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A new scoring system to predict mortality in community-acquired pneumonia: CURB (S)-65

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Abstract. – OBJECTIVE: The first decision to be made in the case of community-acquired pneumonia (CAP) is whether hospitalization of the patient is mandatory. In this study, we aimed to investigate whether the addition of oxygenation parameters to CURB-65 has diagnostic value in predicting mortality in CAP.

PATIENTS AND METHODS: A total of 903 CAP patients were included in the study. Patients with a CURB-65 score of 0 and 1 were classified as Group 1 and patients with a CURB-65 score of 2 or more were classified as Group 2. The prediction of mortality through Pneumonia Severity Index (PSI), CURB-65 and CURBS-65/CURBP-65 with the addition of SaO_2 and PaO_2 values; hence the four different models, was compared among all patient groups.

RESULTS: As a result, 3.3% of the cases in Group 1 and 12.7% of the cases in Group 2 died. In both CURB-65 groups, it was noted that the frequency of patients with SaO_2 <90% was significantly higher in the dead group than in the alive patient group (*p*=0.009 and *p*=0.001, respectively). In the univariate analysis, PaO_2<60, and SaO_2<90 were significantly associated with mortality. Model 2 (CURBS-65) and Model 3 (CURBP- 65) were examined, SaO_2<90 (OR 2.08) was found to have an effect on death. In predicting mortality by the receiver operating characteristics (ROC) analysis, it was understood that the CURBS-65 score had a slightly higher area under the curve (AUC) value than CURB-65.

CONCLUSIONS: As a result, it has been shown that the use of CURBS-65 scoring instead of CURB-65 clinical scoring may be more useful in predicting mortality.

Key Words:
Community-acquired pneumonia, Mortality, Pneumonia, Scoring system.

Introduction

Community-acquired pneumonia (CAP) is responsible for a significant part of hospital admissions, treatment costs, loss of labor days, and deaths worldwide[1-3].

The first decision to be made in the case of pneumonia is whether hospitalization of the patient is mandatory. Some objective criteria have been defined to assist the physician in making this decision, such as the CURB-65, Pneumonia Severity Index (PSI), CURB-age, CRB-65 criteria[4]. Using these criteria will help the identification of

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high-risk patients, as well as reduce unnecessary hospitalizations. Many treatment guidelines, that have been updated in recent years, recommend CURB-65 Score (Confusion, Urea ≥42.8 mg/dL, Respiratory rate ≥30/min, Blood pressure systolic <90 mmHg or diastolic ≤60 mmHg and age≥65 criteria) and PSI scores in this regard. The validity of both scoring systems has been demonstrated[2,5-8] in a large number of patients. CURB-65 is a scoring system defined to distinguish patients with high mortality risk and can be easily applied and used even in primary care[7]. Nevertheless, it is neither sensitive nor specific enough to determine the need for intensive care[9]. In CURB-65, the positivity of each parameter is numbered with 1 point, and hospitalization is recommended for patients with 2 points or above. The CURB-65 score combines only five variables to determine disease severity, and all parameters, besides blood urea nitrogen, can easily be calculated according to the patient's clinical evaluation. This is what makes CURB-65 an easy and practical scoring method for the clinician.

The PSI index, on the other hand, is a scoring system aiming to prevent unnecessary hospitalizations, and this scoring includes many laboratory measurements that can be performed in secondary or tertiary care and are difficult to recall and to use practically[5]. The PSI scoring system evaluates patients under five categories[5]. Accordingly, Group 1-2 (PSI <70 points) indicates those who can be outpatients, Group 3 (PSI 71-90 points) indicates patients who can be treated as outpatients but require individual assessment, Group 4 (PSI 91-130 points) indicates those who require hospitalization, and Group 5 (>130 points) indicates who requires intensive care follow-up.

Both scoring systems aim to assist the physician in deciding on hospitalization and predicting the prognosis. On the other hand, the decision to hospitalization in CAP depends on the opinion of the physician who evaluates the patient clinically and socially.

