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*RESEARCH ARTICLE*

# PNEUMONIA SEVERITY INDEX COMPARED TO CURB-65 IN PREDICTING THE OUTCOME OF COMMUNITY ACQUIRED PNEUMONIA -A PROSPECTIVE STUDY

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## Abstract

**Introduction:** Community-acquired pneumonia (CAP) is a leading cause of morbidity and mortality worldwide. Several severity scores have been proposed to guide initial decision making on hospitalization and to predict the outcome. Pneumonia Severity Index (PSI) and CURB 65 are the two most widely used scoring systems to prognosticate pneumonia.

**Objectives:** Tocompare the efficacy of PSI and CURB 65 scoring systems in prognosticating the outcome in cases of CAP.

**Methods:** This is a prospective study conducted over a period of one year on 150 patients who presented with community acquired pneumonia on the grounds of their clinical and paraclinical findings in our institution under the Department of respiratory Medicine, and fulfilling the inclusion and exclusion criteria. The patients were classified as per CURB 65 and PSI system and their outcome compared.

**Results:** We studied 150 patients with community-acquired pneumonia (114 men, 36 women). In our study 100 % of patients in CURB 65 class 4 and 5 required ICU admission and death was 84.6% and 100% respectively. Majority of patients of PSI class 4 and 5 needed ICU admission 67% and 96% respectively and death was 16% and 58% respectively. The sensitivity and specificity of CURB-65 class ≥3 in predicting mortality were 79% and 89%, respectively (AUC 0.92). As for pneumonia severity index class ≥4, the rates were 79% and 84%, respectively (AUC 0.86). The mortality rate and need for ICU admission increased progressively with increasing scores.

**Conclusion:** CURB-65 seems to be the preferred method to predict mortality and need for ICU admission in patients with community-acquired pneumonia.



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## Introduction:-

Infectious disease society of America(IDSA) defines community acquired pneumonia(CAP) as "an acute infection of pulmonary parenchyma that is associated with at least some symptoms of acute infection , accompanied by the presence of an acute infiltrate on a chest radiograph or auscultatory findings consistent with pneumonia (such as altered breath sounds and/or localized roles), in a patient not hospitalized, or residing in a long term care facility for more than 14 days before onset of symptoms."[1]

It is estimated that India together with Bangladesh, Indonesia and Nepal account for 40% of global acute respiratory infection; 90% of mortality is due to pneumonia, mostly bacterial in origin.[2]Though definite statistics are lacking CAP remains a leading cause of death in India too.[3.] The mortality in a study of CAP reported by Bansal et al[4]was 11 percent. In another Indian study[5]a significantly higher mortality was noticed in patients aged 50 years or above and in those with underlying comorbid conditions. The mortality of patients with severe CAP requiring admission to an intensive care unit (ICU) is high. This is likely to be particularly evident in health services where ICU beds are at a premium such that only critically ill patients in need of assisted ventilation can be admitted. It is hoped that the knowledge of relevant prognostic factors might be useful for early identification of patients at high risk requiring intensive care treatment. Prognostic scoring systems for CAP have been developed to address these issues. The two prominent tools for this purpose are the pneumonia severity index (PSI), developed in the USA after Pneumonia Outcome Research Trial (PORT), and the BTS rule, which has recently been modified to the CURB-65 rule "confusion, elevated blood urea nitrogen, elevated respiratory rate, low systolic or diastolic blood pressure (BP), and age over 65 years (CURB-65)" rule.[6,7]The two scoring approaches are viewed as being complementary, as each has different strengths and weaknesses. Even though most of the burden in terms of mortality and morbidity occurs in the developing world, little has been done to study the factors associated with an adverse prognosis in CAP in this region. The present study was designed to compare the prognostic value of these two scores for predicting the outcome of community acquired pneumonia.

Aim of the study was to study and compare pneumonia severity index and CURB 65 (confusion ,blood urea, respiratory rate, blood pressure, age) in assessing the outcome of community acquired pneumonia.

Relevance of the study: Unnecessary admission to ICU will increase the treatment cost and leads to depletion of precious hospital resources. It is vital to identify patients at low risk of complications. These scoring systems also provides meaningful information for physicians to discuss prognosis with patient's family.

## Materials & Methods:-

**Study Design:**
Hospital based prospective study.

**Study Setting:**
This observational comparative study was conducted on patients diagnosed with community acquired pneumonia, admitted in the Department of Respiratory Medicine, Academy of Medical Sciences, Pariyaram.

