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The Effectiveness of CURB-65 and PSI Scores in Predicting Hospital Length of Stay in Patients Diagnosed with Community-Acquired Pneumonia in the Emergency Department

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Abstract

Introduction: Community-acquired pneumonia (CAP) is a major cause of infectious disease mortality and a burden on healthcare systems. CURB-65 and Pneumonia Severity Index (PSI) scores assess disease severity and guide hospitalization decisions, but their role in predicting hospital stay remains unclear. This study evaluates the effectiveness of CURB-65 and PSI scores in predicting hospital stay and their utility in forecasting ICU admission and mortality.

Materials and Methods: This retrospective study included adult CAP patients admitted to the Pulmonology Department via the Emergency Department between September 2021 and September 2022. CURB-65 and PSI scores were calculated, and their correlations with hospital stay, ICU admission, and mortality were analyzed using SPSS 20.0.

Results: A total of 82 patients (median age 67.69 years) were included. Patients hospitalized ≤7 days had a median CURB-65 score of 1 and PSI score of 83, while those >7 days had a CURB-65 score of 2 and PSI score of 115. CURB-65 scores ≥2 were linked to prolonged stays (>7 days) in 70% of patients, compared to 41% in those ≤7 days. PSI scores also differed significantly between groups ($p < 0.01$). Moderate positive correlations were observed between hospital stay and both CURB-65 ($r = 0.411$) and PSI scores ($r = 0.472$). ROC analysis showed an AUC of 0.754 for PSI, with 84.8% sensitivity and 46.9% specificity.

Conclusion: CURB-65 and PSI scores effectively predict hospital length of stay in CAP patients, aiding clinical decision-making and resource allocation.

Key words: Community-acquired pneumonia; severity of illness index; length of stay; mortality.

Introduction

Community-acquired pneumonia (CAP) is a leading infectious disease worldwide, significantly contributing to mortality and placing a substantial burden on healthcare systems (1). In the United States, it accounts for over 4.5 million visits to outpatient and emergency departments annually, making up approximately 0.4% of all hospital admissions (2). CAP is the second most common cause of hospitalization and the leading contributor to deaths related to infectious diseases (3). In managing patients with CAP, evaluating disease severity and selecting the appropriate care setting are crucial steps. Clinical assessments and standardized severity scoring tools are commonly used for this purpose. Among these tools, the Pneumonia Severity Index (PSI) and CURB-65 (confusion, uremia, respiratory rate, BP, age ≥ 65 years) are widely utilized (4). While PSI is highly regarded for its accuracy and proven reliability in clinical decision-making, CURB-65 offers a simpler alternative that is preferred by many emergency physicians (5, 6). The PSI score evaluates 20 clinical factors, including underlying health conditions, abnormalities in vital signs, and results from laboratory and imaging studies. Patients are classified into five prognostic categories (I-V). Lower scores (Group I) indicate an extremely low mortality risk of 0.1%, while higher scores (Group V) are linked to a significantly increased mortality risk of 27%. Regarding hospitalization recommendations, patients in Groups I and II are usually treated as outpatients, Group III is considered a borderline category, and those in Groups IV and V are typically admitted to general hospital wards or intensive care units (ICUs) (7, 8). CURB-65

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scoring system evaluates five straightforward and measurable criteria, as indicated by its acronym: altered mental status (assessed through tests or new confusion about identity, location, or time), blood urea nitrogen levels exceeding 7 mmol/L (20 mg/dL), respiratory rate equal to or above 30 breaths per minute, systolic blood pressure below 90 mmHg or diastolic pressure of 60 mmHg or less, and age 65 years or older (9). The 30-day mortality rates are estimated to be approximately 0.7%, 2.1%, 9.2%, 14.5%, and 40% for scores of 0, 1, 2, 3, and 4, respectively. Patients scoring 0-1 are generally eligible for outpatient care, while those scoring 2 often require hospitalization. Scores of 3 or higher, particularly 4 or 5, indicate the need for intensive care unit admission (10).

The primary aim of this study is to evaluate how effectively CURB-65 and PSI scores can predict hospital length of stay in pneumonia patients, emphasizing the identification of individuals at risk for extended stays exceeding seven days. The secondary aim is to investigate the ability of these scores to predict patient mortality.