Although CURB-65 is sensitive in identifying patients with severe clinical manifestations, it may ignore some other factors that may be associated with the disease in milder cases[2]. Especially in cases with low blood oxygen saturation, the physician may hospitalize the patient to provide oxygenation, even if the patient does not indicate hospitalization according to the CURB-65 scoring index.

In this study, we aimed to investigate whether the addition of oxygenation parameters to CURB-65 has diagnostic value in predicting mortality in CAP and ICU admission.

Patients and Methods

Eleven centers, including 9 University Hospitals and 2 training and Research Hospitals contributed to this multicenter study. A total of 903 CAP patients who were registered to the Turkish Thoracic Society Pneumonia Study Group Pneumonia Database (TURKCAP) were included in the study.

Adult patients over 18 years of age registered in the TURKCAP database, whose data were complete, were included in the study. In light of the current guidelines, cases diagnosed as hospital-acquired pneumonia, pneumonia developed in immunocompromised patients, and ventilator-related pneumonia were excluded from the study. All of the patients were hospitalized with the diagnosis of CAP. CAP was diagnosed with the presence of pneumonic infiltrations in the chest X-ray, hearing localized rales and/or bronchial breathing sounds in the physical examination, and clinical findings consistent with pneumonia[2]. The prediction of mortality through PSI, CURB-65, and CURBS-65/CURBP-65 with the addition of SaO_2 and PaO_2 values; hence the four different models, was compared among all patient groups.

Model-1 refers to the classical CURB-65 score; Model-2 expresses the addition of SaO_2<90% in room air to the CURB-65 score (the saturation levels of the patients were measured at the time of hospital admission); Model 3 expresses the addition of decreased partial oxygen pressure (PaO_2<60 mmHg in room air) to the CURB-65 score (the partial oxygen pressure levels of the patients were measured at the time of hospital admission), and Model-4 refers to the classical PSI scoring. The CURB-65 and PSI scores were calculated for all patients at the time of hospital admission. The saturation levels and arterial blood gas values in room air during admittance were considered for the CURBS-65 and CURBP-65 scores. The decision whether to hospitalize patients was entirely at the discretion of the physician who examined the patient[10]. The data in the study were evaluated retrospectively. Approval was taken from the Ethics Committee of the Faculty of Medicine Gazi University (Ethics Committee No./Date: Gazi University Clinical Research Ethic Committee 104/22.04.2016).

Statistical Analysis

Data were analyzed using the SPSS 21 software (IBM Corp., Armonk, NY, USA). Descriptive statistical methods (mean, standard deviation, median, interquartile range) were used for the evaluation of the data. For group comparisons, *t*-test, Mann-Whitney U test, and Wilcoxon tests were used. Receiver operating characteristics (ROC) analysis was performed to analyze whether the new scoring systems have diagnostic value for prognosis. The results were evaluated with the area under the curve (AUC), 95% confidence interval, and *p*-value of the AUC was considered statistically significant ($p<.001$). Univariate logistic regression analysis was performed to examine the effects of variables on prognosis and variables with $p<.001$ were analyzed with the multivariate logistic regression model.

Results

Demographic characteristics and laboratory data of 903 patients included in the study are represented in Table I.

The relationship between death and SaO_2, PaO_2, and PSI score were examined separately in the patient groups with a CURB-65 score of 0-1 and a CURB-65 score ≥2. In both CURB-65 groups, it was noted that the frequency of patients with SaO_2 <90% was significantly higher in the dead group than in the alive patient group ($p=.009$ and $p=.001$, respectively), and the PSI scores were statistically significantly higher in those who died ($p<.001$ and $p<.001$, respectively). In light of these results obtained in univariate analysis, it was observed that SaO_2 <90% and high PSI score were parameters that could predict mortality, and whether they were independent risk factors was evaluated with multivariate analysis.