**Study Period:**
The study was conducted for a period of 1 year , From 2019 march – 2020 march

**Sample Size:**
Minimum sample size of the study was calculated as 150 according to the formula

Sample size = $4pq/d^2$Where p = prevalence

Here p was taken as 10.2 as per study done by bashir ahmed shah[8] in the research article entitled "Validity of pneumonia severity index and CURB 65 severity scoring system in community acquired pneumonia in an indian setting"
q = 100 – p (here 100 – 10.2 = 89.3)
d = precision, here d = absolute precision fixed at 5%
Hence sample size = $(4pq/d^2)$ = ( 4 x 10.2 x 89.3)/(25) = 145.73 ~ 150

**Sampling:**
Consecutive sampling

**Study Subjects:**
Patients aged 18 years or more diagnosed with community acquired pneumonia on the grounds of their clinical and paraclinical findings were enrolled in the study. Those whose diagnosis changed during treatment was excluded.

**Inclusion Criteria:**
Patients older than 18 years,No history of hospitalization within the last 2 weeks,Patients found to have infiltration compatible with pneumonia on chest x-ray at admission,Who has clinical manifestations of pneumonia (fever, cough, sputum production, clinical signs of consolidation) and new onset focal chest signs.

**Exclusion Criteria:**
Patients with missing clinical data (according to PSI and CURB 65 scoring criteria),Diagnosed pulmonary embolism,Who had aspiration pneumonia,Who were diagnosed with pneumonia and were treated for pneumonia in an external center,Who underwent trauma,Patients with HIV infection, pulmonary tuberculosis,Patients with long term immunosuppressant or steroid therapy,Pregnant women

## Methodology:-

Subjects were selected according to inclusion and exclusion criteria. The written informed consent was obtained from them and a complete clinical history and physical examination of patients were done. The patients with clinical diagnosis of pneumonia underwent investigations mentioned below. Investigations done:Arterial blood gas analysis ,Complete blood count ,Renal function test,Chest radiograph,ECG,Liver function test,Serum electrolytes,Random blood sugar,Sputum for acid fast bacilli, gram staining & cultureAll patients were assessed using pneumonia severity index scoring and CURB65 scoring. A questionnaire including the demographic data, clinical, Para clinicaland imaging findings was completed for each patient. PSI and CURB-65 scores were calculated for each patient. The CURB-65 is a 5-item index while PSI uses 20 items to predict the patient's outcome. The need for ICU stay as well as the risk of mortality was compared according to PSI and CURB-65.

At the clinical end points , the following parameters were recorded:
1. Death
2. Need for admission to ICU
3. Need for mechanical ventilation
4. Duration of antibiotics
5. Time taken for defervescence
6. Condition at the time of discharge

**Variables Studied -**
Age, clinical signs , blood parameters, imaging finding

**Data Analysis:**
Results were entered into excel sheet and analysed using spss new version.Results were expressed as means and SD using SPSS. Sensitivity, specificity, and relative risks was calculated for each study outcome using standard formulas.

## Results:-Total 150 patients included in the study

**Table 1:-** Sociodemographic profile.

| Variable | Percentage | Frequency |
|---|---|---|
| **AGE** | | |
| **20-30** | 2.7 | 4 |
| **31-40** | 9.3 | 14 |
| **41-50** | 12.7 | 19 |
| **51-60** | 22.7 | 34 |
| **61-70** | 29.3 | 44 |
| **71-80** | 16.0 | 24 |

| | | |
|---|---|---|
| **81-90** | 7.3 | 11 |
| **GENDER** | | |
| **Male** | 76.0 | 114 |
| **Female** | 24.0 | 36 |
| **NURSING HOME RESIDENT** | | |
| **Yes** | 2.7 | 4 |
| **No** | 97.3 | 146 |

Out of the 150 patients we studied, 114 had cough and shortness of breath (76%), 111 patients had scanty expectoration (74%), 109 patients had mucoid expectoration. These symptoms were observed in more than 70% of the population. 96(64%)patients were admitted with fever and 71(47.3%) had chills. 34(22.7%) patients had fatigue, 31(20.7%) patients had complaints of chest pain and night sweats. 10 patients each had Nausea and Myalgia and only 7 patients had hemoptysis. Majority93(62%) had habit of smoking, alcohol consumption observed in 42(28%) patients and only 8 had other addictions such as chewing tobacco and substance abuse.

The co-morbidities observed in the present study population are, diabetes mellitus (38%), hypertension (32.7%), COPD (31.3%), other respiratory diseases (6.7%), congestive cardiac failure (16.7%), neoplastic disease (1.3%), liver disease (4%), renal disease (13.3%), cerebro vascular disease (5.3%).

