Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/gtfpk192

STUDY OF PNEUMONIA SEVERITY INDEX AND CURB-65 IN COMMUNITY ACQUIRED PNEUMONIA IN INDUSTRIAL SET-UP

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ABSTRACT

Background

This study was conducted to determine if the pneumonia severity index and CURB-65 are applicable to patients who have community-acquired pneumonia and to investigate the prognostic usefulness of these markers (need for ICU admission and death) in these individuals.

Methods

This was a hospital-based prospective observational study conducted among eighty patients who were diagnosed to be having community-acquired pneumonia admitted to Hindustan Aeronautics Hospital, over a period of 18 months after obtaining clearance from the institutional ethics committee and written informed consent from the study participants.

Results

In our study, we observed a significant association between age, ventilator support, inotropes, ICU stay, and mortality with increasing scores in both PSI and CURB-65 scoring systems, demonstrating a high degree of sensitivity and specificity. Whereas the PSI score has a higher prediction for ICU admission and ventilator requirement in CAP patients, the CURB score has a higher prediction for mortality in CAP patients. The ROC curve for ICU admitted patients, patients who received ventilator support, and mortality among CAP subjects was higher for PSI score than CURB-65, that is, PSI score has higher sensitivity, specificity, and area under curve for mortality for all the three aforementioned parameters in CAP patients.

Conclusion

Both our study's and the earlier research's mortality rates in the various risk classes demonstrated that, in both the PSI and CURB-65 risk classes, mortality rates increased steadily as risk scores increased. In predicting ICU admission, ventilator support, inotropic support, and mortality, both PSI and CURB65 have good specificity, with PSI having better sensitivity and specificity than CURB65.

Keywords: PSI, CURB-65, Community Acquired Pneumonia.

INTRODUCTION

Pneumonia is a common disease throughout human history. The word pneumonia is derived from Greek (pneúmōn) meaning "lung". The symptoms were described by Hippocrates.

Sir William Osler, known as "the father of modern medicine" appreciated the death and disability caused by pneumonia, describing it as the "captain of the men of death" in 1918, as it had overtaken tuberculosis as one of the leading causes of death at that time. He also described pneumonia as "the old man's friend" as death was often quick and painless.

Pneumonia has been considered a health problem for ages with significant mortality and morbidity often being misdiagnosed, mistreated, and underestimated.

Pneumonias are classified as following types:

- CAP (Community Acquired Pneumonia)
- HAP (Hospital Acquired Pneumonia)
- VAP (Ventilator Associated Pneumonia)
- HCAP (Health Care Associated Pneumonia)

CAP is a major cause of morbidity and mortality worldwide. CAP is a disease in which individuals who have not been hospitalized recently will develop an infection of the lungs (pneumonia).

Very few extensive research has been conducted on the incidence of CAP, despite the availability of statistics on the overall mortality caused by "LRTIs" in India. The annual incidence of CAP is estimated to range from 2 to 12 cases per 1,000 people, with newborns and the elderly reporting the greatest rates. Less than 1 to 5% of patients die in outpatient settings, but up to 12% of inpatient patients do. The anticipated range is 18.2 per 1,000 for those between the ages of 65 and 69 and 52.3 per 1,000 for those beyond the age of 85.

The importance of CAP is also increasing economically, as it is one of the leading causes of absence of jobs, activity restriction, and disability.

So in order to decrease the mortality and for proper assessment of the severity of pneumonia, many scoring systems had been developed for management and to decrease the mortality. Among such scoring systems, the two prominent are the PSI (Pneumonia Severity Index), developed in the USA after PORT (Pneumonia Outcome Research Trial), and the CURB-65, developed in the U.K. as “confusion, elevated blood urea nitrogen, elevated respiratory rate, low systolic or diastolic BP (Blood Pressure), and age over 65 years (CURB-65)”. Given that each scoring method has unique advantages and disadvantages, it is thought that the two complement one another.

AIMS AND OBJECTIVES

- To investigate the predictive significance of CURB-65 and the pneumonia severity index (need for ICU admission and mortality) in patients with community-acquired pneumonia.
- To evaluate the suitability of CURB-65 and the pneumonia severity index for community-acquired pneumonia.

MATERIALS AND METHODS

This was a hospital-based prospective observational study conducted among eighty patients who were diagnosed to be having community-acquired pneumonia admitted to Hindustan Aeronautics Hospital, over a period of 18 months after obtaining clearance from the institutional ethics committee and written informed consent from the study participants.

