Original Article

Impact of empirical antimicrobial therapy on the outcome of critically ill patients with *Acinetobacter* bacteremia

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Abstract:

RATIONALE: Empirical antimicrobial therapy (EAT) for *Acinetobacter* infections may not be appropriate as it tends to be multidrug-resistant. This study evaluated the relationship between appropriate EAT and the outcomes of Intensive Care Unit (ICU) patients with *Acinetobacter* bacteremia.

METHODS: This is a retrospective study of patients admitted to a medical-surgical ICU (2005-2010) and developed *Acinetobacter* bacteremia during the stay. Patients were categorized according to EAT appropriateness, defined as administration of at least one antimicrobial agent to which the *Acinetobacter* was susceptible before susceptibility results were known. The relation between EAT appropriateness and outcomes was evaluated.

RESULTS: Sixty patients developed *Acinetobacter* bacteremia in the 6-year period (age = 50 ± 19 years; 62% males; Acute Physiology and Chronic Health Evaluation II score = 28 ± 9; 98.3% with central lines; 67% in shock and 59% mechanically ventilated) on average on day 23 of ICU and day 38 of hospital stay. All isolates were resistant to at least three of the tested antimicrobials. Appropriate EAT was administered to 60% of patients, mostly as intravenous colistin. Appropriate EAT was associated with lower ICU mortality risk (odds ratio: 0.15; 95% confidence interval: 0.03-0.96) on multivariate analysis.

CONCLUSIONS: In this 6-year cohort, *Acinetobacter* bacteremia was related to multidrug-resistant strains. Appropriate EAT was associated with decreased ICU mortality risk.

Key words:

Acinetobacter, critical illness, treatment outcome

Acinetobacter species is a strictly aerobic, Gram-negative coccobacillus that may cause pulmonary, bloodstream, urinary and surgical wound infections.[1] It is notorious as a nosocomial pathogen[2] and is capable of acquiring resistance against almost all currently available antibiotics through a variety of mechanisms such as acquisition of mobile genetic elements (integrons, plasmids, and transposons) and natural transformation.[3] In addition, *Acinetobacter* displays antibiotic resistance through efflux pumps, porin deficiency, and expression of antimicrobial degrading enzymes.[4] Typically, the multi-drug resistant (MDR) *Acinetobacter* shows characteristic patterns of resistance to multiple antimicrobials including aminoglycosides, antipseudomonal penicillins, carbapenems, cephalosporins, and quinolones.[5] This intrinsic antimicrobial resistance along with a resistance to desiccation[6] is responsible for outbreaks of *Acinetobacter* infections in clinical settings and makes this pathogen a high burden on healthcare.[7-9]

There is considerable dichotomy regarding the impact of *Acinetobacter* nosocomial infection on patient prognosis and length of stay in the Intensive Care Unit (ICU). Several groups have reported that *Acinetobacter* infections are associated with a higher mortality rate[10-14] while some investigators suggest that morbidity and mortality due to *Acinetobacter* are dependent on many variables and not due to the infection itself.[15,16] Since infections with MDR *Acinetobacter* strains are increasing, it can be expected that empirical treatment, which is commenced before susceptibility results are known, may be inappropriate. The main aim of this study was to describe the characteristics of critically ill patients who developed *Acinetobacter* bacteremia during ICU stay, study empirical antimicrobial use, and evaluate the relationship between appropriate empirical therapy and outcomes.