**Table 2:-**Distribution of clinical examination among the study population.

| **Clinical Examination** | **Yes** | | **No** | |
|---|---|---|---|---|
| | **Frequency** | **Percentage** | **Frequency** | **Percentage** |
| **Altered Mental Status** | 36 | 24.0 | 114 | 76.0 |
| **Pulse Rate > 120** | 23 | 15.3 | 127 | 84.7 |
| **Respiratory Rate >30** | 89 | 59.3 | 61 | 40.7 |
| **Systolic BP < 90** | 20 | 13.3 | 130 | 86.7 |
| **Temperature > 40** | 38 | 25.3 | 112 | 74.7 |
| **Ph<7.35** | 26 | 17.3 | 124 | 82.7 |
| **Urea>7** | 42 | 28.0 | 108 | 72.0 |
| **Sodium<130** | 10 | 6.7 | 140 | 93.3 |
| **Glucose>140** | 55 | 36.7 | 95 | 63.3 |
| **HCT<30%** | 4 | 2.7 | 146 | 97.3 |
| **PAO2<60%** | 111 | 74.0 | 39 | 26.0 |

Chest X Ray results among the study population**:**Out of the 150 patients right upper lobe consolidation was present among 6 (4%)patients, 12(8%) had right middle lobe consolidation, 18(12%) had right lower lobe consolidation, 26(17.3%) had right multilobar consolidation, 11(7.3%) had left upper lobe consolidation, 9(6%) left middle lobe consolidation, 10 (6.7%) had left lower lobe consolidation 8(5.3%) had left multilobar consolidation and 46 (30.7%) had bilateral multilobar consolidation.Pleural effusion was present in only 6(4%) patients.

Out of the 150 cases 71 (47.3%) had clearance after 1 week. Next assessment was after three weeks which shows complete CXR clearance in 112 (74.7%) patients.

Sputum culture & sensitivity showed no growth in 38(25.3%) patients. Klebsiella species were present in 32(21.3%) patients, candida sp were observed in 28 (18.7%)patients, pseudomonas were seen in 18(12%) patients, 16(10.7%) had acinetobacter, staph aureus were present in 9 (6%)cases, non-fermenting gram negative bacilli were observed in 8 (5.3%)patients and only 1(.7%) patient had streptococci pneumonia.

51 were admitted in ward and 99 were admitted to ICU after the assessment of severity of pneumonia.
Non invasive ventilation was given for 34 cases and invasive ventilation given for 19 patients.
Out of the 150 only 19 (12.7%) required long term oxygen therapy.

117 (78%) out of 150 were cured .