Inclusion Criteria

1. Age more than 18 years.
2. Patients with clinical diagnosis of pneumonia and chest radiograph consistent with diagnosis of pneumonia.

Exclusion Criteria

1. Chronically immunosuppressed patients (patients on steroids, neutropenic patients, immunosuppressive agents).

2. Patients hospitalized within the previous 14 days.
3. Patients with alternate diagnosis during follow up.
4. Patients diagnosed with chronic obstructive pulmonary disease.

Sample Size

The following formula has been used to determine the sample size: p1 and p2 are pre-study estimates of the two proportions to be compared; zcrit and z pwr are cut-off points along the x axis of a standard normal probability distribution that demarcate probabilities matching the specified significance criterion and statistical power, respectively.
D= (p1- p2) (i.e. the minimum expected difference) and p= (p1+p2)/2.

$$N = 2 \cdot [z_{crit}\sqrt{2\bar{p}(1-\bar{p})} + z_{pwr}\sqrt{p_1(1-p_1)+p_2(1-p_2)}]^2/D^2$$

A significance criterion of 0.05 and a power of 0.90 were chosen.

Statistical Methods

SPSS 22 version software was used for data analysis after the data was entered into a Microsoft Excel data sheet. Frequencies and proportions were used to depict categorical data. Chi-square was employed as a significance test. The mean and SD were used to represent continuous data. To determine the significance of the mean difference between two groups, the independent t test was employed. A p-value of less than 0.05 was deemed statistically significant. To determine the area under the curve, sensitivity, and specificity of PSI and CURB-65 Score with regard to ICU stay, need for ventilator use, and mortality, a ROC curve was plotted.

RESULTS

		CURB – 65 Score												**P Value**
		0		**1**		**2**		**3**		**4**		**5**		
		Count	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	
Age	Mean ± SD	43.29±10.06		45.73±15.43		54.89±3.26		49.22±17.57		63.54±19.20		70.00±7.07		0.005*
Sex	Female	6	42.9%	6	40.0%	11	61.1%	9	50.0%	5	38.5%	0	0.0%	0.544
	Male	8	57.1%	9	60.0%	7	38.9%	9	50.0%	8	61.5%	2	100.0%	
Ventilator Support		1	7.1%	3	20.0%	3	16.7%	8	44.4%	9	69.2%	2	100.0%	0.001*
Inotropes Support		0	0.0%	0	0.0%	2	11.1%	10	55.6%	7	53.8%	2	100.0%	0.001*
ICU Stay		1	7.1%	3	20.0%	9	50.0%	10	55.6%	9	69.2%	2	100.0%	0.002*
Death		0	0.0%	0	0.0%	0	0.0%	2	11.1%	8	61.5%	2	100.0%	0.001*

Table 1: Association between CURB – 65 Score with Various Parameters

In the study, when the CURB-65 score was compared with various parameters, it was observed that there was a significant association between age, ventilator support, inotropes, ICU stay, and mortality. i.e., higher CURB-65 scores were seen in > 60 years' subjects, patients who were put on ventilators, patients on inotropes, patients in the ICU, and patients who had mortality. (The p-values obtained for all the parameters were within the set limits of statistical significance that was <0.05).

	PSI Score	**P**

		0		1		2		3		4		5		Value
		Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	
Age	Mean ± SD	43.29±10.06		45.73±15.43		54.89±13.26		49.22±17.57		63.54±19.20		70.00±7.07		0.005*
Sex	Female	6	42.9%	6	40.0%	11	61.1%	9	50.0%	5	38.5%	0	0.0%	0.544
	Male	8	57.1%	9	60.0%	7	38.9%	9	50.0%	8	61.5%	2	100.0%	
Ventilator Support		1	7.1%	3	20.0%	3	16.7%	8	44.4%	9	69.2%	2	100.0%	0.001*
Inotropes Support		0	0.0%	0	0.0%	2	11.1%	10	55.6%	7	53.8%	2	100.0%	0.001*
ICU Stay		1	7.1%	3	20.0%	9	50.0%	10	55.6%	9	69.2%	2	100.0%	0.002*
Death		0	0.0%	0	0.0%	0	0.0%	2	11.1%	8	61.5%	2	100.0%	0.001*

Table 2: Association between PSI Score with Various Parameters

In the study, when PSI score was compared with various parameters, it was observed that there was a significant association between age, ventilator support, inotropes, ICU stay, and mortality; i.e., higher PSI scores were seen in > 60-year-old subjects, patients who were put on ventilators, patients on inotropes, patients in ICU, and patients who had mortality (the p values obtained for all the parameters were within the set limits of statistical significance that was <0.05).