Material and Methods

Study design: This retrospective study evaluated patients diagnosed with community-acquired pneumonia (ICD-10 codes J12.0-J18.9) who were admitted to the Emergency Department of Kutahya Health Science University Faculty of Medicine between September 11, 2021, and September 11, 2022, and subsequently hospitalized in the Pulmonology Department. The diagnosis of CAP was established using a combination of clinical, laboratory, and imaging findings. The findings included, for example, crackles or abnormal respiratory sounds on auscultation, positive laboratory tests for complete blood count, C-reactive protein, and other markers of infection, and imaging by chest radiography or computed tomography. Complementary methods increase the accuracy of diagnosis, which is verified retrospectively from the patient's record. The diagnostic approach was in line with the Infectious Diseases Society of America (IDSA) and the American Thoracic Society (ATS) established guidelines for community-acquired pneumonia. The CURB-65 and PSI scores of all patients were calculated, and their association with the duration of hospital stay was analyzed.

Patient selection: Patient information was gathered from follow-up records and the hospital's electronic medical system. The study included individuals aged 18 and above who were admitted to the Emergency Department. Exclusion criteria involved patients under 18 years of age and those with a positive COVID-19 (SARS-CoV-2) PCR (polymerase chain reaction) test either at admission or during their hospital stay. Out of 120 patients hospitalized in the pulmonology department, 22 were excluded due to COVID-19 PCR positivity, and 16 were excluded for incomplete data. The final sample consisted of 82 patients, categorized into two groups: 49 patients with hospital stays of 7 days or less and 33 patients with stays exceeding 7 days (Flow Chart 1).

CURB-65 Score and admission criteria: As per established guidelines, a CURB-65 of ≥2 usually mandates hospital admission, whereas a score of 0–1 usually favors outpatient care (10, 11). However, in the present study, a number of patients had a CURB-65, of which 1 was also admitted. The admitting decision was based on other clinical and social factors like frailty, poor social support, and concerns about patient compliance. These factors were considered by treating physicians at the time of hospital admission.

Ethical approval: Ethical guidelines were followed in accordance with the Declaration of Helsinki, strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for retrospective studies. Ethical approval for the research was obtained from the Non-Interventional Clinical Research Ethics Committee of Kutahya Health Science niversity (Decision No: 2022/10-06, Date: October 12, 2022).

Statistical analysis: Statistical analyses were performed using SPSS version 29.0 (IBM, Armonk, NY, USA). The Student's t-test was applied for variables with normal distribution, whereas the Mann-Whitney U test was used for non-normally distributed variables. Continuous variables are expressed as medians (min.-max.), and categorical variables are presented as percentages (%). Pearson's Chi-Square test was used for cross-tabulations. ROC analysis was conducted to assess the predictive value of PSI scores for prolonged hospital stays. A p-value below 0.05, within a 95% confidence interval, was considered statistically significant.

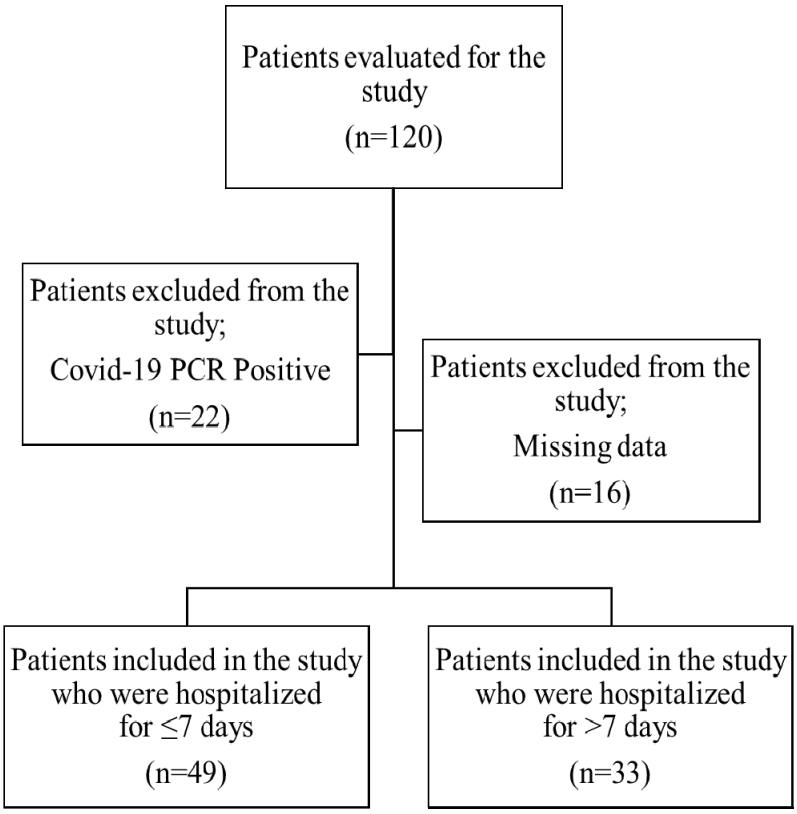
Results

Table 1 compares demographic and clinical characteristics of patients based on hospital stay duration (≤7 days vs. >7 days). Significant differences were observed in CURB-65 and PSI scores, both higher in the >7 days group (p=0.001