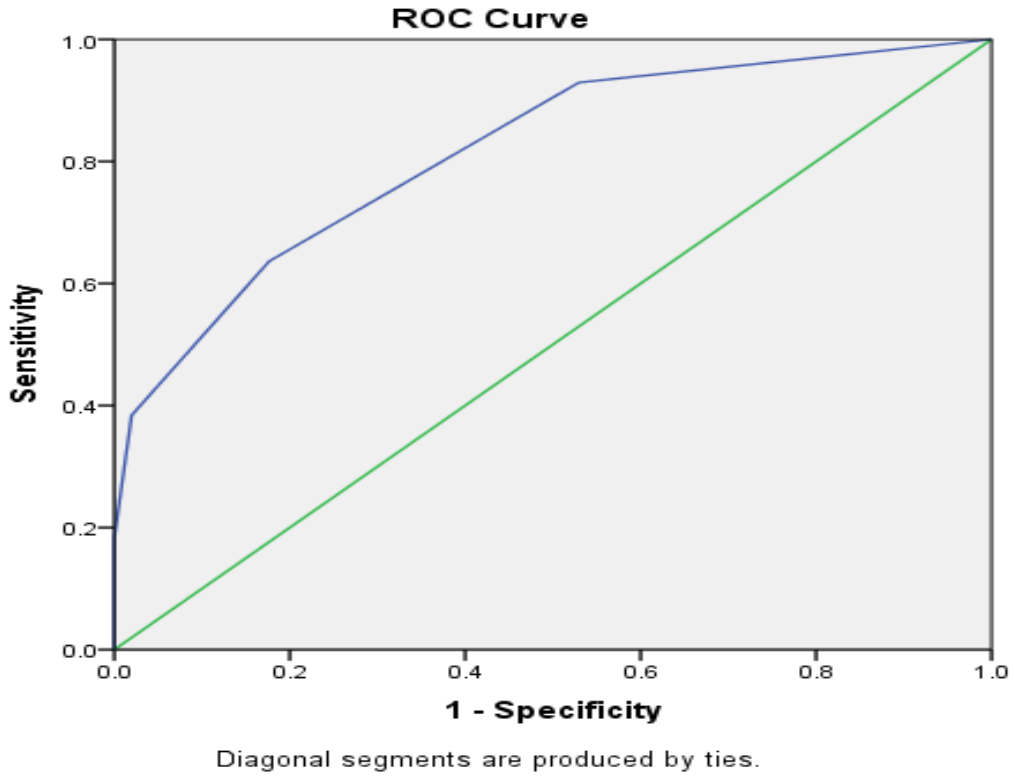
**Table 3:-**

| Severity assessment scores | | |
|---|---|---|
| **Pneumonia Severity Index** | | |
| 1 | 6.7 | 10 |
| 2 | 13.3 | 20 |
| 3 | 20.0 | 30 |
| 4 | 30.0 | 45 |
| 5 | 30.0 | 45 |
| **CURB 65** | | |
| 0 | 20.7 | 31 |
| 1 | 31.3 | 47 |
| 2 | 22.0 | 33 |
| 3 | 14.0 | 21 |
| 4 | 8.7 | 13 |
| 5 | 3.3 | 5 |

**Table 4:-** Distribution of ICU admission in different CURB-65 classes.

| **Variable** | **CURB-65** | | | | | | **Total** |
|---|---|---|---|---|---|---|---|
| | **0** | **1** | **2** | **3** | **4** | **5** | |
| **Number of Patients** | 31(20.67) | 47(31.33) | 33(22) | 21(14) | 13(8.67) | 5(3.33) | 150 |
| **ICU Admission** | 7(7.08) | 29(29.29) | 25(25.25) | 20(20.20) | 13(13.13) | 5(5.05) | 99 |