Test Result Variable(s)	Optimal Cut Off Score	Sensitivity	Specificity	Area Under the Curve	P-Value	95% CI	
						Lower Bound	Upper Bound
PSI	>2	0.912	0.717	0.826	<0.0001	0.732	0.920
CURB - 65	>1	0.882	0.543	0.765	<0.0001	0.662	0.869

Table 3: Sensitivity, Specificity and Area Under Curve (AUC) of PSI and CURB-65 for Need for Admission to ICU

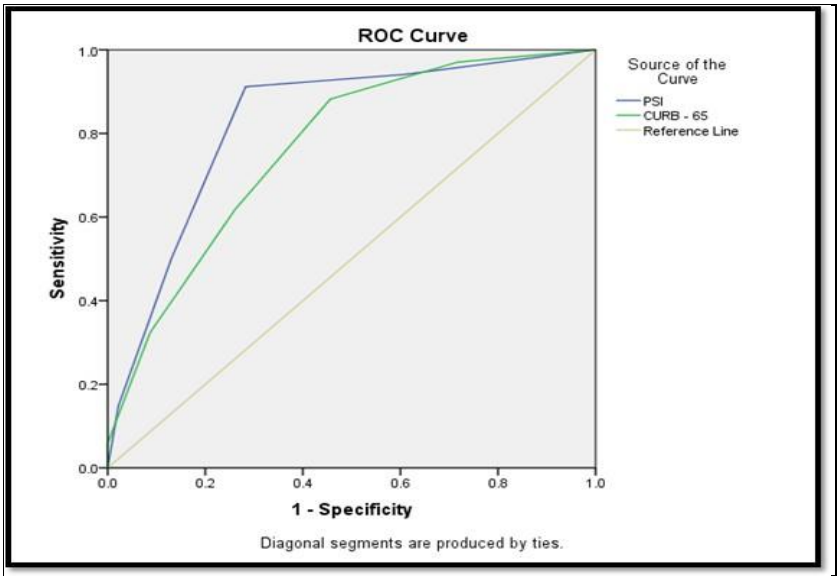

Figure 1: ROC Curve-Need for Admission to ICU

In our study, 34 subjects were admitted to ICU. Area under the curve for ICU admitted patients was highest for PSI score than CURB-65. PSI score has a higher prediction for ICU admission in CAP patients. The p-value obtained was within the parameters of significance and hence the association with both the CURB-65 score and PSI score with the need for admission to ICU was significant.

Test Result Variable(s)	Optimum Point of Cut-Off	AUC	Sensitivity	Specificity	P-Value	95% CI Lower Bound	95% CI Upper Bound
PSI	>3	0.892	0.962	0.648	<0.0001	0.813	0.972
CURB - 65	>2	0.781	0.731	0.741	<0.0001	0.671	0.892

Table 4: Sensitivity, Specificity and Area Under Curve (AUC) of PSI and CURB65 for Need for Ventilation