Table 1: Demographic data

Variable		≤7 days (n=49)	>7 days (n=33)	p-value
Age (Median, Min-Max)		68 (27-94)	74 (35-92)	0.539*
Gender (n, %)	Male	26 (53)	23 (70)	0.132*
	Female	23 (47)	10 (30)	
CURB-65 (Median, Min-Max)		1 (0-3)	2 (0-3)	0.001*
PSI Score (Median, Min-Max)		83 (17-132)	115 (70-158)	<0.001*
Length of Stay (Median, Min-Max)		5 (1-7)	24 (8-32)	<0.001*
Pulse (Median, Min-Max)		99(67-154)	101 (56-214)	0.712*
Respiratory Rate (Median, Min-Max)		22 (14-35)	30 (15-37)	0.013*
Systolic Blood Pressure (Median, Min-Max)		120 (90-220)	120 (90-220)	0.098*
Diastolic Blood Pressure (Mean,±SD)		75.3±9.99	75.0±14.4	0.904**
Fever (Median, Min-Max)		36.7(35.9-39)	36.5(36-39.5)	0.147*
BUN (Median, Min-Max)		17 (7-54)	22 (8-90)	0.002*
Na (Mean,±SD)		138±3.77	137±4.25	0.190**
Glucose (Median, Min-Max)		119 (84-371)	137 (85-347)	0.101*
Hematocrit (Mean,±SD)		39.3±5.75	38.3±6.36	0.443**
Chronic Conditions (n, %)	Cerebrovascular Disease		7 (8.5)	
	Malignancy		18 (21)	
	Congestive Heart Failure		7 (8.5)	
	Chronic Obstructive Pulmonary Disease		28 (34)	

**Mann-Whitney U **Student's t-test*



Flow chart of the study patients

and p<0.001, respectively). Additionally, respiratory rate and BUN levels were elevated in patients with longer stays (p=0.013 and p=0.002). No significant differences were found for age, gender distribution, or other clinical parameters. Among chronic conditions, COPD was the most common comorbidity, present in 34% of the patients. Table 2 highlights the relationship between scoring systems and hospital length of stay. Patients with longer stays (>7 days) exhibited significantly higher PSI scores (median: 115) compared to those with shorter stays (median: 83, p<0.001). Similarly, CURB-65 scores of ≥2 were more common in the >7 days group (70%) than in the ≤7 days group (41%, p=0.010). Moderate positive correlations were observed between both scoring systems and length of stay (r=0.411 for CURB-65 and r=0.472 for PSI, p<0.001). Table 3 examines the relationship between scoring systems and mortality. Patients who died had significantly higher PSI scores (median: 139) compared to survivors (median: 92, p<0.001). Although a higher CURB-65 score (≥2) was more frequent among deceased patients (12%), this difference was not statistically significant (p=0.115). Length of stay was notably longer in deceased patients (median: 15 days) compared to survivors (median: 6 days, p<0.001). The PSI score demonstrated an AUC of 0.754, indicating a fair diagnostic performance. At the optimal cut-off value of 83.50, the sensitivity (Sn) was 84.8%, while the specificity (Sp) was 46.9%. The positive predictive value (PPV) and negative predictive value (NPV) were 52.8% and 82.1%, respectively. The positive likelihood ratio (+LR) was 1.63, and the negative likelihood ratio (-LR) was 0.32, suggesting a moderate ability to rule out the condition when the score is below the threshold. (Table 4).

