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RESEARCH ARTICLE

The Relationship between Acinetobacter Pneumonia Rale Scores and Mortality

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ABSTRACT

Objectives: Acinetobacter baumannii is an opportunistic pathogen that is frequently detected in intensive care unit (ICU) patients. It is a cause of ventilator-associated pneumonia (VAP). The severity of lung involvement can be determined using Radiographic Assessment of Lung Edema (RALE) scores, which are determined based on data from chest X-rays. This study aimed to investigate the relationship between the RALE scores of patients with Acinetobacter VAP and mortality.

Methods: The study was conducted in ICUs between 2020 and 2021. All ICU inpatients older than 18 years with a diagnosis of Acinetobacter baumannii pneumonia were included in the study. Patients infected with other bacteria or viruses, those with immunodeficiency, and those younger than 18 years of age were excluded from the study. Chi-square tests were used for all statistical analyses.

Results: The cohort had a mean age of 68.1 years and 56% were males. The incidence of comorbidities was 85%. Treatment was empirical antibiotics in 42% of patients and antibiotics specific to the causative agent in 58%. RALE scores were 25–36 in 50%, 37–48 in 32%, and 13–24 in 18% of the patients. The mortality rate was 65%.

Conclusion: RALE scores in the 13–24 range were correlated with persistent pneumonia using combined antibiotics. RALE scores in the 25–36 and 37–48 ranges were correlated with mortality.

Keywords: Acinetobacter, mortality, pneumonia, radiology, RALE scores

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Introduction

Acinetobacter baumannii is an opportunistic pathogen that is detected in intensive care units (ICUs) with increasing prevalence. The bacterium becomes distributed throughout the ICU environment, colonizing human mucosal surfaces and medical devices.[1] Acinetobacter causes ventilator-associated pneumonia (VAP), and can infect the abdomen, bloodstream, skin, and soft tissue, as well as causing catheter-related urinary tract infections.[2] VAP is a form of pneumonia that occurs at least 48 h after endotracheal intubation and is associated with high mortality.[3] There is often severe pulmonary involvement. The severity of lung involvement can be determined using Radiographic Assessment of Lung Edema (RALE) scores, which are assessed using chest X-rays (CXR). On CXR, increased lung edema and opacities are associated with more severe clinical findings. It has been reported that, for each unit of increase in the RALE score, the risk of mortality is increased by 1.23 times.[4,5] Hence, the severity of lung involvement is an important risk factor.[6] In this study, we investigated the relationship between the RALE scores of patients with Acinetobacter VAP and mortality.

Methods

The study was conducted in internal medicine departments and surgical ICUs in 2020–2021. All patients >18 years of age who were diagnosed with Acinetobacter baumannii pneumonia at least 48 h after intubation (indicating VAP) were included in the study. Patients with pneumonia before intubation, those with another bacterium growth in their cultures,