Methods

This was a retrospective study of all adult patients (age ≥18 years) who were admitted to the ICU of King Abdulaziz Medical City between January 1, 2005 and December 31, 2010 and developed *Acinetobacter* bacteremia while in the

ICU. The hospital was a 900-bed tertiary-care referral center in Riyadh, Saudi Arabia and was accredited by Joint Commission International. The ICU was a 21-bed medical-surgical unit staffed by board-certified staff 24 h a day, 7 days per week[17] and admitted about 900 patients per year. In addition, the ICU service covered an 8-bed burn unit on a consultation basis usually for mechanical ventilation care and shock management. Clinical rounds were multidisciplinary and led by intensivists, some of whom were also infectious disease specialists, and included a clinical pharmacist. Decisions on antimicrobial therapy were usually made during these rounds. In our hospital, colistin was available as Colomycin (Dumex-Alpharma A/S, Copenhagen, Denmark). The hospital had an active infection control and prevention program with the ICU implementing ventilator-associated pneumonia and central line-associated bloodstream infection bundles.[18] The study was approved by the Institutional Review Board of the hospital.

Patients with nosocomial bloodstream infection[19] due to *Acinetobacter* were identified from the Microbiology Laboratory database as those who had at least one blood culture growing *Acinetobacter* species 48 h after hospital admission. Patients with the same blood culture growing >1 organism were excluded from the study to avoid confounding effect. *Acinetobacter* was identified to the species level using an automated system (MicroScan Walkaway, Simens®) that also provided antimicrobial susceptibility testing results according to the guidelines of the Clinical and Laboratory Standards Institute. The antimicrobial activity of colistin was provided as susceptible or resistant, based on minimal inhibitory concentration cut-off of $\leq 2\,\mu g/mL$ and $\geq 4\,\mu g/mL$, respectively.

The antimicrobial susceptibility patterns of *Acinetobacter* species were recorded. The cultured *Acinetobacter* was considered to be MDR if the organism was resistant to three or more classes of the tested antimicrobial agents.[20] Specifically, the susceptibility of *Acinetobacter to* cephalosporins, antipseudomonal penicillins, carbapenems, quinolones, aminoglycosides, and colistin was recorded. Then, the medical records of ICU patients who developed *Acinetobacter* bacteremia were reviewed to evaluate the appropriateness of empirical antimicrobial therapy (EAT). Appropriate empirical antibiotic therapy was defined as the empirical administration of at least one antimicrobial agent to which the *Acinetobacter* strain was susceptible before susceptibility test results were known,[21] otherwise the therapy was considered inappropriate. Other recorded variables included age, gender, admission Acute Physiology and Chronic Health Evaluation II (APACHE II) score,[22] ICU admission category (medical, surgical, burn and trauma), reason for ICU admission, presence of shock, central lines and mechanical ventilation, and the main laboratory test results on the day of bacteremia, institution of a new do-not-resuscitate order during ICU stay, ICU and hospital length of stay and ICU and hospital mortality.

Statistical analysis

Data were analyzed using SAS software (version 9·0, SAS Institute, Cary, NC, USA). Continuous data were presented as medians with the first and third quartiles or as means with standard deviations, whereas categorical variables were summarized as numbers and percentages. Chi-square or Fisher's exact test was used to evaluate differences in categorical variables between groups. Similarly, the Student's *t*-test was used to assess differences in continuous variables. Multiple logistic regression analysis was used to evaluate factors associated with appropriate antimicrobial therapy. The studied factors were 2008-2010 versus 2005-2007 admission period, age, gender, APACHE II score, medical versus nonmedical admission, chronic illnesses, shock state, mechanical ventilation, central line, white blood cell and platelet counts, lactate, creatinine, and the international normalized ratio (INR). In addition, multivariate analysis was used to study whether appropriate empirical therapy predicted mortality. The clinically-relevant variables entered in the model were age, gender, APACHE II score, medical versus nonmedical admission, chronic illnesses, presence of shock, mechanical ventilation, creatinine, lactate, and INR. Results were presented as odds ratios (ORs) with 95% confidence interval (CI).