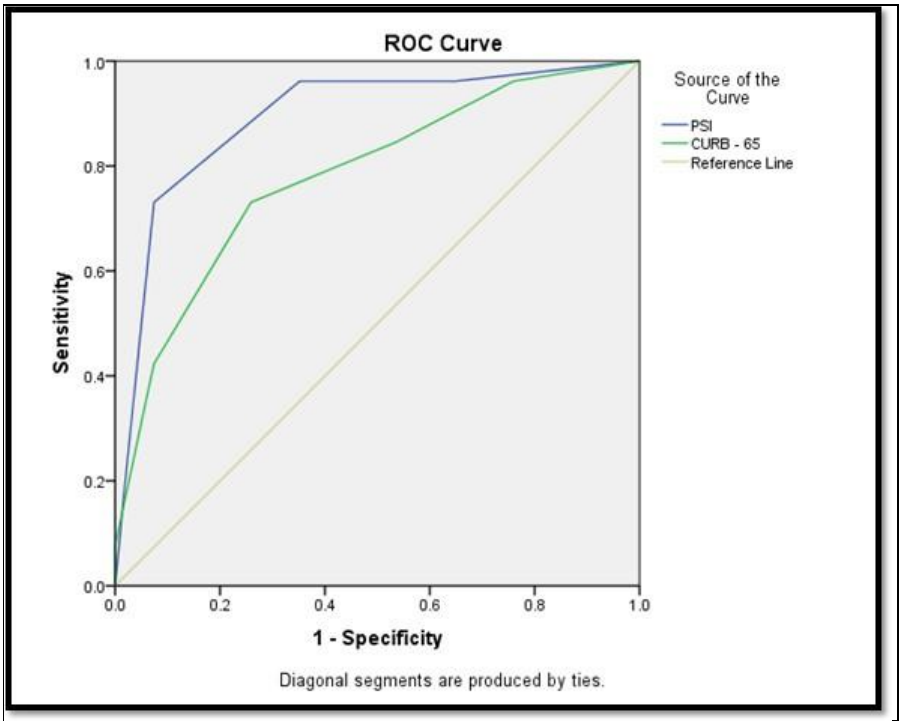

Figure 2: ROC Curve-Need for Need for Ventilator Support

In the study, 26 subjects were ventilator subjects. Area under the curve for ventilator support patients was highest for PSI score than CURB-65. PSI score has a higher prediction for ventilator requirement in CAP patients. The p-value obtained was within the parameters of significance, and hence the association with both the CURB-65 score and PSI score with the need for ventilator support was significant.

Test Result Variable(s)	Optimal Cut-Off	Sensitivity	Specificity	Area Under the Curve	P-Value	95% CI Lower Bound	95% CI Upper Bound
PSI	>3	0.917	0.176	0.936	<0.0001	0.873	1.000
CURB - 65	>3	0.833	0.074	0.944	<0.0001	0.890	0.997

Table 5: Sensitivity, Specificity and Area Under Curve (AUC) of PSI and CURB65 for Prediction of Mortality

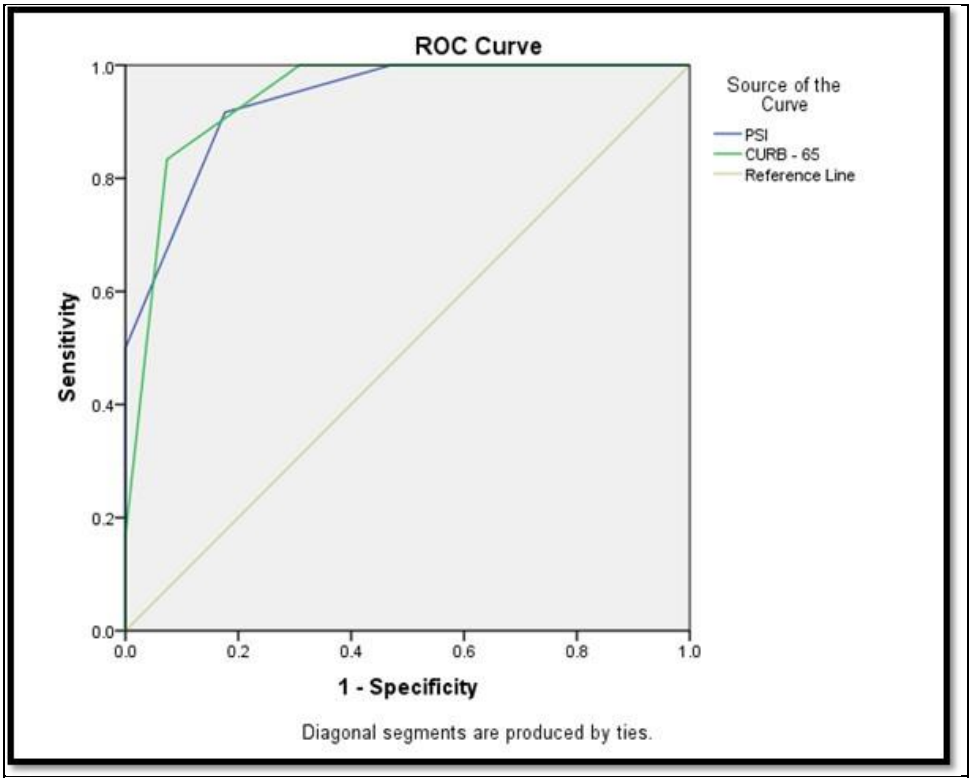

Figure 3: ROC Curve–Comparison of Mortality

In the study, 12 subjects had mortality. Area under the curve for mortality among CAP subjects was highest for CURB-65 than PSI. The CURB-65 Score has a higher prediction for mortality in CAP patients. The p-value obtained was within the parameters of significance, and hence the association with both the CURB-65 score and PSI score with the mortality prediction was significant.

