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Original Article

Prognostic Value of Procalcitonin/Albumin Ratio in Patients with Severe Community Acquired Pneumonia

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ABSTRACT

Objective: To evaluate the effectiveness of procalcitonin to albumin ratio (PAR) in predicting in-hospital mortality among patients presenting with severe community acquired pneumonia (CAP), using mortality outcomes as a reference standard.
Study Design: Cross-Sectional Validation Study.
Place and Duration of Study: Intensive Care Unit, Department of Medicine, Combined Military Hospital Gujranwala, Pakistan from Jul to Dec 2025.
Methodology: A total of 120 adults admitted to ICU with a confirmed diagnosis of severe CAP were enrolled. Informed consent was obtained prior to participation. Baseline demographic and clinical data including age, sex, residence and symptom duration were documented. Serum procalcitonin and albumin levels were measured to compute PAR. A PAR threshold of ≥ 0.22 was used to anticipate in-hospital mortality. All patients were monitored throughout their hospital stay to determine outcomes. Statistical analysis was performed using SPSS version 26.0. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and overall diagnostic performance of PAR were calculated using a 2×2 contingency approach, taking mortality during hospitalization as a comparator.
Results: The mean age of participants was 58.28±5.00 years, and 75% patients were males. The mortality rate during hospitalization was 60.8%. Sensitivity, specificity, PPV, NPV and diagnostic accuracy of PAR were 84.93%, 80.85%, 87.3%, 77.6% and 83.3% respectively.
Conclusion: The procalcitonin to albumin ratio is a dependable and practical biomarker for early prediction of mortality in patients with severe CAP. Incorporating PAR into routine assessment may support better clinical decision making in critical-care settings.

Keywords: Albumin, CURB-65, Hospital Mortality, Pneumonia, Procalcitonin, Severity of Illness.

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INTRODUCTION

Pneumonia remains a major global health challenge and continues to be a leading infectious cause of death particularly in the United States and many other developed and developing nations. Despite its burden, a clear and universally accepted clinical definition is still evolving.[1] Recent data from health insurance-based research in Germany estimates an incidence of approximately 9.7 cases per 1,000 individuals annually, translating into more than 660,000 affected persons each year.[2] Community acquired pneumonia (CAP) is among the most prevalent and life-threatening infectious conditions, yet many aspects of its pathophysiology and optimal management remain inadequately understood.[3] Although considerable progress has been made in antimicrobial therapy and vaccination, CAP continues to pose a significant health threat, especially in low and middle socioeconomic countries.[4] It is often not regarded as a high priority condition among general population, despite its substantial mortality. Nearly one third of patients may die within a year following hospital discharge for pneumonia.[5] CAP affects individuals across all age groups and contributes heavily to healthcare costs because of repeated admissions and complications. Globally, it remains one of the leading causes of hospitalizations and infectious-disease related deaths.[6]

Given the high mortality associated with severe CAP, early recognition of high-risk patients is essential for timely and aggressive management. Numerous biomarkers have been explored to gauge pneumonia severity, each demonstrating varying levels of diagnostic performance.[7] Procalcitonin, a precursor of calcitonin, rises within few hours of bacterial infection and correlates well with CAP severity.[8] Albumin, in contrast, is a negative acute phase reactant with antioxidant and anti-inflammatory properties. Combining these two markers as the procalcitonin to

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albumin ratio (PAR) has shown promise, with earlier studies suggesting that a PAR value ≥0.22 may predict mortality in hospitalized patients.[9]

Although some researches have assessed PAR in other infectious conditions such as sepsis,[10] and COVID-19 pneumonia, there is scarcity of data evaluating its diagnostic utility specifically in patients with severe CAP, particularly in local populations like ours. Many patients presenting to our facility come from rural backgrounds and economically disadvantaged communities, often resulting in delayed hospital presentation due to limited healthcare access and financial constraints. Assessing the usefulness of PAR in this setting may help clinicians identify high-risk patients more accurately, initiate timely intensive care interventions, and ultimately improve clinical outcomes.