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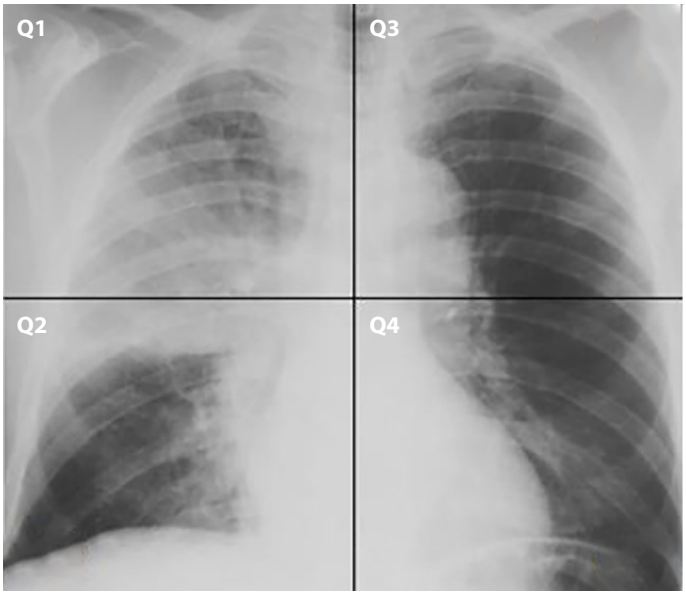
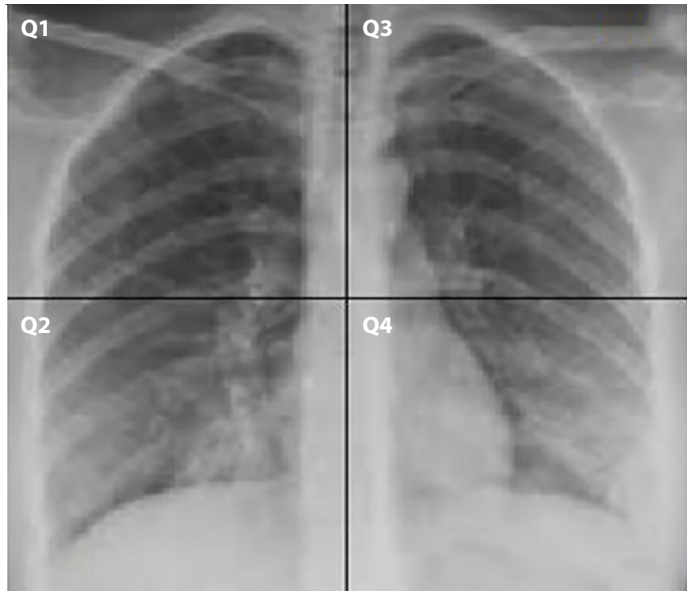
those with COVID-19 pneumonia, those with immunodeficiency, those transferred from the ICU of another hospital, transferred to another hospital, and those younger than 18 years old were excluded from the study. The data from a total of 125 patients who met the criteria were analyzed retrospectively. The data collected and analyzed from each patient comprised age, sex, comorbidities, laboratory results (white blood cell (WBC), neutrophil (NEU), and lymphocyte (LYM) counts; C-reactive protein (CRP) and procalcitonin (PCT) levels; and blood gases), RALE score, antibiotics administered, response to treatment, the day of intubation after admission, the duration of intubation, the lengths of stay in the ICU and hospital, complications, and mortality. The normal reference ranges of the laboratory parameters are 4–11/nL WBC, 1–4.8/nL NEU, 1–4.8/nL LYM, 0–5 mg/L CRP, 0–0.05 ng/mL PCT. The percentage value of alveolar opacity was calculated and the consolidation score was calculated as 0, 1, 2, 3, or 4. The density of alveolar opacity was calculated as 1, 2, or 3 on CXR. The density and consolidation scores for each quadrant on the CXR were summed. The total of the scores of the four quadrants was recorded as the patient's radiological RALE score (Fig. 1, Table 1). Chi-square tests were used in the statistical analysis of all data. This study was conducted in accordance with the tenets of the 1964 Declaration of Helsinki and its later revisions. Ethical approval was received from the Medical Ethics Committee of our institution.

Results

Of the 125 patients in our cohort, 56% were male and 44% were female. The distribution of patients by age range was 9% aged 20–40, 16% aged 41–60, 57% aged 61–80, and 18% aged >80 years (Table 2). The mean values of the laboratory parameters were 13.3 nL WBC, 11.5 nL NEU, 1.09 nL LYM, 137.7 mg/L CRP, and 3.17 ng/mL PCT. The mean intubation day was day 4.6, and the mean duration of intubation was 33.5 days (Table 3). Comorbidities were present in 85% of the patients. These included hypertension (HT), coronary artery disease, diabetes mellitus, cerebrovascular accident (CVA), chronic renal failure, chronic obstructive pulmonary disease, and malignancy (Fig. 2). Acinetobacter pneumonia was treated with empirical antibiotics in 42% of the patients. The remaining 58% were treated with non-empirical antibiotics specific to the causative agent. In the latter group of patients, 24% received a single type of antibiotic and 76% received an antibiotic combination. The response to antibiotics was infection eradication in 13% of patients and infection persistence in 87%. RALE scores were calculated from the radiological evaluation of CXRs and ranged from 13–24 in 18% of the cohort, from 25–36 in 50%, and from 37–48 in 32%. None of the patients had RALE scores in the 0–12 range, which were indicative of the lowest level of pulmo-





Score	Q1	Q2	Q3	Q4	Total
Consolidation	4	2	1	1	
Density	3	2	1	2	
Quadrant score	12	4	1	2	19

Score	Q1	Q2	Q3	Q4	Total
Consolidation	3	3	3	4	
Density	2	3	2	3	
Quadrant score	6	9	6	12	33

Figure 1. Calculation of RALE scores.
RALE: Radiographic Assessment of Lung Edema.

