performed using STATA software version 14.1 (Stata Corp LP).

Results:

There were a total of 978 *Acinetobacter* cultures identified during the study timeframe. After excluding duplicates (n=205) there were 773 *Acinetobacter* cultures identified in 571 individuals with SCI/D. Overall, of a total 27,904 MDRGNO cultures among 8,691 patients were identified, of which 2.8% of cultures were *Acinetobacter* and 6.6% of SCI/D patients were found to be colonized or infected with *Acinetobacter*. Over two thirds (66.8%) of all *Acinetobacter* cultures were obtained from patients seen at SCI specialty care centers, with inpatient cultures accounting for 60.4% of all isolates. This is comparable to the overall MDRGNO cultures where 63.0% were obtained from SCI centers.

The average age and duration of injury of the cohort was 61.3 years and 18.4 years respectively, and 48.1% had tetraplegia. Over half (58.9%, n=455) of the 773 *Acinetobacter* cultures, were MDR. Highest rates of MDR were seen in the 50-64 age group (61.9%) compared to those younger than 50 (46.8%) and those greater than 65 (58.7%). Over two thirds of all inpatient (71.7%) and long term care (LTC) (65.1%) cultures were MDR respectively, while only 32.5% of outpatient cultures were MDR. Cultures at SCI centers had a higher proportion of MDR (62.6%) compared to non-SCI VA facilities (51.4%). Furthermore, significant variation was seen by U.S. geographic region where the highest proportion of MDR *Acinetobacter* was seen in the Northeast (72.1%) while the lowest was in the Midwest (53.5%).

The bivariate analysis showed a number of factors that were associated with MDR *Acinetobacter*. Older age, male gender, and Northeast region were more likely to be associated with MDR *Acinetobacter* (Table 1). MDR *Acinetobacter* was not associated with any of the SCI characteristics examined except for a protective effect for MDR in those with duration of injury 11-20 years and 21+ years compared to those injured for 0-10 years. MDR *Acinetobacter* was more likely to be found in an inpatient culture versus an outpatient culture (OR=5.27; 95% CI: 3.77-7.37) and at an SCI center (OR=1.58; 95% CI: 1.17-2.15). Compared to urine specimens, blood specimens (OR= 2.71; 95% CI: 1.16-6.32), sputum specimens (OR= 3.83; 95% CI: 2.30-6.40) and other specimen types (OR= 3.08; 95% CI: 2.17-4.38) were more likely to be MDR. Comorbidities that were associated with multi-drug resistance were chronic heart failure, cerebrovascular accident, myocardial infarction, and pressure ulcer. Hospitalization, surgery, mechanical ventilation, and ICU stay in the 90 days prior to positive culture were associated with increased odds of multi-drug resistance. Antibiotic use in the previous 90 days was also associated with an increased odds of MDR (OR=3.04; 2.20-4.19). Most antibiotic exposures in the previous 90 days also had increased odds of MDR with the exception of 1st and 2nd generation cephalosporins. All bivariate results are displayed in Table 1.

The multivariable regression analysis showed that inpatient culture, male gender, sputum and other specimen type, receipt of antibiotics within 90 days before culture date, and pressure ulcers were independent predictors of MDR *Acinetobacter*. The highest odds of MDR *Acinetobacter* was seen with previous antibiotic use (OR=7.27; 95% CI: 2.59-20.54). A sputum specimen had a 5.6 times increased odds for MDR (OR=5.59; 95% CI: 1.39-22.48) while other specimen types had 7.66 times increased odds for MDR (OR=7.66; 95% CI: 2.53-23.20). Although female gender was significantly protective in the bivariate results, it was dropped from the final multivariable model as the data were too sparse with only 9 females included in the study. Results of the multivariable regression can be seen in Table 2.

When evaluating outcomes based on MDR, there were a total of 41 deaths (5.3%) within 30 days of the culture and 176 deaths (22.8%) within 1 year. In the bivariate analysis, mortality was greater in those with MDR *Acinetobacter* for 30-day mortality and 1-year mortality. MDR did not increase 30-day readmission in inpatients. For the mortality analysis, cultures were limited to first culture per patient with a total of 571 patients in the cohort. There were 25 deaths within 30-days of first culture. Average age of the cohort was 61.2 with a mean Charlson score of 2.2. Bivariate analysis showed that, source, specimen type, multi-drug resistance, cancer, pressure ulcers, previous hospitalization, previous mechanical ventilation, and previous exposure to 3rd & 4th generation cephalosporins, carbapenems, quinolones, colimethates, and vancomycins. A polymicrobial culture was found to be protective for mortality. Unadjusted odds ratios are displayed in Table 3. The multivariate Poisson model showed that MDR, previous mechanical ventilation 90 days before the culture, and cancer are all independent risk factors for 30 day mortality. Cancer was the largest risk factor (IRR: 6.41, 95% CI: 1.45-28.40). Those with MDR cultures had 4.4 times the risk of 30 day mortality (IRR: 4.4, 95% CI: 1.48-13.10). Results of the multivariate regression for 30-day mortality are also displayed in Table 3.