Results

A total of 60 patients developed *Acinetobacter* bacteremia during the ICU stay in the study period. Table 1 describes the general patient profile. These patients had an average age of 50.4 ± 19.3 years, were predominantly males (56.7%) and admitted mostly for medical reasons and had high severity of illness (APACHE II score = 27.6 ± 8.6). Twelve (20%) patients had burns involving >40% of total body surface area and seven (11.7%) patients had solid organ transplant. *Acinetobacter* bacteremia occurred at variable frequency during the 6 years of the study period. There were 3 episodes in 2005, 11 in 2006, 16 in 2007 and 2008, 5 in 2009 and 9 in 2010. On average, *Acinetobacter* bacteremia occurred on the 23rd day of ICU admission (Q1-Q3 = 6th and 17th day), which corresponded to the 38th day of hospital admission (Q1-Q3 = 12th and 34th day). Figure 1 describes the distribution of *Acinetobacter* bacteremia from ICU and hospital admission. Eleven (18.3%) patients had ≥2 blood cultures growing *Acinetobacter*.

The characteristics of patients who received appropriate empirical therapy were largely not different from those who did not as shown in Table 1. At the time of bacteremia, 59.3% were mechanically ventilated, 98.3% had central venous catheters, and 66.7% of patients had a shock with elevated lactate (7.0 ± 6.5 mmol/L). In addition, they had high

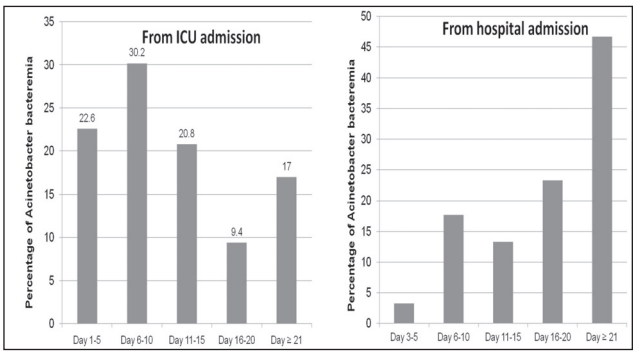

Figure 1: Distribution of *Acinetobacter* bacteremia from Intensive Care Unit and hospital admission

Table 1: Characteristics of the 60 patients who developed *Acinetobacter* bacteremia during stay in the ICU

Variables	All patients (*n* = 60)	Appropriate empirical therapy (*n* = 36)	Inappropriate empirical therapy (*n* = 24)	*P*
Admission year, *n* (%)				
2005-2007	30 (50)	14 (38.9)	16 (66.7)	0.04
2008-2010	30 (50)	22 (61.1)	8 (33.3)	
Age (years), mean±SD	50.4±19.3	46.0±17.9	57.1±19.8	0.03
Male gender, *n* (%)	37 (62.0)	19 (52.8)	18 (75.0)	0.08
BMI (kg/m^2), mean±SD	29.5±8.0	29.1±8.8	30.1±6.5	0.71
APACHE II score, mean±SD	27.6±8.6	27.3±8.7	28.0±8.5	0.79
Diabetes mellitus, *n* (%)	18 (30)	9 (25)	9 (37.5)	0.37
Admission category, *n* (%)				
Medical	34 (56.7)	19 (52.8)	16 (66.7)	0.72
Surgical	11 (18.3)	8 (22.2)	3 (12.5)	
Trauma	3 (5.0)	7 (19.4)	4 (16.7)	
Burn	12 (20.0)	2 (5.6)	1 (4.2)	
Solid organ transplant	7 (11.7)	5 (13.9)	2 (8.3)	0.26
Chronic illnesses, *n* (%)				
Cardiac	15 (25.0)	11 (30.6)	4 (16.7)	0.40
Respiratory	12 (20.0)	7 (19.4)	5 (20.8)	0.60
Renal	15 (25.0)	11 (30.6)	4 (16.7)	0.41
Hepatic	6 (10.0)	1 (2.8)	5 (20.8)	0.01
Immunocompromised state	10 (16.7)	7 (19.4)	2 (8.3)	0.37
Sepsis on ICU admission, *n* (%)	31 (51.7)	22 (61.1)	9 (37.5)	0.07
Shock at time of bacteremia, *n* (%)	40 (66.7)	23 (63.9)	17 (70.8)	0.42
MV at time of bacteremia, *n* (%)	35 (59.3)	22 (61.1)	13 (54.2)	0.73
Central line at time of bacteremia, *n* (%)	28 (48.4)	35 (97.2)	23 (95.8)	
Internal jugular vein	14 (23.3)	15 (41.7)	12 (50.0)	0.42
Femoral vein	12 (20.0)	6 (16.7)	8 (33.3)	
Subclavian vein	3 (5.0)	9 (25)	2 (8.3)	
Creatinine* (μmol/L), mean±SD	140±101	126±80	166±129	0.23
Lactate* (mmol/L), mean±SD	7.0±6.5	7.1±5.9	6.8±4.3	0.90
Albumin* (g/dL), mean±SD	2.4±0.6	2.3±0.5	2.7±0.6	0.03
Bilirubin* (μmol/l), mean±SD	81±119	83±140	80±74	0.94
INR*±SD	1.9±1.3	1.6±0.7	2.3±2.0	0.20
Hemoglobin* (g/dL), mean±SD	8.7±1.6	8.6±1.5	9.0±1.9	0.31
White blood cell count*/μL, mean±SD	12,300±12,300	11,600±13,000	13,500±11,000	0.59
Platelet count*/μL, mean±SD	175,000±204,000	177,000±226,000	169,000±158,000	0.89