Univariate and Multivariate Analysis

The effects of the parameters forming CURB-65 and the variables SaO_2 and PaO_2, on mortality were evaluated by univariate logistic regression analysis. These data are presented as odds ratios (OR) with 95% confidence intervals (95% CIs). Variables with $p<.001$ in the univariate logistic regression analysis were included in the multivariate logistic regression analysis. The multivariate logistic regression model was performed to determine the relationship between mortality and these variables. In the univariate analysis, age≥65 years, uremia, low blood pressure, respiratory rate ≥30/min, confusion, PaO_2<60, and SaO_2 <90 were significantly associated with mortality. The models, developed with multivariate logistic regression analysis, revealed that age and blood pressure did not contribute to all three models. When Model 2 (CURBS-65) and Model 3 (CURBP-65) were examined, SaO_2 <90 (OR 2.08) was found to have an effect on death, while PaO_2 <60 was not found to be effective.

Receiver Operating Characteristics (ROC) Analysis

The power of different CURB-65 models (CURB-65, CURBS-65, CURBP-65) and PSI in predicting mortality were evaluated by ROC analysis (Figure 1).

As a result, the highest AUC value of PSI was found to be more effective in predicting mortality. It was understood that the CURBS-65 score had a slightly higher AUC value than CURB-65, and all scores had close prognostic values (Table II). The diagnostic values of CURB-65, CURBS-65, CURBP-65, and PSI scores in predicting the need for intensive care in pneumonia patients in the ward were also compared. According to the obtained results, it was determined that the AUC values of each score were very close to each other (Table III). As a result, it was understood that each of them had very close diagnostic values in predicting admission to intensive care (Figure 2).

What Should the Limit Value for CURBS-65 Be?

In the CURBS-65 scoring, each parameter was evaluated over 1 point, and it was calculated as the lowest zero score and the highest from 6 points. Max Youden index is one of the most commonly used methods to decide the cut-off value[11]. Considering the sensitivity and specificity values, it was observed that the highest cut-off value for Youden Index in mortality was 3.

Discussion

In this study, it was found that CURBS-65 may be more effective than CURB-65 in predicting mortality in CAP patients ($p<.001$). Multivariate regression analysis also showed that SaO_2 is an independent variable in terms of mortality risk. On the other hand, partial oxygen pressure was not found to be an independent risk factor.

CURB-65 is an easily applicable scoring system, but due to its low sensitivity in predicting mortality and intensive care unit (ICU) admission in low-risk patients, studies[12-17] that have tried to modify the CURB-65 scoring system have been performed previously.

Table I. Comparison of demographic characteristics and laboratory data between groups.

	Group 1 (CURB-65=0-1) n=241 (26.1%)	Group 2 (CURB-65≥2) n=662 (73.3%)	*p*
Sex, n (%)			415[1]
Male	74 (30.7%)	167 (69.3%)	
Female	222 (33.6%)	439 (66.4%)	.
Age, mean±SD	49.75±13.17	71.05±14.24	<.001[2]
Sigara, n (%)			.003[1]
Nonsmokers	90 (37.5%)	248 (37.7%)	
Current smokers	46 (19.2%)	71 (10.8%)	
Ex-smokers	104 (43.3%)	338 (51.5%)	
pH, n (%)			.001[4]
≥7.35	228 (98.3%)	602 (91.5%)	
<7.35	4 (1.7%)	56 (8.5%)	
PaO_2 (mmHg), mean±SD	64.95±16.44	59.90±15.26	<.001[2]
SaO_2 (%), mean±SD	91.66±10.13	89.24±9.23	.0012
$PaCO_2$ (mmHg)*			.565[3]
Median (min-max)	34.00 (13.00-61.00)	33.00 (14.00-93.00)	
Mean±SD	34.29±7.54	36.42±12.19	
Coexisting morbidities (n=235/653), n (%)	172 (73.2%)	586 (89.7%)	<.001[1]
COPD	40 (17)	241 (36.9)	<.001[1]
Astma	22 (9.4)	27 (4.1)	.004[4]
Lung cancer	23 (9.8)	32 (4.9)	.012[4]
Coronary artery disease	21 (8.9)	145 (22.2)	<.001[4]
Cerebrovascular disease	4 (1.7)	55 (8.4)	.001[4]
Diabetes mellitus	42 (17.9)	140 (21.4)	.245[1]
Congestive heart failure	12 (5.1)	104 (15.9)	<.001[4]
Chronic kidney disease	8 (3.4)	28 (4.3)	.692[4]
Chronic hepatitis	3 (1.3)	11 (1.7)	.900[4]
Other organ cancers	26 (11.1)	47 (7.2)	.087[4]
PSI scores*			<.001[3]
Median (min-max)	63.00 (8.00-154.00)	105.00 (20.00-243.00)	
Mean±SD	67.16±27.01	108.04±32.11	
Duration of hospitalization*		.205[3]	
Median (min-max)	13.00 (6.00-20.00)	15.00 (4.00-66.00)	
Mean±SD	13.38±4.11	16.20±8.60	
ICU admission n (%)	4 (1.9%)	78 (12.4%)	<.0014
Exitus n (%)	8 (3.3%)	84 (12.7%)	<.0014