Discussion:

The goal of this study was to identify risk factors for MDR *Acinetobacter* and assess outcomes in Veterans with SCI/D. Our results showed that over half the *A. baumannii* cultures in the study period were MDR. This is similar to the CDC's national rate of 63%.¹ Considering that 6.6% of all SCI/D patients with cultures had *Acinetobacter* in our study, it is important to note that prevalence of MDR *Acinetobacter* is prominent in Veterans with SCI/D.

Our study also showed that antibiotic exposure in the previous 90 days was the greatest risk factor for MDR *Acinetobacter*, with nearly 7-fold increased odds for MDR *Acinetobacter* compared to patients with non-MDR isolates. Previous antibiotic exposure has been identified in prior studies as a significant risk factor for MDR *Acinetobacter*.^{13;12;15} Specifically, previous receipt of carbapenems,^{11;12} quinolones,^{12;15} and metronidazole¹² have all been found to increase risk. Although our multivariable analysis focused on any type of antibiotic exposure, results from the bivariate analysis showed that receipt of quinolones and carbapenems, specifically, increased odds of MDR in this population.

Furthermore, this study identified that presence of a pressure ulcer, upon admission or in the year prior to the culture, as well as an inpatient culture increased the odds of MDR. Pressure ulcers have been identified as a risk factor for MDROs in general patient populations, both in acute care and long-term care settings.^{11;15} Our study found that persons with SCI/D with a pressure ulcer had nearly 6 times the odds of MDR *Acinetobacter*. Our findings were twice the rate of that identified by Lim et al. (OR=3.69 95%CI: 1.06-12.86) at a long-term care facility.¹¹ Due to neurologic impairments and immobility, patients with SCI/D are at much higher risk of pressure ulcers compared to general patient populations, and patients with SCI/D and pressure ulcers also have frequent and prolonged contact with the healthcare system. This likely contributes substantially to the increased risk of MDROs in patients with SCI/D. Our study confirms this association for MDR *Acinetobacter*, in particular, and further supports the importance of appropriate pressure ulcer prevention and care in this population to minimize risk of MDRO colonization and spread.

We also found that, compared to urine cultures, sputum and other specimen cultures were more likely to be MDR. Although bloodstream and urinary tract infections are common, *Acinetobacter* is also frequently cultured from the respiratory tract, wounds, and intra-abdominal infections where it may be a true pathogen or a colonizer.^{4;21;22} High rates of MDR are often observed from *Acinetobacter* isolates obtained from these sites.²² Few prior studies have examined the importance of specimen type in determining the likelihood of MDR in *Acinetobacter* isolates in patients with SCI/D, as most prior studies of risks for MDROs in patients with SCI/D have been limited to the urinary tract.^{9;10}

The 30-day mortality for this study was 4.4%, when limiting to the first *Acinetobacter* culture which is lower than other studies reporting 30-day mortality between 30% and 44.8%.^{12;23} This difference in 30-day mortality may be due to our restriction to first *Acinetobacter* specimen per patient within the study period for mortality. Additionally Gulen et al. and Guo et al. included only blood stream isolates in their study compared to our

study that also included urine and wound isolates and these patients are more likely to be colonized and not infected. We found that those with MDR *Acinetobacter* had higher odds for 30 day mortality and 1 year mortality compared to those with non-MDR *Acinetobacter*. This is consistent with Fitzpatrick et al. showing that MDR *Acinetobacter* results in worse outcomes¹⁷ and MDR is a risk factor for mortality.^{2;23}

Other factors identified as a risk factor for mortality were cancer and mechanical ventilation. This is not surprising as infections are a leading cause of mortality among cancer patients as they are immunocompromised.¹⁴ Cancer was found to be the greatest risk factor for 30-day mortality in our study. Cancer has been identified as a risk factor for MDR *Acinetobacter*¹⁴ and has been noted as a concern.²⁴ This is concerning in SCI/D as multiple comorbidities increase risk of infection in this population.