*Values on the day of bacteremia, APACHE = Acute Physiology and Chronic Health Evaluation, INR = International normalized ratio, ICU = Intensive Care Unit, SD = standard deviation, BMI=Body mass index, MV = Mechanical ventilation

creatinine (140 ± 101 μmol/L) with 13 patients requiring renal replacement therapy. Three patients were on total parenteral nutrition. Fourteen patients had *Acinetobacter* cultured from a different source within the 14 days before bacteremia (7 from the respiratory tract, 1 from a wound, 3 from central line tips, none from the urine and 4 from other sites).

Forty percent of cultured *Acinetobacter* species were identified as *baumannii*. Figure 2 describes the results for the antimicrobial susceptibilities of the cultured *Acinetobacter*. All cultured *Acinetobacter* were found to be resistant to at least 3 of the antimicrobials tested making them MDR. There were 44 *Acinetobacter* isolates that were resistant to five classes of antimicrobials. Only one (1.7%) isolate was resistant to colistin.

Despite being MDR, EAT for *Acinetobacter* bacteremia was appropriate in 36 (60.0%) patients and comprised of intravenous

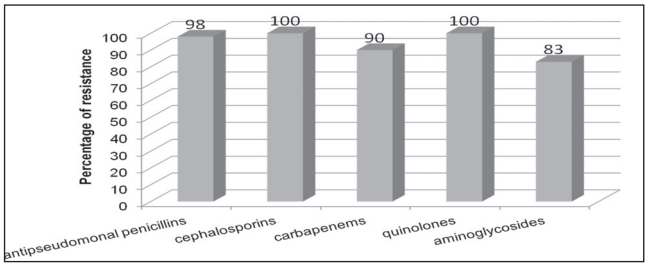

Figure 2: Antimicrobial susceptibility of the isolated *Acinetobacter* species from the blood of 60 critically ill patients

colistin in all except for 3 patients. In 6 patients, colistin was started a median of 7 days before the blood culture was taken. The mean daily colistin dose was 158 ± 32 mg (Q1–Q3 = 145 and 160 mg; Colomycin® with each 160 mg equivalent to 2 million units). For patients requiring renal replacement therapy, it was

180 ± 47 mg. In other patients, the daily dose was 166 ± 26 mg for those with serum creatinine <121 μmol/L, the median of the cohort, and 148 ± 27 for those with creatinine ≥121 μmol/L. Colistin was combined with carbapenem in 27 patients and with antipseudomonal penicillin in 6 patients. For patients on inappropriate therapy (n = 24, 40% of patients), 17 were on carbapenems, 12 on quinolones, 6 on antipseudomonal penicillins, and 3 on aminoglycosides with 16 patients being on combination therapy. Factors associated with appropriate antimicrobial therapy were female gender (OR: 6.57; 95% CI: 1.48-29.21), admission in 2008-2010 versus the 2005-2007 period (OR: 5.36; 95% CI: 1.38-20.77), mechanical ventilation (OR: 4.19; 95% CI: 1.01-17.33) and age (OR: 0.96 per 1-year increment: 95% CI: 0.92-0.99).