DISCUSSION

Severe pneumonia remains difficult to define, regardless of the reference used when validating defined criteria. This is mainly due to structural differences across treatment settings with regard to the relative role of emergency departments, intermediate care facilities, ICUs, and ongoing changes in medical practice such as non-invasive ventilation which inherently modify concepts of severity.[1]
The majority of patients in our study group were middle-aged, with 59.9% being between 30 and 60 years old. The 50–60 age range was the greatest age group. According to research by Dey et al.[2] and colleagues, patients older than 50 are more prevalent than those younger than 50. Pneumonia is a well-known illness that frequently strikes the general population and whose frequency increases noticeably with age. Comparing our study, where 55% of patients were over 50 and 45% were under 50, Dey et al., study showed that 60% of patients were over 50 and 40% were under 50. The distribution of ages followed a comparable pattern.
There were 37 (36%) female patients and 43 (54%) male patients in our study. Twenty percent were female and eighty percent were male in research by Metley et al.[3] Of the 150 participants in Shah BA et al.'s study,[1] 89 (59.3%) were men. This could be attributed to the well-established fact that cigarette smoking and alcoholism, as well as underlying lung disease, e.g., COPD, predispose to pneumonia and are more common in the male population.
This comparison thus shows a variable distribution of cases, with males being more commonly affected than females across all the studies, with our study showing a similar pattern.
Other studies have shown that as scores increased on the PSI and CURB-65, there was an increased risk of death and the necessity for ICU hospitalisation.[4,5] According to our research, the risk of death also rose with age, the existence of underlying heart failure, high urea levels in the blood, a pH of less than 7.35, and a lower state of consciousness. Aside from diabetes (23.7%) and hypertension (25%) being the most prevalent underlying conditions in this investigation, heart failure (5%), exhibited a

statistically significant association with death. Additionally, 1.3% of the patients had bronchial asthma, pulmonary tuberculosis, post-splenectomy status, and cor pulmonale, while 2.5% of the patients had CKD. In a study of 170 individuals with community-acquired pneumonia, Musher et al. discovered heart problems in 33 (19.7%) of the patients, specifically CHF.[6] Lichman et al. observed that 6.8% of their patients had significant heart problems, which supports these findings.[7] Eighty-nine individuals in a research by Shah BA et al.[1] had one or more co-morbidities. COPD (Chronic Obstructive Pulmonary Disease), diabetes mellitus, and hypertension were the most frequent comorbidities.

Thirteen percent of the participants had a history of smoking, whereas 2.5 percent were alcoholics and 10% were smokers. In a study conducted by Shah BA et al.[1] 79 patients (83.2%) were male and 89 patients (59.3%) smoked.

The most prevalent presenting symptom in our study was cough, which accounted for 78 (97.5%) of the total presenting symptoms. Other common symptoms were haemoptysis (15%), expectoration (91%), fever (92.5%), dyspnoea (71.2%), and altered sensorium (30%). The most common symptom of CAP was cough, according to Mac Fartane's[8] study on the disease's genesis and course. Fever (86%), chest pain (62%), and hemoptysis (15%) were the additional symptoms.

Of the 80 participants in our study, 67 individuals (83.7%) had a cumulative count of more than 11,000/microL. A study by Joshua, Michael et al. found that leucocytosis affected 58% of the patients.

In our study, hyponatremia (serum sodium concentration < or = 130 mmol/l) was seen in 23 (28.5%) of the patients. In a study done by Dhawan A.[9] hyponatraemia was found in 31% of patients at the time of admission, the probable cause of which in 94% of those cases was postulated to be the syndrome of inappropriate antidiuretic hormone secretion (SIADH) in the study.