Mechanical ventilation was also an independent risk factor for 30-day mortality in Veterans with SCI/D and use of mechanical ventilation has been identified as a risk factor in other studies.^{13;23} *Acinetobacter baumannii* is commonly detected in those with healthcare associated and ventilator associated pneumonia and could be why mechanical ventilation was a risk factor for mortality.²⁵ Guo et al. and Park et al. both identified mechanical ventilation as current use in patients.^{13;23} However, our study defined mechanical ventilation as use up to 90 days prior to the culture. Collectively these findings suggest both current and previous mechanical ventilator use present risk for mortality from *Acinetobacter* infections.

Our study has some important limitations. First, we did not distinguish between infection and colonization and did not collect data on antibiotic treatments prescribed due to *Acinetobacter*. Not specifying between colonization and infection may have contributed to the lower mortality rate reported in this study if many of the patients included were colonized rather than infected. Second, our study employed a retrospective cohort design, which did not allow us to separate factors associated with both non-MDR cases and uninfected individuals. Third, we did not capture any non-VA data such as cultures performed outside of the VA system; this may introduce bias as there may be unique characteristics associated with this group of patients. Finally, because our study used exclusively VA data with predominantly male subjects, these results may not be generalizable to other populations with SCI/D.

An advantage of this study is the benefit of data from the Veterans Health Administration (VHA), the largest integrated health care system in the U.S. as well as the largest provider of care of patients with SCI/D. Our study is the largest known study of MDR *Acinetobacter* for patients with SCI/D.

Risk factors identified for both MDR and 30-day mortality in our study were similar to those found in the general population. However, for Veterans with SCI/D these risk factors are an added concern as they are often in contact with healthcare systems, exposed to antibiotics, and frequently use invasive devices. Antibiotic exposure is strong risk factor that is potentially modifiable. Therefore, there should be increased efforts to highlight the importance of antimicrobial stewardship in order to decrease multi-drug resistant infection and improve infection control to help limit spread of *Acinetobacter* in healthcare settings.

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Table 1.Bivariate analysis of risk factors for MDR *Acinetobacter*

Characteristic	MDR (n=455)	Non-MDR (n=318)	Unadjusted OR (95% CI)	p-value
Demographics & SCI Characteristics				
Age (years)				
18-49	44 (9.7%)	50 (15.7%)	Reference	
50-64	239 (52.5%)	147 (46.2%)	1.85 (1.17-2.91)	p=0.008
65+	172 (37.8%)	121 (38.1%)	1.62 (1.01-2.58)	p=0.043
Gender				
Male	452 (99.3%)	310 (97.5%)	Reference	
Female	3 (0.7%)	8 (2.5%)	0.26 (0.07-0.98)	p=0.032
Region				
Northeast	62 (13.6%)	24 (7.5%)	Reference	
Midwest	85 (18.7%)	74 (23.3%)	0.44 (0.25-0.78)	p=0.005
South	257 (56.5%)	176 (55.4%)	0.56 (0.34-0.94)	p=0.028
West	51 (11.2%)	44 (13.8%)	0.45 (0.24-0.83)	p=0.011
Extent				
Incomplete	159 (34.9%)	131 (41.2%)	Reference	
Complete	229 (50.3%)	145 (45.6%)	1.30 (0.95-1.78)	p=0.097
Missing	67 (14.7%)	42 (13.2%)	1.31 (0.84-2.06)	p=0.234
Level				
Tetraplegia	221 (48.6%)	151 (47.5%)	Reference	
Paraplegia	189 (41.5%)	141 (44.3%)	0.92 (0.68-1.24)	p=0.567
Missing	45 (9.9%)	26 (8.2%)	1.18 (0.70-2.00)	p=0.532
Onset of Injury				
Non-Traumatic	97 (21.35)	64 (20.1%)	Reference	
Traumatic	279 (61.35)	222 (69.8%)	0.83 (0.58-1.19)	p=0.31
Missing	79 (17.4%)	32 (10.1%)	1.63 (0.97-2.73)	p=0.064
Duration of Injury				
0-10 years	189 (41.5%)	102 (32.1%)	Reference	
11-20 years	54 (11.9%)	51 (16.0%)	0.57 (0.36-0.90)	p=0.015
21+ years	168 (36.9%)	128 (40.3%)	0.71 (0.51-0.99)	p=0.042
Missing	44 (9.7%)	37 (11.6%)	0.64 (0.39-1.06)	p=0.082
Clinical Characteristics				
Source				
Outpatient	79 (17.4%)	164 (51.6%)	Reference	
Inpatient	335 (73.6%)	132 (41.5%)	5.27 (3.77-7.37)	p<0.0001
Long Term Care	41 (9.0%)	22 (6.9%)	3.87 (2.16-6.93)	P<0.0001
SCI Center				
No	132 (29.0%)	125 (39.3%)	Reference	
Yes	323 (71.0%)	193 (60.7%)	1.58 (1.17-2.15)	p=0.003
Specimen Type				