Table 1. RALE score calculation method

Consolidation	
Consolidation score	**Extent of alveolar opacities**
0	None
1	<25%
2	25–50%
3	50–75%
4	>75%
Density	
Density score	**Density of alveolar opacities**
1	Hazy
2	Moderate
3	Dense
Final RALE score	
Right upper quadrant	Consolidation×Density=Q1 score
Right lower quadrant	Consolidation×Density=Q2 score
Left upper quadrant	Consolidation×Density=Q3 score
Left lower quadrant	Consolidation×Density=Q4 score
Total RALE score	Q1+Q2+Q3+Q4

RALE: Radiographic Assessment of Lung Edema

Table 2. Demographic characteristics of the patient cohort

	n	Mean (%)	SD	95% (±)
Gender	125			
Male	70	56		5.20
Female	55	44		
Ages		68.1	2.42	
20–40	11	9	0.26	2.22
41–60	20	16	0.37	
61–80	72	57	0.49	
>80	22	18	0.38	

SD: Standard deviation

nary involvement. Intubation was initiated on the day of ICU admission (day 1) in 45% of the patients. In 78%, intubation was initiated during the first 3 days. Intubation was initiated later than day 10 in 13%. In 36% of the sample, the duration of intubation times was >30 days. Intubation durations were up to 20 days in 50%. The rate of extubation was 8% in all patients. Complications of VAP included Acute Respiratory Distress Syndrome (ARDS) in 84% and Multiple Organ Dysfunction Syndrome in 44%. The length of stay in the ICU was >30 days in 44% of the patients and up to 20 days in 39%. The length of hospital stay was up to 1 month in 51% of the patients and >2 months in 22% of patients. The mortality rate was 65%.

All statistical analyses for this study used chi-square tests. The incidence of VAP with Acinetobacter was significantly higher in males (p=0.027). VAP was correlated with comorbidities in patients >80 years (p=0.039). Acinetobacter VAP infection was significantly more prevalent among patients in the 61–80 age range (p=0.026). The use

Table 3. Study data and ranges of normal values

	Mean	Median	Normal values	SD	95%CI
White blood cells (WBC)	13.3 (4.1–39.2)	10.9	4–11 / nL	7.51	8.15
Neutrophil (NEU)	11.5 (1.0–73.2)	9.3	1–4.8 / nL	8.38	8.39
Lymphocyte (LYM)	1.09 (1.0–12.4)	0.91	1–4.8 / nL	1.10	10.41
C-Reactive Protein (CRP)	137.7 (2–413)	124	0–5 mg/L	74.7	22.8
Procalcitonin (PCT)	3.17 (0.025–14)	0.78	0–0.05 ng/mL	4.49	4.44
Blood gases					
pH	7.42 (7.1–7.7)	7.45	7.35–7.45	0.10	25.8
PO_2	82.1 (50–175)	79.7	75–100 mmHg	23.4	23.9
PCO_2	42.1 (18–99)	40	35–45 mmHg	12.8	21.5
SO_2	94.1 (82–99)	95	95–100%	4.07	15.6
HCO_3	26.9 (11–42)	26.6	21–27 mEq/L	6.12	10.3
Lactate	2.28 (0.14–20)	17	1–1.5 mmol/L	2.26	3.94
Data of intubation					
Days (th)	4.60 (1–53)	15		7.86	1.16
Times (days)	33.5 (2–150)	24		31.5	4.66
Length of stay					
ICU (days)	39 (4–152)	29		33.2	4.92
Hospital (days)	44.9 (4–155)	34		35.3	5.23

SD: Standard deviation; pH: Potential hydrogen; PO_2: Partial pressure of oxygen; PCO_2: Partial carbon dioxide pressure; SO_2: Sulfur dioxide; HCO_3: Bicarbonate; ICU: Intensive care unit.