Use of inotropes and transfusion of blood and blood products was higher in the patients with fatal outcomes compared to recovered patients in our study, and use of ionotropes (p=<0.05) showed statistical significance between deaths and recovered and is similar to the study done by Gong et al.[10]

Use of blood transfusion and its products is not statistically significant between the deaths and recovered in our study. However, a study done by Gong et al.,[10] showed that use of blood and blood transfusion products was significantly high in dead patients.

In our study, 25% of subjects had class I on the Pneumonia Severity Index, 20% had class II, 26.3% had class III, 21.3% had class IV, and 7.5% had class V. Comparing the data with other studies:

Maximum distribution of cases was seen in PSI Score classes III and IV in our study, while it was in classes IV and V on comparison with Diwaker et al.[11]

When PSI score was compared with various parameters, it was observed that there was a significant association between age, ventilator support, inotropes, ICU stay, and mortality that is higher. PSI scores were seen in >60-year-old subjects, patients who were put on ventilators, patients on inotropes, patients in the ICU, and patients who had mortality. A high degree of sensitivity and specificity was observed in PSI scores IV and V, indicating that higher PSI scores had better diagnostic accuracy in predicting the need for intensive ventilator and inotropic support and mortality.

In our study, 17.5% of subjects had a CURB-65 score of 0, 18.8% had a score 1, 22.5% had a score 2, and score 3, respectively, 16.3% had a score 4, and 2.5% had a score 5.

Maximum distribution of cases was seen in CURB-65 Score classes I-III in our study, while it was seen in classes II and III in comparison with the Diwaker et al. study.

Higher sensitivity and specificity were observed in CURB 65 scores IV and V, that is, higher CURB-65 scores had better diagnostic accuracy in predicting the need for intensive ventilatory and inotropic support and mortality.

Similar research was conducted by Diwakar et al.,[11] of the patients who passed away, 7 (24.1%) belonged to PSI class IV, 6 (42.9%) to PSI class V, and no patient in PSI class I perished. Of the eighteen patients that died, eight (34.8%) belonged to CURB-65 class 2, just two (66.7%) to class 4, and no patient in CURB-65 class 0 died. In Shah et al., study, sixteen patients (10.7%) passed away. PSI class >IV applied to all 16 patients (100%) who passed away. In CURB-65, class 3 had 2 (12.5%) deaths, class 4 had 11 (68.7%) deaths, and class 5 had 3 (18.8%) deaths. Mortality in PSI classes I through III was 0%, in class IV it was 14.1%, and in class V it was 34.8%.

Mortality rates in risk classes I, II, and III are low in the original Fine et al. PSI (PORT research (0.1% to 0.4% in class I and 0.9% to 2.8% in class III), whereas mortality rates in risk classes IV and V are greater. Patients in risk classifications I through III have a cumulative death rate of less than 1%.

On comparing our study with those by Diwaker et al. and Shah et al., it can be inferred that all the 3 studies had a similar case distribution and prediction of outcome when mortality was compared with various parameters under the various classes of the CURB-65 scoring system (classes 3–4).

The mortality risk for each of the distinct groups in the initial CURB-65 study by Lim and colleagues was as follows: Groups 1 through 5 had percentages of 3.2%, 3%, 17%, 42%, and 57%, respectively.[12,13] These scores made it possible to make predictions that were extremely close to the PSI's. A 30-day mortality of one percent was linked to the lack of any CURB criteria in a later study,[14] 8% was connected with the presence of one or two, and 30% was associated with the presence of three or four.

In our study on comparison of prediction of mortality in the highest class of scoring system, we found the CURB-65 scoring system to be the better predictor as it has higher sensitivity and NPV (Negative Predictive Value) although both the scoring systems have similar specificity and PPV (Positive Predictive Valve).

A significant association between age, ventilator support, inotropes, ICU stay, and mortality was observed with increasing scores in both PSI and CURB-65 scoring systems in our study, with a high degree of sensitivity and specificity.

Thus, the PSI score has a higher prediction for ICU admission and ventilator requirement in CAP patients, and the CURB score has a higher prediction for mortality in CAP patients.

In our study, the AUC for ICU admitted patients and the patients who received ventilator support was higher in PSI score than CURB-65, i.e., PSI score has higher sensitivity, specificity, and AUC, but among the 12 subjects who suffered mortality, AUC was highest for CURB-65 score than PSI score, that is CURB Score has a higher prediction for mortality in CAP patients, although the PSI Scoring System has a higher prediction for ICU admission and need for ventilatory support. Thus, both scoring systems are complementary to each other.