**Figure 1:-** ROC curve for predicting ICU admission using CURB-65 classes.



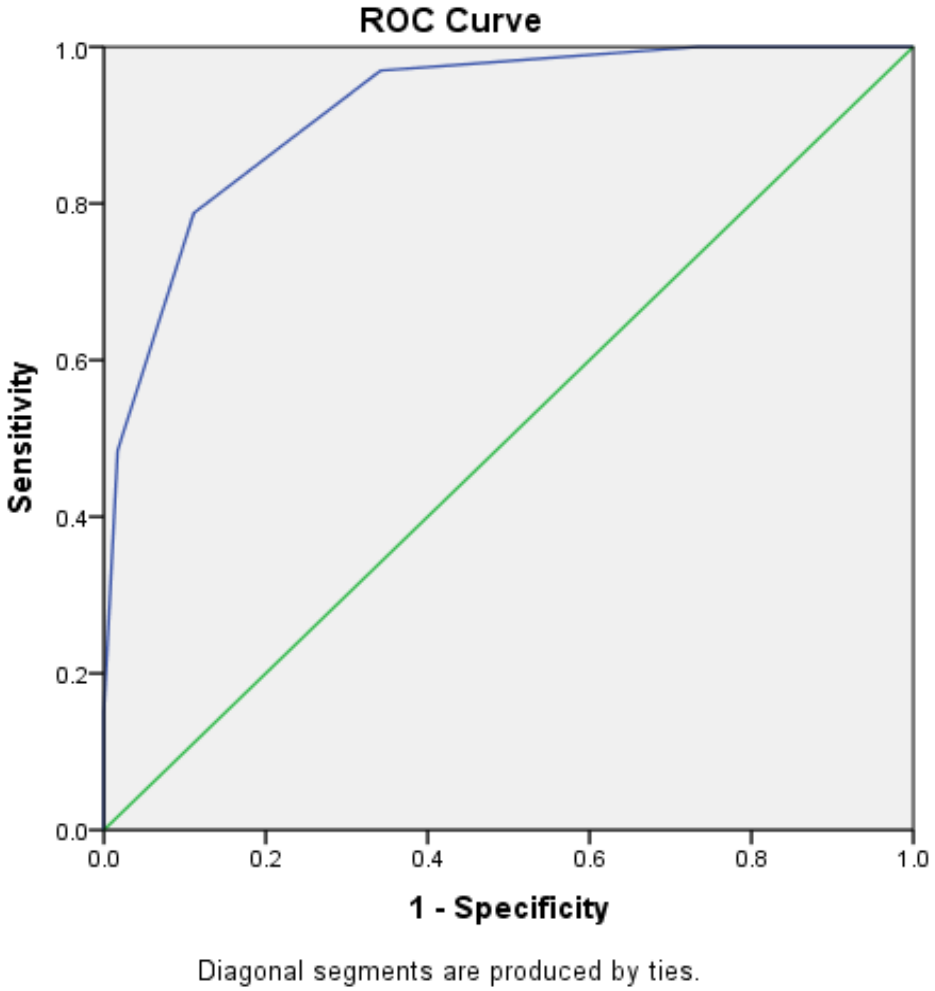

Area Under the Curve: 0.816 (95% CI: 0.748-0.884)

**Table 5:-** Distribution of mortality in different CURB-65 classes.

| **Variable** | **CURB-65** | | | | | | **Total** |
|---|---|---|---|---|---|---|---|
| | **0** | **1** | **2** | **3** | **4** | **5** | |
| **Number of Patients** | 31(20.67) | 47(31.33) | 33(22) | 21(14) | 13(8.67) | 5(3.33) | 150 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Mortality** | 0 | 1(3.03) | 6(18.19) | 10(30.30) | 11(33.33) | 5(15.15) | 33 |