Table 2: Relationship between scoring systems and length of stay

Variable	≤7 days (n=49)	>7 days (n=33)	p-value
PSI Score (Median, Min-Max)	83 (17-132)	115 (70-158)	<0.001*
CURB-65			
Score <2 (n, %)	29 (59)	10 (30)	0.010**
Score ≥2 (n, %)	20 (41)	23 (70)	
	Curb65 Score	PSI Score	
Length of stay (%)	0.411	0.472	<0.001***

** Mann Whitney U, ** Chi-Square test, *** Spearman Rho Korelasyon*

Table 3: Relationship between scoring systems and mortality

Variable		Survival (n=76)	Dead (n=6)	p-value
PSI Score (Median, Min-Max)		92 (17-158)	139 (75-147)	<0.001*
CURB-65	Score <2 (n, %)	38 (97)	1 (3)	0.115**
	Score ≥2 (n, %)	38 (88)	5 (12)	
Length of stay (Median, Min-Max)		6 (1-32)	15 (4-30)	<0.001*

**Mann-Whitney U ** Chi-Square test*

Table 4: Diagnostic test results for PSI score

Cut off	AUC	Sn(%) / Sp(%)	PPV(%) / NPV(%)	+LR / -LR
83.50	0.754	84.8 / 46.9	52.8 / 82.1	1.63 / 0.32

AUC: Area Under the Curve, **Sn:** Sensitivity, **Sp:** Specificity, **PPV:** Positive Predictive Value, **NPV:** Negative Predictive Value, **+LR:** Positive Likelihood Ratio, **-LR:** Negative Likelihood Ratio

This means that the PSI score is highly sensitive in identifying patients with a likelihood of requiring prolonged hospitalization. Therefore, it classified mostly the patients with longer stays appropriately. However, its relatively lower specificity in classification has indicated that it classified a great proportion of patients whose stay was much shorter than others at high risk. While the high sensitivity ensures most high-risk cases are captured, the moderate specificity may lead to some unnecessary admissions, and there is a strong need for clinical judgment in conjunction with scoring systems (Figure 1).

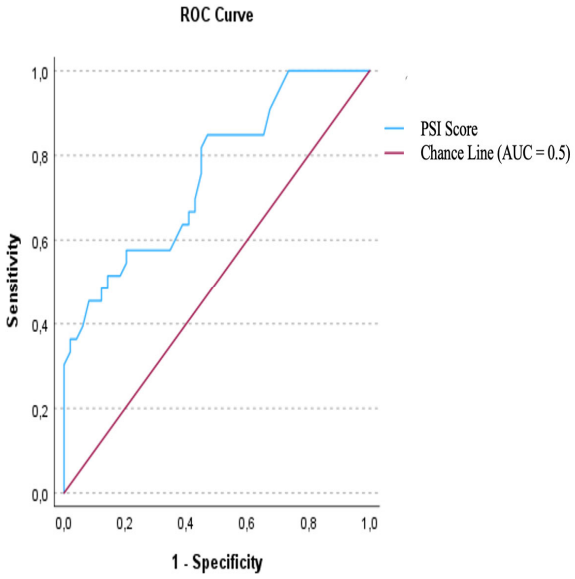


Figure 1. ROC Analysis of PSI Score for >7 days hospital length of stay

Discussion

CAP remains a significant health issue, particularly in developing countries, where its incidence ranges from 20% to 30%, compared to 3% to 4% in developed nations. Its frequency is notably higher among very young and elderly populations, reflecting age-related changes in lung physiology and immune defense mechanisms (12). With aging, reduced lung elasticity, weakened respiratory muscles, and decreased functional residual capacity increase the risk of CAP. In addition, impaired mucociliary clearance and diminished cough reflex efficiency contribute to bacterial colonization in the respiratory tract of elderly individuals, further heightening their susceptibility to CAP (13). In a study involving 1,068 patients, it was reported that 58% of the cases were aged 65 years and older (14). In line with these factors, our study reported a median age of 67.69 years among hospitalized patients, with men comprising 59.8% of the cohort. The predominance of male patients may be attributed to higher smoking rates, which are linked to chronic conditions like Chronic obstructive pulmonary disease (COPD) and cardiovascular diseases that predispose individuals to CAP. Comorbidities significantly impact CAP outcomes, influencing disease severity, treatment response, and hospitalization duration. Our findings align with prior research demonstrating a high prevalence of comorbidities among patients hospitalized with CAP. Our study identified the most prevalent comorbidities as COPD (34%), malignancy (21%), congestive heart failure (8.5%), and cerebrovascular disease (8.5%), consistent with the literature reporting COPD (13–53%), cardiovascular diseases (6–30%), and diabetes (5–16%) as frequent conditions (15). In a study conducted in our country by Bircan et al., comorbid conditions were identified in 41 cases (44.1%), including COPD (23.7%), diabetes mellitus (17.2%), and congestive heart failure (15.1%) (16). The severity scoring systems CURB-65 and PSI play a critical role in guiding hospitalization decisions for CAP patients. Guidelines recommend hospitalization for patients with PSI scores of ≥III or CURB-65 scores of ≥1 (or ≥2 if aged >65 years). While these scores are well-validated for predicting mortality, studies exploring their effectiveness in predicting hospital length of stay are limited. Our study addresses this gap and provides new insights into the utility of these scores in this context. Several studies in the literature have assessed the effectiveness and predictive ability of these two scores in relation to mortality. In the study conducted by Aynur et al., similar to our findings, a significant relationship was observed between higher PSI scores and mortality, with non-surviving patients having significantly higher scores than survivors. While CURB-65 was statistically insignificant for mortality prediction in this cohort, it demonstrated its utility in predicting severe pneumonia outcomes, similar to our study. Additionally, the prolonged hospital stays observed in non-surviving patients in their study highlight the burden of severe pneumonia, a finding consistent with our results, where non-surviving patients also had longer hospital stays (17). Our results demonstrated that a CURB-65 score of ≥2 was associated with a 41.1% increased likelihood of hospital stays exceeding 7 days. This finding aligns with the study by Carlos P. et al.,