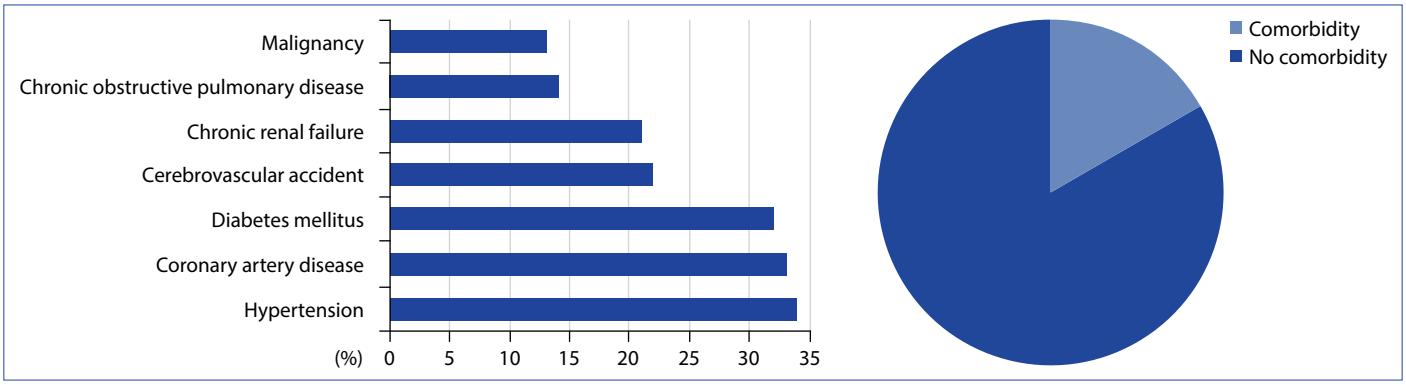


Figure 2. The distribution of patients' comorbidities.

of combined antibiotics was significantly more common than treatment with a single antibiotic (p=0.009). Treatment with antibiotics specific to the causative agent was correlated with the presence of comorbidities (p=0.044), but also with eradication of the infection (p=0.003). Treatment with just one type of antibiotic was correlated with the persistence of VAP (p=0.005). Patients aged 61–80 years with comorbidities were significantly more likely to be intubated on day 1, despite a low level of evidence (p=0.057). Patients who were intubated after the tenth day were related to those without comorbidity (p=0.023). Male patients >80 years with comorbidities had significantly shorter intubation durations (p=0.012). Ages <40 years were associated with longer intubation durations, to low evidence (p=0.063). The length of stay in the ICU was longer than 1 month for most of the cohort. Shorter stays in the ICU were correlated with the absence of comorbidities (p=0.041). Patients with comorbidity using empirical antibiotics were related to longer hospital stays (p=0.018). Shorter hospital stays were correlated with an absence of comorbidities combined with antibiotics specific to the causative agent (p=0.015). Patients with a RALE score of 13–24 were related to persistent pneumonia using combined antibiotics (p=0.041). Mortality was correlated with ages >80 years combined with comorbidities (p=0.042). RALE scores in the 25–36 (p=0.036) and 37–48 (p=0.053) ranges were correlated with mortality (Table 4).

Discussion

VAP is a form of pneumonia that occurs after intubation. It constitutes approximately 50% of all hospital-acquired pneumonia.[7] VAP is the most common intensive care infection with an incidence of 6%–52%[8] and, in ICU patients, it can have serious consequences. The rate of VAP in ICUs in the present study was 25%–35%. Acinetobacter baumannii is a serious hospital-acquired infection with a mortality rate of 45%–80% in cases resistant to antibiotic treatments.[9] Given the propensity of VAP to multi-drug resistance (MDR), there are few therapeutic options. Acinetobacter baumannii bacteria are able to survive on non-living surfaces such as endotracheal tubes and catheters, making their spread difficult to control.[10] The ability of Acinetobacter baumannii to produce biofilm is also an important contributor to its virulence as this facilitates its transmission over many surfaces.[11]

A previous study has reported a mean age of 54.9 years and a higher incidence in men among VAP patients, with hypertension being the most common comorbidity.[12] The present study supported two of these findings as we also saw a significantly higher rate of VAP in men and found hypertension to be the most common comorbidity. However, the mean age in our cohort was 68.1 years. Since Acinetobacter baumannii is usually an MDR bacterium, antibiotic options for the treatment of patients are limited.[13] The patients in our sample were treated with single or combined antibiotics based on whether their pneumonia was contracted in the hospital or the community. The single antibiotics used empirically included ceftriaxone, piperacillin-tazobactam, meropenem, and (rarely) levofloxacin. Combined antibiotics used empirically included meropenem vancomycin, piperacillin-tazobactam levofloxacin, and colistin tigecycline. When Acinetobacter was detected in a patient's culture, antibiotics were selected according to the sensitivity of the antibiogram. Antibiotics used that specifically targeted the causative agent included colistin tigecycline, meropenem tigecycline, and sulfamethoxazole tigecycline. Ampicillin is the most commonly resistant antibiotic so this was not used. The overall response rate to antibiotic treatments was 13% in our VAP cohort. Unfortunately, despite treatment, pneumonia persisted in the remaining 87%. The majority of Acinetobacter strains found in the patients studied were MDR.