**Figure 2:-** ROC curve for predicting mortality using CURB-65 classes.



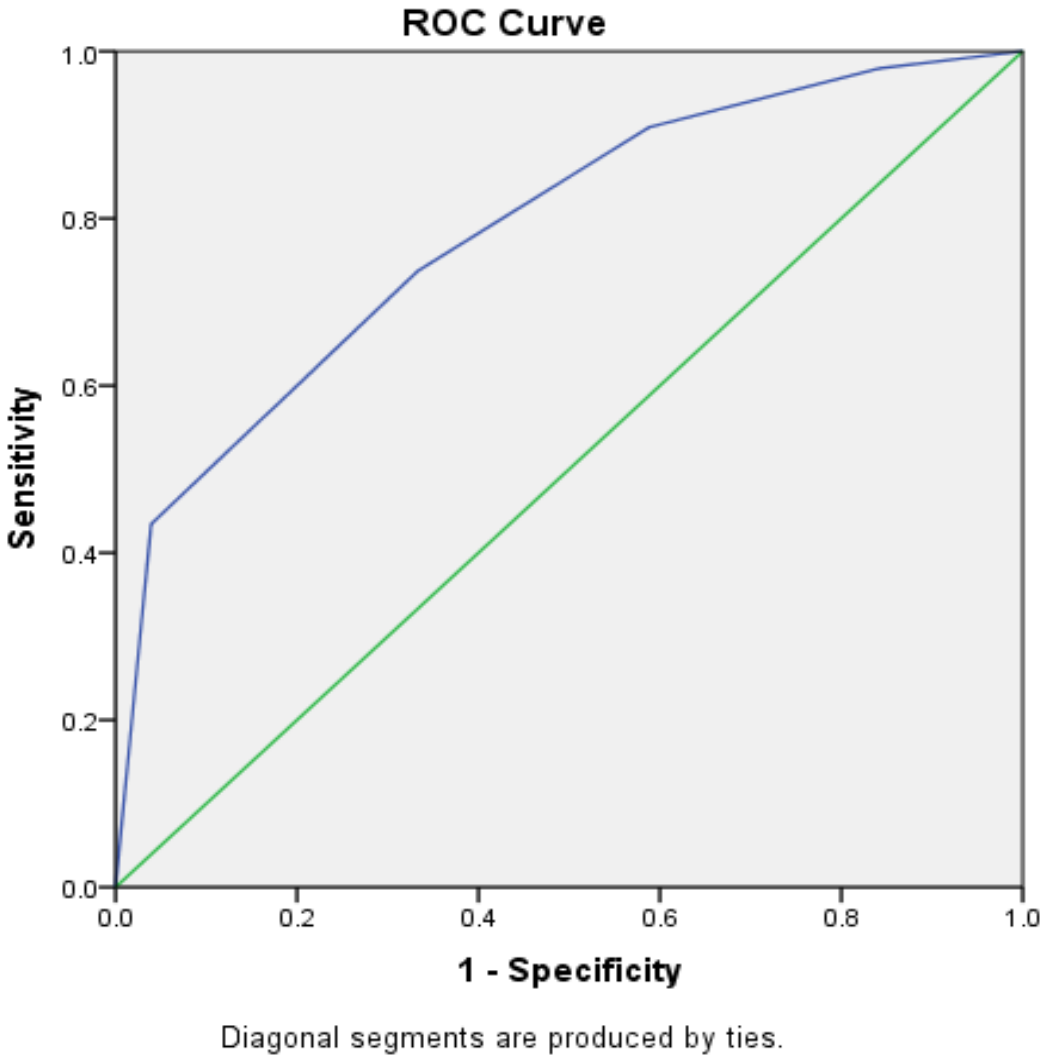

**Area under the curve: 0.920 (95% CI: 0.872-0.969)**

**Table 6:-** Distribution of ICU admission in different PSI classes.

| **Variable** | **PSI** | | | | | **Total** |
|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | |
| **Number of Patients** | 10(6.67) | 20(13.33) | 30(20) | 45(30) | 45(30) | 150 |
| **ICU Admission** | 2(2.02) | 7(7.08) | 17(17.17) | 30(30.30) | 43(43.43) | 99 |

Out of the 150 patients, 99 were referred for ICU admission as per PSI class.

**Figure 3:-** ROC curve for predicting ICU admission using PSI classes.



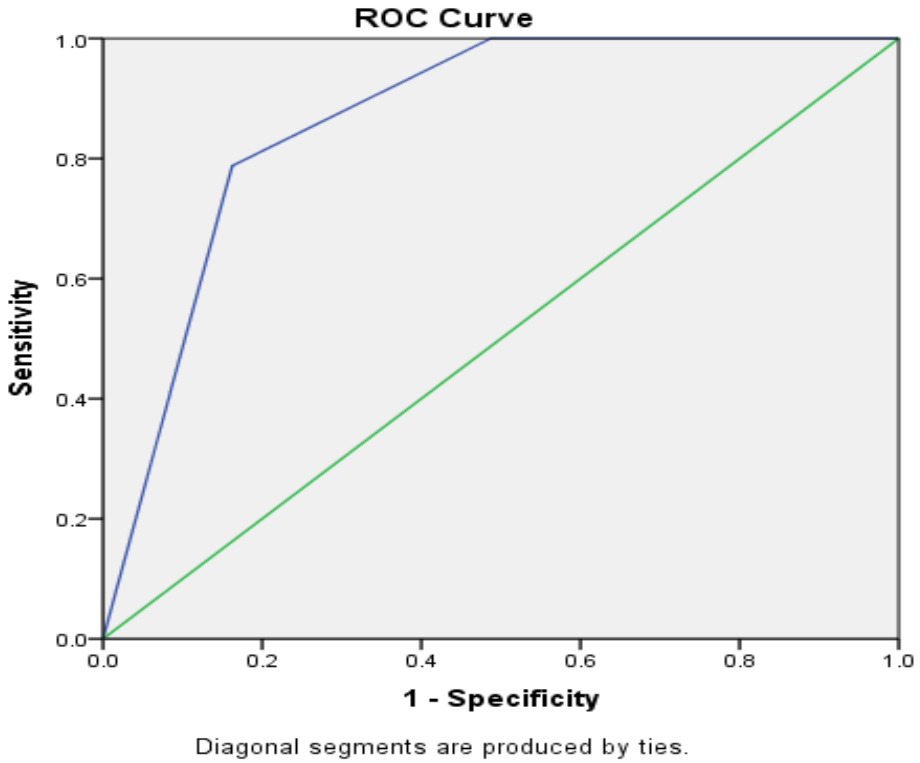

**Predictive Area Under the Curve: 0.787 (95% CI: 0.713-0.860)**

**Table 7:-** Distribution of mortality in different PSI classes.

| Variable | PSI | | | | | Total |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | |
| **Number of Patients** | 10(6.67) | 20(13.33) | 30(20) | 45(30) | 45(30) | 150 |
| **Mortality Admission** | 0 | 0 | 0 | 7(21.21) | 26(78.79) | 33 |

Out of the 150 patients, prevalence of mortality was 33(22%).

**Figure 4:-** ROC curve for predicting mortality using PSI classes.




**Area under the curve: 0.867(95% CI: 0.809-0.926)**

**Table 8:-** Distribution of duration of ICU stay, total hospital stay, antibiotic and time taken for Defervescence.

| Variables | Range | Mean | Standard Deviation |
|---|---|---|---|
| **ICU stay duration** | 0-12 | 2.94 | 2.76 |
| **Duration of total hospital stay** | 1-20 | 8.38 | 4.01 |
| **Duration of antibiotic** | 1-20 | 9.18 | 3.90 |
| **Time taken for Defervescence** | 0-14 | 3.24 | 2.64 |

The results shows that duration of ICU stay varies from 0-12 days with an average of 2.94±2.76 days, total hospital stay duration varies from 1-20 days with an average of 8.38±4.01, duration of antibiotic intake range from 1-20 days with average duration of 9.18±3.90 and time taken for Defervescence ranges from 0-14 days with mean duration of 3.24±2.64.