Compared with nonsurvivors, ICU survivors had a lower APACHE II score (23.0 ± 10.0 vs. 29.8 ± 7.2, P = 0.006) at the time of admission. Survivors also had lower rates of medical admissions (40.0% vs. 67.5%, P = 0.04), and fewer had been either in shock (47.4% vs. 77.5%, P = 0.02) or on mechanical ventilation (32.3% vs. 74.4%, P = 0.003) at the time of bacteremia. The outcomes of patients are described in Table 2 according to the appropriateness of empirical therapy. The ICU and hospital mortality rates were lower in the appropriate therapy group, but the difference was not statistically significant. However, appropriate empirical therapy was associated with lower ICU mortality risk (OR: 0.15; 95% CI: 0.03-0.96) on multivariate analysis. The other variables associated with ICU mortality were mechanical ventilation (OR: 8.99; 95% CI: 1.75-46.13) and serum lactate on the day of *Acinetobacter* bacteremia (OR: 1.21 per 1 mmol increment: 95% CI: 1.01-1.45).

Discussion

This retrospective cohort study of 60 adult critically ill patients who developed *Acinetobacter* bacteremia during ICU stay from January 2005 to December 2010 found a high prevalence of antimicrobial resistance among cultured *Acinetobacter* strains and showed that appropriate empirical antibiotic therapy was given only to 60% of patients and associated with reduced ICU mortality risk.

Acinetobacter bacteremia is mainly a nosocomial infection, mostly acquired in the ICU.[23] In our study, the overall occurrence of *Acinetobacter* bacteremia in our patient population was rare as only 60 cases were identified within a 6-year period in our ICU, which admitted approximately 900 patients annually. This relatively rare incidence has been seen in other studies. A prospective study in a Dutch university hospital between 1999 and 2006 found that the incidence of *Acinetobacter* isolates from all cultured specimens to be around 1.7-3.7 per 10,000 patient-days.[24] Another study evaluated nosocomial bloodstream infections from 1995 to 1998 at 49 US hospitals and found that infections caused by *Acinetobacter* species accounted for only 1.5% of all infections and were more likely to occur in ICUs.[25]

Risk factors for nosocomial *Acinetobacter* bacteremia are generally thought to be those of opportunistic infections.[26] A cohort study in a 40-bed medical and surgical ICU identified immunosuppressed state, respiratory failure at ICU admission, previous antimicrobial therapy, previous sepsis in the ICU, and the invasive procedures index as independent risk factors for *Acinetobacter* bacteremia.[27] Another study additionally found that burn infections preceded *Acinetobacter* bacteremia.[28] In burn patients, total body surface area burn of >50% was significantly associated with the development of *Acinetobacter* bacteremia.[29] In our study, *Acinetobacter* bacteremia occurred in patients several days after hospital and ICU admission, suggesting that prolonged stay and probably extended antimicrobial exposure were significant risk factors. Moreover, most patients had central venous catheters (98%) and required mechanical ventilation (61%) at the time of bacteremia and there was a high prevalence of burn and solid organ transplant patients in our cohort suggesting that these factors and conditions might also be important.