Antibiotic resistance is a serious problem in VAP. Acinetobacter in ICUs commonly shows MDR. Risk factors for MDR microorganisms are antibiotic treatment in the last

Table 4. Statistical analyses of study data

Parameters	Acinetobacter Baumannii			Parameters	Acinetobacter Baumannii		
	n	%	p		n	%	p
Gender	125			4–5rd days	10	8	
Male	70	56	0.027	6–10rd days	14	11	
Female	55	44		>10rd days	16	13	0.023
Ages				Intubation times			
20–40	11	9		0–10 days	26	21	
41–60	20	16		11–20 days	36	29	0.012
61–80	72	57	0.026	21–30 days	18	14	
>80	22	18	0.039	>30 days	45	36	0.063
RALE scores				Length of stay in ICU			
0–12	0			0–10 days	18	14	
13–24	22	18	0.041	11–20 days	32	25	0.041
25–36	63	50	0.036	21–30 days	21	17	
37–48	40	32	0.053	>30 days	54	44	
Antibiotics				Length of stay in Hospital			
One antibiotic	30	24		0–15 days	26	21	
Combined antibiotic	95	76	0.009	16–30 days	38	30	0.015
Empirical antibiotic	53	42		31–60 days	33	26	
For the causative agent	72	58	0.044	>60 days	28	22	0.018
Response to treatment				Complications			
Persistent	109	87	0.005	ARDS	105	84	
Eradication	16	13	0.003	MODS	55	44	
Day of intubation				Mortality	82	65	0.042
1rd day	56	45	0.057				
2–3rd days	29	23					

RALE: Radiographic Assessment of Lung Edema; ICU: Intensive care unit; ARDS: Acute Respiratory Distress Syndrome; MODS: Multiple Organ Dysfunction Syndrome

3 months, hospitalization for more than 5 days, a high frequency of bacterial resistance in the hospital, and immunosuppression.[14] Fortunately, these risk factors were very rare in the patients studied. Early and appropriate treatment of VAP is related to decreased mortality, while inadequate treatment in the first 48 h is associated with a 91% mortality rate. The mortality rate is lower with appropriate empirical treatments.[15] Most of the patients in our study received early treatment and combined antibiotics. Although the mortality rate was lower in patients who received appropriate empirical treatment, the difference in mortality according to treatment type was not statistically significant. Intubation after the tenth day in the ICU and intubation durations of up to 20 days were both correlated with mortality.

Radiology is important in the evaluation of pneumonia. CXR is the preferred means of examination in pneumonia patients due to its accessibility and cost-benefits. Of course, computed tomography should be used in cases where pathology cannot be detected on CXR. Nosocomial pneumonia is a form specifically acquired in hospitals; imaging is usually limited but indicative. The radiological patterns of different pneumonias are variable but diffuse, multifocal involvement with pleural effusion is the most common.[16] Pulmonary edema is important to the pathogenesis and prognosis of ARDS. The RALE score assesses both the extent and intensity of alveolar opacity on CXR.[17] Because VAP is aggressive, ARDS is often seen in patients. The ARDS rate was 84% in the study. We investigated the relationship between RALE scores and VAP. RALE scores in the 0–12 range, which represented the least severe lung involvement, were not correlated with VAP. RALE scores in the 13–24 range were correlated with persistent pneumonia using combined antibiotics. RALE scores in the 25–36 and 37–48 ranges were correlated with increased mortality. The length of stay in the ICU was often longer than a month in patients with VAP. Shorter stays in the ICU were correlated with the absence of comorbidities. Patients with comorbidities using empirical antibiotics had significantly longer hospital stays.

Disclosures

Ethics Committee Approval: The study was approved by The Gaziantep Islam Science and Technology University Non-interventional Clinical Research Ethics Committee (Date: 23/03/2022, No: 72).

Informed Consent: Written informed consent was obtained from all patients.

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

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