[1]Pearson's Chi-Square test. [2]Independent Samples *t*-test. [3]Mann-Whitney U Test. [4]Continuity Correction Chi-Square test. *The data are not normally distributed.

Table II. The comparison of different models to predict mortality.

	AUC	95% CI	*p*
CURB-65	0.684	0.620-0.748	<.001
CURBS-65	0.697	0.636-0.758	<.001
CURBP-65	0.686	0.622-0.749	<.001
PSI Score	0.765	0.713-0.817	<.001

Table III. The comparison of different models to predict ICU admission.

	AUC	95% CI	*p*
CURB-65	0.843	0.789-0.898	<.001
CURBS-65	0.841	0.786-0.897	<.001
CURBP-65	0.822	0.762-0.882	<.001
PSI Score	0.831	0.784-0.878	<.001

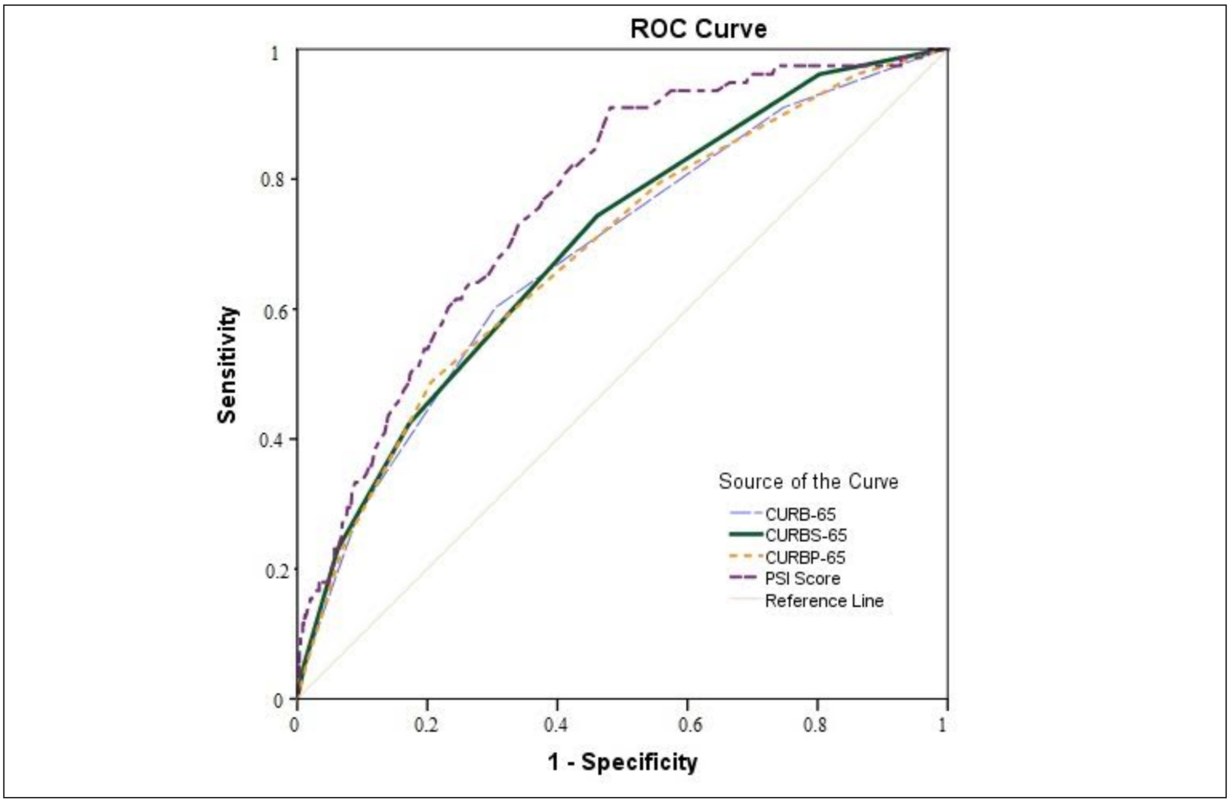

Figure 1. ROC analysis curve of CURB-65, CURBS-65, CURBP-65, and PSI scores for predicting mortality.

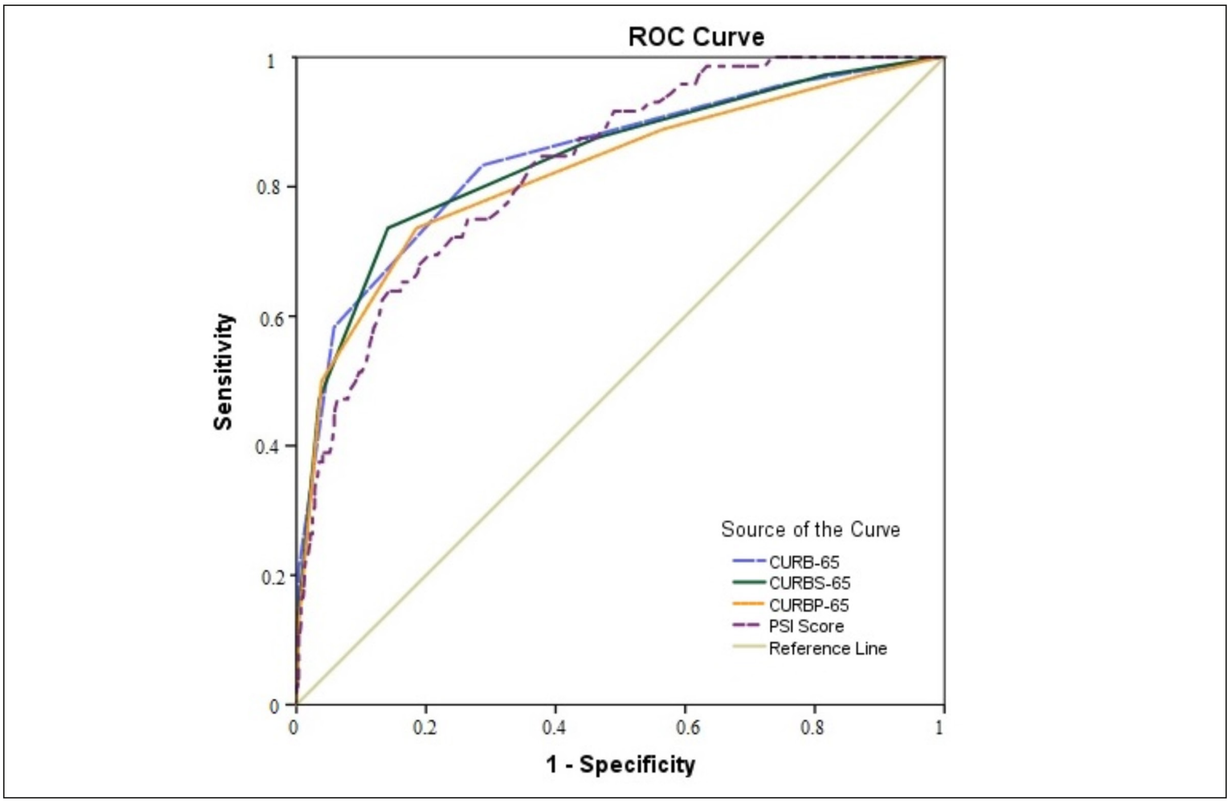

Figure 2. ROC analysis curve for CURB-65, CURBS-65, CURBP-65, and PSI scores to predict ICU admission.