Importantly, all *Acinetobacter* cultures in this study were found to be MDR. The vast majority (90%) of cultured strains were resistant to carbapenems. This high rate of MDR strains has also been reported in other studies.[15,23,25,30,31] The susceptibility patterns of *A. baumannii* strains seem to be different according to study dates and geographical locations. A US study from 1995 to 1998 found that *A. baumannii* isolates were 100% susceptible to imipenem, 92% to tobramycin and 90% to amikacin.[25] More recently, a study from the UK showed increasing resistance to carbapenems from 0% in 1998 to 55% in 2006.[23] In Saudi Arabia, *Acinetobacter* isolates from a tertiary-care ICU had decreasing susceptibility patterns from 2004 to 2009.[32] For instance, the susceptibility to imipenem decreased from 55% to 10% (P < 0.001) and to meropenem from 33% to 10% (P < 0.001).[32] In our study, we found limited resistance (1.7% of isolates) to colistin. Nevertheless, resistance in *A. baumannii* to colistin is an emerging problem.[30,31,33] Regional colistin resistance ranged between 1.8% and 12%.[30,33]

Table 2: The outcomes for the cohort patients who were received the appropriate empirical antimicrobial therapy versus inappropriate therapy

Variables	All patients (n = 60)	Appropriate empirical therapy (n = 36)	Inappropriate empirical therapy (n = 24)	P
MV duration (days), mean±SD	16.3±16.0	18.5±17.4	13.0±13.2	0.20
Hospital LOS (days), mean±SD	53.5±60.8	63.6±73	38.4±27.9	0.07
ICU LOS (days), mean±SD	20.0±15.9	22.3±17.3	16.7±13.3	0.20
New do-not-resuscitate order in the ICU, *n* (%)	27 (45)	17 (51.5)	10 (55.6)	0.78
ICU mortality, *n* (%)	40 (66.7)	22 (61.1)	18 (75.0)	0.26
Hospital mortality, *n* (%)	54 (90)	33 (91.7)	21 (87.5)	0.68

ICU=Intensive Care Unit, LOS=Length of stay, SD=Standard deviation, MV=Mechanical ventilation

It can be logically expected that the presence of high rates of resistance to multiple antimicrobials would lead to high rates of inappropriate EAT. In a Turkish study, the initial antimicrobial treatment was appropriate in only 19.7% of patients with imipenem-resistant *A. baumannii* bacteremia.[11] In a study from Taiwan, inappropriate EAT for *Acinetobacter junii* bacteremia occurred in 53.5%.[34] However, in our study, appropriate therapy was colistin-based, correctly administered in 60% of patients and more common in the 2008-2010 admission period than the preceding 3 years suggesting that the ability of the treating intensivists to predict and treat MDR pathogens as the cause of ICU-acquired septic shock improved with time. Prior cultures from other sites growing *Acinetobacter* might be another reason for the administration of appropriate empirical therapy.