**Table 9:-** Correlation between outcome parameters and CURB 65 criteria in the study population.

| Outcome Parameters | Correlation (R Value) | P Value |
|---|---|---|
| **ICU stay duration** | 0.575 | <0.001 |
| **Hospital stay duration** | -0.156 | 0.057 |
| **Duration of antibiotic** | -0.108 | 0.190 |
| **Time taken for Defervescence** | -0.260 | 0.001 |

**Spearman Rank Correlation, p<0.05 shows significance**

There was a significant moderate positive correlation between ICU stay duration and CURB-65 classes (R=0.575, P<0.001). Hospital stay duration shows a less negative correlation with CURB-65 classes which was not statistically significant (R=-0.156, P=0.057). Duration of antibiotic also shows a very less negative correlation with CURB-65 classes which was not significant (R=-0.108, P=0.190). Time taken for Defervescence shows a weak negative correlation with CURB-65 classes which was statistically significant (R=-0.260, P<0.05).

**Table 10:-** Correlation between outcome parameters and PSI classes in the study population.

| Outcome Parameters | Correlation (R Value) | P Value |
|---|---|---|
| **ICU stay duration** | 0.513 | <0.001 |
| **Hospital stay duration** | -0.123 | 0.135 |
| **Duration of antibiotic** | -0.052 | 0.525 |
| **Time taken for Defervescence** | -0.222 | 0.006 |

**Spearman Rank Correlation, p<0.05 shows significance**

There was a significant moderate positive correlation between ICU stay duration and PSI classes (R=0.513, P<0.001). Hospital stay duration shows a less negative correlation with PSI classes which was not statistically significant (R=-0.123, P=0.135). Duration of antibiotic also shows a very less negative correlation with PSI classes which was not significant (R=-0.052, P=0.525). Time taken for defervescence shows a weak negative correlation with PSI classes which was statistically significant (R=-0.222, P<0.05).

## Discussion:-

The decision regarding the most appropriate site of care, including whether admission to hospital is warranted, is the first and single most important decision in the overall management of CAP.It has consequences both for the level of treatment received by the patient as well as the overall costs of treatment.[9]

Majority of the patients in our study group was in age group 61 – 70 years. The median age in our study was 55 years (20 – 90 years). The mean age in the studiesdone by Patil P et al , Babu et al and Dey et al was 54.33±16.87, 53(±17) years and 50.6 years respectively.[10,11,12]Majority of patients were male 114 constituting about 76% of the study population. In our study majority of patients presented with symptoms of cough and shortness of breath. Similar was seen in the study by ravindranath et al.[13]Smoking did not a have any association with ICU admissions & mortality in our study (P = 0.101, P = 0.826). It was contrary to the study by ravindranath et al where Smoking was found to have significant association with need for ICU admission. No study till date mentions a direct association between smoking and mortality in CAP. Of the co morbidities associated, in our study COPD was not significantly associated with mortality and ICU admission (P = 0.88, P = 0.70). In a study by ravindranath et al COPD was significantly associated with death & ICU admission.[13] The association of COPD and adverse outcome in CAP is well established as found in study of Restrepo et al and Rello et al.[14,15]AcuteRenal Failure was significantly associated with death in our study (P <0.001), similar to the study done by ravindranath et al. Association of mortality from CAP with ARF has been reported in a number of studies such as those of Moine P et al and Díaz et al.[16,17]

Study included 150 cases of CAP of which 99 patients (66%) needed ICU admission, 19 patients (12.7%) needed invasive ventilatory support, and 35 patients (23.3%) had non invasive ventilation. Of the 150 patients 33 patients (22%) succumbed to death and rest were cured (78%). Thirty out of 45 patients (66.6%) in PSI class IV and 43 patients out of 45 (95.5%) in PSI class V were admitted to ICU. Majority of patients admitted to ICU were from PSI class IV and class V. Similarly 13 patients out of 13 (100%) in CURB 65 class IV and 5 patients out of 5 (100%) in CURB 65 class V were admitted to ICU. Thus in our study 100% of patients in CURB 65 class IV and class V required ICU admission. This was not similar to study by Shah et al and Mohanty S et alin which ICU admissions were 23.33% and 25%.[6,18]