METHODOLOGY

This cross-sectional validation study was conducted in Department of Medicine, Combined Military Hospital Gujranwala, Pakistan over a period of 6 months. The sample size of 120 participants was determined using Buederer's formula for diagnostic test studies, taking a 95% confidence level (Z=1.96), 10% absolute precision, an estimated in-hospital mortality rate of 66.5%,[11] and previously reported sensitivity and specificity values of 87.4% and 77.6%,[12] respectively for the procalcitonin to albumin ratio (PAR). The minimum sample size calculated from sensitivity was 64 participants and from specificity was 200 participants. Considering resource and time constraints, a consecutive sample of 120 patients meeting inclusion criteria, were recruited through a non-probability consecutive sampling method during the study period.

Inclusion Criteria: Patients aged 20–65 years, of either gender, who were diagnosed with severe CAP were included. Diagnosis of CAP was made is patients presenting with productive cough and fever (>100 0F) for > 1 week having crepitation on auscultation and radio-opaque shadows on x-ray chest. Patients with CURB-65 scores of ≥ 3 were categorized as cases of severe CAP and included in the study.

Exclusion Criteria: Patients who were HIV positive on ELISA and HIV PCR, those who had taken steroids > 2 doses (IV or oral steroids equivalent to 0.5 to 2mg/kg of prednisolone) in past 2 weeks and those with history of tuberculosis or lung surgery were excluded.

Ethical approval for the study was granted by the Institutional Ethical Review Board (ERB Approval No. 17-2024 dated 09 Oct 2024). Before enrollment, the study objectives and procedures were thoroughly explained to each eligible patient, and written consent was obtained. Demographic and clinical variables including age, sex, residence and symptom duration were documented on a structured proforma. Laboratory investigations were done including serum procalcitonin and albumin measurements, from which PAR was calculated. A threshold value of ≥ 0.22 was used to predict in-hospital mortality. All patients were managed as per institutional guidelines and followed during course of hospital stay for in-hospital mortality.

Collected data was recorded in a predesigned proforma by the principal investigator and analyzed using Statistical Package for Social Sciences version 26.0.. Continuous variables were summarized as Mean±SD. Frequency and percentage was calculated for gender, comorbid (DM and HTN), smoking status and in-hospital mortality. A 2x2 contingency table was constructed to calculate sensitivity, specificity, positive predictive value, negative predictive value and overall diagnostic accuracy of PAR using in-hospital mortality as reference standard.

RESULTS

A total of 120 patients with severe CAP were included. Mean age of patients was 58.28±5.00 years. Gender and PAR categories being categorical variables are presented as frequency and percentage.

Out of 120 patients, 90(75.0%) were males and 30(25% were females (Table-I). Overall, 73(60.8%) patients died during course of hospital stay.

Table-I: Gender Distribution of Study Population (n=120)

Gender	n (%)
Male	90 (75.0)
Female	30 (25.0)
Total	120 (100.0)

71(59.2%) patients had raised PAR (≥0.22) on presentation and out of these, 62(87.3%) experienced in-hospital mortality (TP) while 9(12.7%) patients were discharged from ICU upon stabilization (FP). 49(40.8%) patients had normal PAR (< 0.22) and out of these, 11(22.4%) experienced in-hospital mortality (FN) while 38(77.6%) were discharged upon recovery (TN)(Table-II).

Sensitivity, specificity, PPV, NPV and diagnostic accuracy of PAR for predicting in-hospital mortality in

severe CAP patients was found to be 84.93%, 80.85%, 87.3%, 77.6% and 83.3% respectively (Table-III).