Characteristic	MDR (n=455)	Non-MDR (n=318)	Unadjusted OR (95% CI)	p-value
Urine	200 (44%)	228 (71.7%)	Reference	
Blood	19 (4.2%)	8 (2.5%)	2.71 (1.16-6.32)	p=0.017
Sputum	74 (16.3%)	22 (6.9%)	3.83 (2.30-6.40)	p<0.0001
Other	162 (35.6%)	60 (18.9%)	3.08 (2.17-4.38)	p<0.0001
Charlson Comorbidity index, median (SD)	2.6 (1.7)	1.8 (1.9)		p<0.0001
Pressure Ulcer				
No	153 (33.6%)	225 (70.8%)	Reference	
Yes	302 (66.4%)	93 (29.2%)	4.78 (3.50-6.51)	p<0.0001
Healthcare exposures in previous 90 days				
Long Term Care				
No	442 (97.1%)	311 (97.8%)	Reference	
Yes	13 (2.9%)	7 (2.2%)	1.31 (0.52-3.31)	p=0.572
ICU Stay				
No	358 (78.7%)	293 (92.1%)	Reference	
Yes	97 (21.3%)	25 (7.9%)	3.18 (1.99-5.06)	p<0.0001
Previous Hospitalization				
No	231 (50.8%)	224 (70.4%)	Reference	
Yes	224 (49.2%)	94 (29.6%)	2.31 (1.71-3.13)	p<0.0001
Surgery				
No	361 (79.3%)	279 (87.7%)	Reference	
Yes	94 (20.7%)	39 (12.3%)	1.86 (1.24-2.79)	p=0.002
Mechanical Ventilation				
No	390 (85.7%)	301 (94.7%)	Reference	
Yes	65 (14.3%)	17 (5.3%)	2.95 (1.69-5.14)	p=0.0001
Genitourinary procedure				
No	432 (94.9%)	305 (95.9%)	Reference	
Yes	23 (5.1%)	13 (4.1%)	1.25 (0.62-2.50)	p=0.530
Antibiotic exposure in previous 90 days				
Any Antibiotic				
No	50 (11.0%)	101 (31.8%)	Reference	
Yes	405 (89.0%)	217 (68.2%)	3.77 (2.59-5.50)	p<0.0001
Chronic Steroids				
No	450 (98.9%)	315 (99.1%)	Reference	
Yes	5 (1.1%)	3 (0.9%)	1.17 (0.28-4.92)	p=0.834
Extended Spectrum Penicillins				
No	277 (60.9%)	271 (85.2%)	Reference	
Yes	178 (39.1%)	47 (14.8%)	3.71 (2.58-5.32)	p<0.0001
1 st & 2 nd Generation Cephalosporins				
No	383(84.2%)	280 (88.1%)	Reference	
Yes	72 (15.8%)	38 (11.9%)	1.39 (0.91-2.11)	p=0.129
3 rd & 4 th Generation Cephalosporins				

Characteristic	MDR (n=455)	Non-MDR (n=318)	Unadjusted OR (95% CI)	p-value
No	284 (62.4%)	268 (84.3%)	Reference	
Yes	171 (37.6%)	50 (15.7%)	3.23 (2.26-4.61)	p<0.0001
Carbapenems				
No	305 (67.0%)	295 (92.8%)	Reference	
Yes	150 (33.0%)	23 (7.2%)	6.31 (3.95-10.06)	p<0.0001
Tetracyclines				
No	413 (90.8%)	309 (97.2%)	Reference	
Yes	42 (9.2%)	9 (2.8%)	3.49 (1.67-7.28)	p=0.0004
Aminoglycosides				
No	3613 (79.3%)	304 (95.6%)	Reference	
Yes	94 (20.7%)	14 (4.4%)	5.65 (3.16-10.12)	p<0.0001
Quinolones				
No	231 (50.8%)	221 (69.5%)	Reference	
Yes	224 (49.2%)	97 (30.5%)	2.21 (1.63-2.99)	p<0.001
Vancomycin				
No	217 (47.7%)	255 (80.2%)	Reference	
Yes	238 (52.3%)	63 (19.8%)	4.44 (2.19-5.38)	p<0.0001