As the severity class of the scoring system increased, the percentage of ICU admission also increased.7 out of 45 patients in PSI class IV (16%) and 26 out of 45 patients (58%) in PSI class V succumbed to death. In CURB 65 class IV 11 out of 13 (84.6%) patients died, and all 5 (100%) patients of CURB 65 class V had died. In the present study, the overall mortality was 22%. In a study by Patil P et al and Dey et al mortality rates were 18% and 25% respectively [(5,11)].The mortality increased as the PSI and CURB 65 severity increased. This finding is similar to that found by Shah BA et al which showed a linear rise in mortality with severity of CAP in both CURB 65 and PSI scoring systems.[19]However, Madhu et al, in their study found that overall mortality was 18% and, the mortality rate and need for ICU admission increased progressively with increasing scores of PSI but the CURB-65 score did not show this correlation.[20] Mortality was 49.4% in the study by Woodhead et al; this apparently higher mortality was probably due to delayed admission of the patients into ICU.[21]

In comparison of sensitivity, specificity, NPV and PPV for different PSI classes for predicting death as an outcome we had completely opposite results when compared with results of Shah BA et al[19] we had high specificity and low sensitivity but if we consider class ≥4 as one group and. class 3 and below as another group sensitivity increases. PSI class ≥4 has 79 % sensitivity, 84% specificity (AUC 0.86). This was similar to the study done by Madhu et al.[20]In comparison of sensitivity, specificity, NPV and PPV for different CURB 65 classes for predicting death as an outcome we had opposite results when compared with results of Shah BA et al and sensitivity was severely compromised and to compensate this if we consider class ≥3 as one group and class 2 and below as another group sensitivity increased. CURB 65 class ≥3 sensitivity 79%, specificity 89% (AUC 0.9). Our study had similar results to the study done by Madhu et al.[20]Dividing these groups was consistent with and also previously done in many studies like Shah BA et al and Mohanty Set al.[18,19] However specificity of CURB-65class ≥3 is higher than that of PSI class ≥4 because a major limitation of the PSI is the unbalanced impact of age on the score, which results in a potential underestimation of severe CAP particularly in younger otherwise healthy individuals.

A Brazilian study by Alavi-Moghaddam M et al infers that CURB-65 showed a better predictive value in foreseeing both the need for ICU admission and mortality than PSI.[22]

In our results, however, CURB-65 had better accuracy in predicting mortality and the need for ICU admission among patients with community-acquired pneumonia. CURB-65 had a high specificity in predicting mortality and need for ICU admission than PSI score. In our study CURB 65 score ≥2 shows more chance for ICU admission with 64% sensitivity and 82% specificity (AUC 0.816) and PSI score ≥3 shows more chance for ICU admission with 74% sensitivity and 67% specificity (AUC 0.78).

For predicting ICU admission, however, other indices such as modified ATS, SMART-COP and IDSA/ATS were reported to perform better than PSI and CURB-65 [(23)], as these indices were originally designed to assess ICU admission rather than mortality. Therefore, a poor performance could be found if applied in predicting mortality.

The PSI was developed to identify low mortality risk patients, but this scoring system can occasionally underestimate the severity of illness, especially in young patients without comorbid illnesses.[(19)]. This is because the PSI relies more on age and comorbidities, and therefore, the young patients without any comorbidities may be placed in a lower PSI class and may not receive the care they actually required. In contrast, the CURB-65 approach may be ideal for identifying high mortality risk patients with severe illness due to CAP. However, the main shortfall of the CURB-65 approach is that it does not account for comorbid illness, and thus may not be realistic in older patients who may have considerable mortality risk even with low CURB-65 score.

**Limitation**

An important limitation of the study was the small number of patients included in the study. Considering the limited number of ICU beds in our hospital, it is possible that certain patients were admitted to different wards due to unavailability of ICU beds. Not having an available ICU bed may have affected the final decision on whether the patient needed ICU admission.

## Conclusion:-

In our study we found that CURB-65 is a better indicator for predicting mortality and ICU admissions. Because of its simplicity and ease of use, CURB-65 may be better suited than PSI as a severity scoring system in CAP in developing countries with limited resources. We hope that by using the knowledge of relevant prognostic factors, as obtained from this study, patients of CAP will be better prognosticated as regards severity of their illness with consequently better triaging of patients, utilization of resources and appropriate treatment to improve the outcome in this disease

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