Table-II: Frequency of PAR with in-Hospital Mortality (n=120)

PAR Category	In-hospital Mortality present (%)	In-hospital Mortality absent (%)	Total n(%)
PAR ≥ 0.22	62(87.3)	9(12.7)	71(59.2)
PAR < 0.22	11(22.4)	38(77.6)	49(40.8)
Total	73 (60.8)	47(39.2)	120(100.0)

PAR: Procalcitonin to Albumin Ratio

Table-III: Diagnostic Performance of PAR for Predicting in-Hospital Mortality

Parameter	Sensitivity	Specificity	PPV	NPV	Diagnostic Accuracy
Value (%)	84.93	80.85	87.3	77.6	83.3

PPV: positive predictive value, NPV: negative predictive value

DISCUSSION

The study was done to assess the diagnostic capability of PAR in predicting adverse outcomes of CAP like in-hospital mortality. Raised baseline PAR value was seen to be related with increased risk of worse outcomes during hospitalization, which may help in accurate prognostication and identification of high-risk patients.

Procalcitonin has been used as a marker of acute inflammation and hypoalbuminemia in an indicator of severity of infection. Thus, raised PAR may prove to be an accurate readily available marker for prognostication of CAP. Participants in our study was of mean age of 58.28±5.00 years. In the research undertaken by Alanli *et al*., mean age of patients was 73.5±10.9 years as participants belonged to geriatric age group.[9] In the study by Altug *et al*., patients median age was 66 (57–76) years which was similar to our study.[12]

The prevalence of in-hospital mortality in CAP patients which was 60.8% in our study, was also similar to that reported in previous studies. Espinoza *et al*., in their retrospective cohort study reported that prevalence of in-hospital mortality from CAP was 66.5%.[10] Similarly, Alanli *et al*., reported mortality rate of 52.6% from CAP and Altug *et al*., reported mortality rate of 58.2% in patients presenting with sepsis due to CAP.[9,12] These consistent findings show that CAP is associated with significantly adverse outcomes. In our study, sensitivity of PAR for predicting in-hospital mortality in CAP was 84.93% while specificity was 80.85%. Ergenc *et al*., reported that PAR had 87.3% sensitivity and 91.3% specificity in foretelling mortality during hospitalization in COVID pneumonia patients.[11] In another study, Altug *et al*., reported that PAR had 87.4% sensitivity and 77.6% specificity in predicting mortality in severe CAP.[12] Though most of the previous studies were retrospective, findings of these regarding predictive utility of PAR in CAP were consistent with our prospective study. Small sample size, single center setting and limited time duration were limitations of our study which limit the generalizability of its findings.

The findings of the present study support the growing evidence regarding the prognostic significance of the procalcitonin/albumin (PCT/ALB) ratio in severe infections and pneumonia. Mansas SA *et al*., demonstrated that an elevated PCT/ALB ratio was significantly associated with increased intensive care unit mortality among septic patients, highlighting the combined impact of systemic inflammation and poor nutritional status on patient outcomes.[14] Similarly, Li X *et al*.[15] reported a strong prognostic performance of the PCT/ALB ratio for 28-day mortality in sepsis patients, with an area under the curve (AUC) of 0.835, suggesting good predictive accuracy. Comparable findings were observed by Huang *et al*.[16] who identified the serum PCT/ALB ratio as a valuable marker for both diagnosis and prognosis in sepsis-associated acute respiratory distress syndrome patients. In the context of pneumonia, Çeltekci B and Gülensoy ES found a significant correlation between mortality and inflammatory biochemical parameters in community-acquired and hospital-acquired pneumonia.[17] Alanlı R *et al*. demonstrated that the PCT/ALB ratio was an effective predictor of 30-day mortality in ICU patients with pneumonia.[18] These findings are consistent with the present study and reinforce the utility of the PCT/ALB ratio as a simple, cost-effective, and clinically useful prognostic biomarker in patients with severe community-acquired pneumonia.

CONCLUSION

Raised baseline PAR value was seen to be related with increased risk of worse outcomes during hospitalization, which may help in accurate prognostication and identification of high-risk patients. Serum procalcitonin and albumins levels are routinely performed in severe CAP patients in order to assess the extent of inflammation and response to treatment.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

AR & MT: Data acquisition, data analysis, critical review, approval of the final version to be published.

MA: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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