In a cohort of 1,776 patients, including 676 outpatients, Capelastegui et al. reported a comparative validation of the CURB-65, CRB-65 (which omits the blood urea measurement), and PSI scores.[15] According to ROC analysis, the 30-day mortality rose as the score grew and the 30-day mortality projections were equal for all levels. In contrast, the study by Aujesky et al., which included 1,094 outpatients and 3,181 patients, demonstrated a little but substantial advantage for the PSI score in terms of 30-day mortality prediction using AUC analysis.[16] Nevertheless, the majority of patients in this group were not as sick as those in the current trial (18% PSI IV against only 6% in the former group), which limited the comparability of the two groups.

Shah et al. observed that PSI and CURB-65 had similar sensitivity to predict death from community-acquired pneumonia, but that PSI was more sensitive to predict ICU admission than CURB-65.[1] These findings are consistent with our findings. This might be the case because the CURB-65 model has limited applicability in the elderly due to its failure to account for decompensated co-morbidity caused by community-acquired pneumonia.[17] A other study found that when it came to predicting death, CURB-65 had the best sensitivity, followed by PSI. When sensitivity, specificity, and predictive values are compared between PSI and CURB-65, the results show good sensitivity and NPV. These outcomes are similar to Man et al. study.[17]

In contrast to the study by Man et al., which hypothesized that the major limitation of the PSI is the unbalanced impact of age on the score, resulting in a potential underestimation of severe CAP, particularly in younger, otherwise healthy individuals, the specificity of the PSI was found to be better than CURB-65.[18]

In a different study, compared to published data, a CURB-65 score of ≥2 and a PSI score >III were strongly linked to a greater rate of 28-day death, with a higher proportion for each score. The PSI categorized a larger percentage of patients as high risk and showed a higher sensitivity in predicting mortality when compared to the CURB-65. In predicting 28-day death, the PSI outperformed the CURB-65 in terms of sensitivity, suggesting that it could be a more useful tool for evaluating the risk

of pneumonia-related mortality in cancer patients.[19]

Given their respective advantages and disadvantages, the two scoring methods for the CURB-65 and PSI are thought to work well together.

As a result, although from opposing angles, both instruments provide a useful evaluation of the patient's sickness and are most effective in identifying patients at opposite extremes of the disease severity continuum. The management of severe CAP would be greatly improved if it were possible to identify, early in the course of the disease, those patients who are most likely to develop complications and are at risk of mortality with a combined approach of estimating biomarkers and severity scores in collusion. This was the conclusion drawn from recent studies by Agrawal et al. and Lalitha et al. comparing the prognostic utility of procalcitonin with biomarkers and clinical risk scores (PSI and CURB-65).[20,21]

However, as PSI and CURB-65 were not intended to measure mortality but rather ICU admission, alternative indices, including modified ATS, SMART-COP, and IDSA/ATS, were found to outperform PSI and CURB-65 in this regard.[22] Therefore, if used to forecast mortality, a poor performance might be discovered.

CONCLUSION

The comparison between mortality rates in different risk classes in our study and that of the previous studies showed that in all the studies mortality rates progressively increase with increasing risk scores in both PSI and CURB-65 risk classes. PSI score has higher sensitivity, specificity, and AUC for all three parameters, i.e., prediction of ICU admission in patients, them having received ventilator support, and probability of mortality among CAP subjects. Whereas the PSI score has a higher prediction for ICU admission and ventilator requirement in CAP patients, and the CURB-65 score has a higher prediction for mortality in CAP patients. A significant association between age, requirement of ventilatory support, inotropic support, ICU stay, and mortality was observed with increasing scores in both PSI and CURB-65 scoring systems in our study, with a high degree of sensitivity and specificity. The two scoring CURB-65 and PSI approaches are complementary, as each has different strengths and weaknesses. By using the knowledge of these criteria, patients with CAP can be better prognosticated as regards the severity of their illness, with consequently better triaging of patients, utilization of resources, and appropriate treatment to improve the outcome in this disease. The use of biomarkers and scoring systems together will improve the predictive power, especially in the younger age groups where PSI falters, particularly due to its high dependency on the patient’s age. The severity score for community-acquired pneumonia seems to be the preferred method to predict the need for ICU admission and the prognosis of patients seen at emergency departments. Both the scoring systems are applicable and dependable.

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