Table 2.Multivariable regression analysis of risk factors for MDR *Acinetobacter*

Variables	Adjusted Odds Ratio (95% CI), p-value
Source (Reference=Outpatient)	
Inpatient	8.45 (2.82-25.93), p<0.0001
Long Term Care	1.84 (0.33-10.22), p=0.485
Specimen Type (Reference=Urine)	
Blood	1.62 (0.21-12.77), p=0.647
Sputum	5.06 (1.279-22.68), p=0.022
Other	7.47 (2.46-22.68), p<0.0001
Any antibiotic in previous 90 days	9.38 (3.08-29.57), p<0.001
Pressure Ulcer	5.69 (2.02-16.14), p<0.0001

Table 3.

Bivariate and multivariable regression analysis of risk factors of 30-day Mortality

Characteristic	Died (n=25)	Alive (n=546)	Unadjusted OR (95% CI), p-value	IRR (95% CI), p-value
MDR				
No	4 (16.0%)	247 (50.2%)	Reference	Reference
Yes	21 (84.0%)	272 (49.8%)	5.23 (1.79-15.61), p=0.003	4.40 (1.48-13.10), p=0.008
Duration of Injury				
0-10 years	7 (28.0%)	200 (36.6%)	Reference	
11-20 years	2 (8.0%)	81 (14.9%)	0.71 (0.14-3.47)	
21+ years	11 (44.0%)	207 (37.9%)	1.52 (0.58-3.99)	
Missing	5 (20.0%)	58 (10.6%)	2.46 (0.75-8.05)	
Source				
Outpatient	1 (4.0%)	196 (35.9%)	Reference	
Inpatient	21 (84.0%)	309 (56.6%)	13.32 (1.78-99.82), p=0.12	
LTC	3 (12.0%)	41 (7.5%)	14.34 (1.46-141.35), p<0.001	
Specimen				
Urine	6 (24.0%)	313 (57.3%)	Reference	
Blood	4 (16.0%)	18 (3.3%)	11.59 (3.00-44.78), p<0.001	
Sputum	8 (32.0%)	51 (9.4%)	8.18 (2.73-24.56), p<0.001	
Other	7 (28.0%)	164 (30.0%)	2.23 (0.74-6.73), p=0.156	
Cancer				
No	23 (92.0%)	541 (99.1%)	Reference	Reference
Yes	2 (8.0%)	5 (0.92%)	9.41 (1.73-51.10), p=0.009	6.41 (1.45-28.4), p=0.014
Pressure Ulcer				
No	8 (32.0%)	288 (52.7%)	Reference	
Yes	17 (68.0%)	258 (47.3%)	2.37 (1.01-5.59), p=0.048	
Previous Hospitalization				
No	10 (40.0%)	342 (62.6%)	Reference	
Yes	15 (60.0%)	204 (37.4%)	2.51 (1.11-5.70), p=0.027	
Mechanical Ventilator Use				
No	16 (64.0%)	500 (91.6%)	Reference	Reference
Yes	9 (36.0%)	46 (8.4%)	6.11 (2.56-14.60), p<0.001	3.57 (1.53-8.32), p<0.001
3 rd & 4 th Generation Cephalosporins				
No	13 (52.0%)	417 (76.4%)	Reference	
Yes	12 (48.0%)	129 (23.6%)	2.98 (1.33-6.70), p=0.008	
Carbapenems				
No	14 (56.0%)	467 (85.5%)	Reference	
Yes	11 (44.0%)	79 (14.5%)	4.64 (2.04-10.60), p<0.001	
Quinolones				
No	9 (36.0%)	348 (63.7%)	Reference	
Yes	16 (64.0%)	198 (36.3%)	3.12 (1.36-7.20), p=0.007	
Colismethate				

Characteristic	Died (n=25)	Alive (n=546)	Unadjusted OR (95% CI), p-value	IRR (95% CI), p-value
No	24 (96.0%)	545 (99.8%)	Reference	
Yes	1 (4.0%)	1 (0.2%)	22.71 (1.37-374.1), p=0.029	
Vancomycin				
No	8 (32.0%)	366 (67.0%)	Reference	
Yes	17 (68.0%)	180 (33.0%)	4.32 (1.83-10.20), p=0.001	
Polymicrobial culture				
No	22 (88.0%)	316 (57.9%)	Reference	
Yes	3 (12.0%)	230 (42.1%)	0.19 (0.05-.63), p=0.007	

Note: Previous hospitalization, mechanical ventilator use, and antibiotics were assessed 90 days before *Acinetobacter* culture.