In our study, *Acinetobacter* bacteremia was associated with high morbidity and mortality. A retrospective matched cohort study of 45 ICU patients with *A. baumannii* bacteremia and 90 matched controls found that *A. baumannii* bacteremia was associated with 5 additional days of ICU stay, longer duration of mechanical ventilation than controls,[35] but not with mortality (hazard ratio: 0.96; 95% CI: 0.67-1.38).[35] The attributable mortality was estimated at 7.8%.[35] A systematic review of 6 matched case-control studies which examined the attributable mortality from infection with or acquisition of *A. baumannii* found that the attributable ICU mortality ranged from 10% to 43% and hospital mortality from 7.8% to 23%.[36] The relationship between the appropriateness of empirical therapy and outcomes of *Acinetobacter* infections showed mixed results. Zaragoza *et al*. failed to attribute inappropriate empirical therapy to increased patient mortality in *Acinetobacter* related nosocomial infections.[13] Falagas *et al*. also found no significant difference in the mortality of patients who had appropriate or inappropriate treatment.[37] In contrast, Erbay *et al*. found that mortality was statistically greater for patients receiving inappropriate initial antimicrobial treatment within 48 h compared with appropriate initial treatment (65.0% vs. 39.5%; $P = 0.011$).[11] Similarly, Choi *et al*. found that inappropriate antimicrobial therapy within 72 h was associated with higher mortality compared to appropriate therapy (40% vs. 8%; $P = 0.007$) with OR = 6.6 (95% CI: 1.7-26.0).[38] A recent systematic review on the relation between antimicrobial resistance and the mortality associated with *Acinetobacter* infections showed that inappropriate antimicrobial therapy was associated with adjusted OR of mortality that ranged between 1.39 and 8.05.[39] We found that appropriate empirical therapy was associated with decreased ICU mortality risk. In general, appropriate antimicrobial therapy has been shown to improve the outcomes of patients with severe sepsis or septic shock.[40,41] The absence of association between appropriate empirical therapy and decreased mortality in some studies can be due to the ineffectiveness of drugs such as intravenous colistin against MDR *Acinetobacter*,[42] which could be due to levels below the minimal inhibitory concentration at the recommended doses.[43] The timing of appropriate antimicrobial therapy might also be very important.[41] Of note, Erbay *et al*. used a 48 h interval for establishing the appropriateness of treatment[11] while Falagas *et al*.[37] used a 72 h interval. Our study suggests that the reported poor outcomes of *Acinetobacter* bacteremia may be related in part to the inappropriate empiric antimicrobial therapy, the delay in administering the appropriate regimen and the inadequate dosing. We used a pragmatic long window, until susceptibility results were available, for defining appropriate empirical therapy. However, evidence suggests that each hour delay in the administration of appropriate antimicrobials adds substantially to the mortality of septic patients.[41] The Surviving Sepsis Campaign recommends the administration of antibiotics within 1 h for patients with severe sepsis and septic shock.[44] This is probably true for *Acinetobacter* sepsis as well. In addition, there is considerable debate about including colistin in the empiric antimicrobial regimen because of concerns about inducing resistance. However, this concern must be weighed against the benefit of early and appropriate institution of antimicrobial therapy. Administering the correct dose of colistin is also important. There are two forms of colistin, colistin base and its produrg colistimethate sodium (also known as sodium colistin methanesulphonate, colistin methanesulfonate, and colistin sulfomethate), with different dosing recommendations.[45] Colistin base has a potency of 30,000 IU/mg, whereas colistimethate sodium has a potency of 12,500 IU/mg.[45] This may confuse physicians and lead to inappropriate dosing.[45] Actually, optimal colistin dose for the treatment of MDR Gram-negative bacterial infections in the ICU is still unknown as its pharmacokinetic and pharmacodynamic data are scarce in this setting.[46] Loading and higher maintenance doses, increased administration frequency or its use as part of combination therapy may be needed to increase colistin effectiveness.[46,47] A study in critically ill patients demonstrated that colistimethate sodium monotherapy was unable to achieve adequate plasma concentrations of colistin base.[47] Further studies are needed to examine the most effective colistin compound, dosing frequency, whether the dose selection should be based on the minimal inhibitory concentrations and the clinical utility of serum colistin levels in guiding dosing. Obviously, there is a growing need for other antimicrobials for the treatment of MDR *Acinetobacter* infections. Tigecycline and minocycline may be good candidates.[48] However, data on their effectiveness are lacking, and tigecycline resistance is emerging and has reached 43% in Saudi Arabia.[49]

This study should be interpreted in the light of its strengths and limitations. The limitations of this study include its retrospective nature and the small number of the patients. Further, it analyzed data from critically ill patients from one center, so the results may not be generalizable. The mortality rate was high for both appropriate and inappropriate antimicrobial therapy groups, which makes the interpretation of results difficult.

Conclusion

All episodes of *Acinetobacter* bacteremia occurring in this 6-year cohort were related to MDR strains and had a poor prognosis. Appropriate EAT was administered in 60% of patients and associated with decreased ICU mortality risk. The study highlights the seriousness of *Acinetobacter* bacteremia and suggests that the poor outcomes of patients with *Acinetobacter* bacteremia may have been related, at least in part, to inappropriate and delayed antimicrobial therapy as well as inadequate dosing.

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