which reported progressively longer hospital stays with higher CURB-65 scores: 5 days for a score of 0, 6.67 days for 1, 11.76 days for 2, 10.6 days for 3, and 11.42 days for 4 (18). Additionally, the PSI score exhibited a moderate positive correlation with length of stay, suggesting its utility in predicting not only mortality but also hospitalization duration. Our findings highlight the potential utility of CURB-65 and PSI scores in hospital resource planning, particularly in emergency and inpatient settings. The ability to predict hospital length of stay can aid in optimizing bed allocation and tailoring individualized patient management strategies. However, the moderate specificity of PSI for predicting long stays indicates that it is useful in risk stratification but cannot be the only parameter for deciding on hospital admissions. Future studies must investigate further clinical variables that might improve the accuracy of these scoring systems, which would, in turn, improve their utility in clinical practice settings.

From a clinical point of view, these outcomes have direct implications for the management of hospitals' resources. Since CURB-65 and PSI can predict hospital length of stay, that may assist in optimizing the bed allocation, prioritizing intensive monitoring of high-risk patients, and making the overall run of the hospital more efficient. Given the burden of CAP on healthcare systems, especially in an aging population, the inclusion of these scores in routine triage and admission protocols could potentially lead to more effective resource utilization and fewer unnecessary hospitalizations. However, the moderate specificity of PSI indicates that, although it is useful for risk stratification, it cannot be the only determinant of hospital admissions.

Study limitations: This study has several limitations, such as the relatively small sample size and its retrospective nature, which coincided with the COVID-19 pandemic. To confirm these findings and enhance their generalizability to various healthcare environments, future research should focus on multicenter prospective studies with larger patient populations. The study lacked a control group of CAP patients without comorbid conditions that may affect the length of hospital stay and other outcomes. Also, no subgroup analysis excluding comorbid patients was conducted. Furthermore, inconsistencies in the use of the CURB-65 cut-off values may also have introduced variability during risk stratification and clinical decision-making. Confirmation of these findings with a more generalizable application in various healthcare environments may be facilitated through multicenter, prospective studies that include a higher number of patients and potentially stratify them by comorbidity status.

Conclusion

CURB-65 and PSI scores are widely applied systems to quantify the severity of disease and identify hospitalization necessity for community-acquired pneumonia patients. In the current study, it was also demonstrated that scores of both scales were predictive of admission and had a significant correlation with the length of hospital stay. Patients with higher CURB-65 and PSI scores tended to stay longer in the hospital, and thus, these scores truly contribute to clinical practice and resource use decisions. Furthermore, our data indicate that PSI scores are highly sensitive predictors of outcomes, but specificity is only moderate and should be integrated with a degree of clinical judgment. Future studies with larger prospective cohorts are needed to refine these predictive models and validate their applicability in diverse clinical settings.

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Author contributions M.K, M.K.O. and H.Y. researched literature, conceived the study and wrote the first draft. M.K., A.H. and H.Y. were involved in protocol development, gaining ethical approval. A.C., M.K. and Y.T. were involved in data acquisition and data analysis. All authors reviewed and edited the manuscript and approved the final version of the manuscript.

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