In our study, when the ROC analyses of 4 different scorings (CURB-65, CURBS-65, CURBP-65, and PSI) were evaluated, it was found that the PSI score was more predictive for mortality with a little difference. However, CURB-65 score is more commonly preferred in emergency service or outpatient clinics, instead of PSI which is not easily used in daily practice. CURBS-65 score, which is easily developed by adding the oxygen saturation parameter to the CURB-65 score, was found to be more predictive of mortality than CURB-65 and CURBP-65. In a study conducted by Ananda-Rajah et al[9], CURB-65 and PSI were compared in 408 community-acquired pneumonia patients, and as a result, it was found that CURB-65 was not sensitive or specific enough to determine the mortality in CAP or the need for intensive care. However, no other study has been conducted on CURBS-65, by adding oxygen saturation to CURB-65.

In clinical practice, the condition that most alarms the physician trying to decide on hospitalization is the oxygen saturation parameter, which is not included in the CURB-65 scoring system. Patients with low oxygen saturation cannot be discharged easily by the physician even if the CURB-65 score is zero or one, which translates to the patient not requiring hospitalization. In our study, it was noted that in both CURB-65 0-1 (Group 1) and CURB-65 ≥2 (Group 2) groups, the mortality rate of those with a saturation parameter below 90% was higher (p=.009 and p=.001, respectively). In other words, among those with saturation below 90%, higher mortality was observed whether the CURB-65 score was lower or higher. This suggests that the concern of physicians who decide to hospitalize patients with low saturation is not unfounded. In the study by Choudhury et al[18], the causes of hospitalization were investigated in 565 CAP patients with low-risk CURB-65 score, and the most common cause detected was hypoxemia (31.4%) and other causes were found to be unstable comorbidities (16.4%). The study by Myint et al[19] found that hypoxemia was the most important factor in predicting 6-weeks mortality. In another study conducted by Sanz et al[20] with 585 patients, it was found that the clinical and radiological prognosis was worse in patients with low CURB-65 scores accompanied by hypoxemia.

According to our study, the use of CURBS-65 scoring instead of CURB-65 clinical scoring may be more useful in predicting ICU admission. Similar to our study, in the study by Ilg et al[21] and Hincapie et al[22], CURB-65 was found to have low sensitivity for critical care intervention. As a result, using only CURB-65 score while following the pneumonia patient in the ward may be inadequate for the determination of patients in need of ICU admission.

As a result of ROC analysis evaluated to find the cut-off value for the CURBS-65 score, the cut-off value was determined as 3 in predicting mortality and admission to ICU. According to these data, hospitalization decisions must be considered for patients with a CURBS-65 score of 3 and above, which can be easily applied in clinical practice.

Limitations

There are several limitations to this study. The study, performed with a retrospective database search, is an important limitation. Long-term oxygen therapy of patients was not recorded in the database. The number of patients with a low CURB-65 score in the study was small. Patient records in the study may not be sequential. This may have caused selection bias.

Conclusions

It has been shown that the use of CURBS-65 scoring instead of CURB-65 clinical score may be more useful in predicting both mortality and ICU admission. Therefore, especially in patients with low saturation, the very practically calculated CURBS-65 scoring system will help the clinician to decide on hospitalization. However, prospective large-scale studies are needed on this subject.

Conflict of Interest

We declare that we have no conflict of interest.

Informed Consent

Not applicable due to the retrospective design of the study.

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Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics Approval

Approval was obtained from the Ethics Committee of the Faculty of Medicine Gazi University (Ethics Committee No./Date: Gazi University Clinical Research Ethic Committee 104/22.04.2016).

Authors' Contributions

Writing, conception, design of the study: SNB, NK, AB, DY, critical reviews and supervision: NK, SNB, FNBA, ST, AS, ASC, AC, OK, collecting data: SNB, AB, CG, FY, BC, SSM, AH, FT, statical analysis: FNBA, DY. All authors provided critical feedback and helped shape the research.

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