Section: General Medicine

Original Research Article

A STUDY ON USE OF SMART-COP SCORE IN PREDICTING THE SEVERITY OUTCOMES AMONG PATIENTS WITH COMMUNITY-ACQUIRED PNEUMONIA

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ABSTRACT

Background: Community-acquired pneumonia (CAP) remains a leading cause of morbidity and mortality worldwide. Early identification of patients at risk for severe outcomes is essential for timely intervention. Conventional scoring systems such as CURB-65 and Pneumonia Severity Index (PSI) have limitations in predicting the need for intensive respiratory or vasopressor support (IRVS). The SMART-COP score was developed to better identify such high-risk patients. The objective is to evaluate the effectiveness of the SMART-COP score in predicting severity outcomes among patients with CAP and compare its performance with CURB-65 and PSI.

Materials and Methods: This hospital-based cross-sectional study was conducted at a tertiary care center over 18 months (June 2023–December 2024). A total of 100 adult patients diagnosed with CAP were included. Clinical evaluation, laboratory investigations, and chest radiography were performed. Severity was assessed using SMART-COP, CURB-65, and PSI scores. Outcomes measured included ICU admission, need for IRVS, ventilatory support, and 30-day mortality. Statistical analysis was performed using SPSS version 26, with ROC curve analysis used to evaluate predictive performance.

Results: The mean age was 57.44 ± 11.99 years, with 62% males. Based on SMART-COP, 57% were low risk, while 30% were categorized as high or very high risk. ICU admission was required in 31% of patients, and 22% required IRVS. The mortality rate was 9%. SMART-COP demonstrated superior predictive performance for ICU admission (AUC = 0.973), IRVS (AUC = 0.991), and intubation (AUC = 0.998) compared to PSI and CURB-65. It also showed excellent sensitivity for mortality prediction.

Conclusion: SMART-COP is a reliable and superior tool for predicting severe outcomes in CAP patients. Its use in routine clinical practice can improve early risk stratification, guide timely intervention, and optimize patient outcomes.

Keywords: Community-acquired pneumonia, SMART-COP, CURB-65, Pneumonia Severity Index, ICU admission, IRVS, Severity scoring.

INTRODUCTION

Community-acquired pneumonia (CAP) is a significant cause of morbidity and mortality worldwide and remains a major public health concern, particularly in developing countries like India. Fever, coughing, sputum production, dyspnea, and radiological evidence of new infiltrates on chest imaging are among the clinical signs of an acute infection of the pulmonary parenchyma that can occur in people outside of hospital settings or within 48 hours of hospital admission.[1] CAP is still one of the world's top causes of mortality and is a major contributor to healthcare use, including hospital admissions and stays in intensive care units (ICUs).[2]

Elderly people and patients with underlying comorbid illnesses such immunosuppression, diabetes mellitus, cardiovascular disease, and chronic obstructive pulmonary disease have a particularly high burden of CAP. Poorer outcomes in these people are a result of various comorbidities, age-related immune loss, and delayed healthcare-seeking behaviour.[3] Although the etiological range varies depending on patient features and geographic location, the most often implicated pathogens are Streptococcus pneumoniae, Haemophilus influenzae, Staphylococcus aureus, and different Gram-negative organisms.[4]

Early detection of patients who are at risk of developing severe illness and needing intensive care support is one of the main issues in managing CAP. Since patients may look stable at first then quickly worsen, clinical presentation alone is frequently insufficient to reliably predict disease progression. The necessity for trustworthy severity assessment instruments that can direct clinical judgments about hospitalization, ICU admission, and the start of intensive medication is highlighted by this unpredictability.[5] Many prognostic score systems have been created over time to categorize CAP patients based on the severity of their illness. The most used instruments in clinical practice are the CURB-65 score and the Pneumonia Severity Index (PSI).

While CURB-65 is a more straightforward bedside assessment based on confusion, urea levels, respiration rate, blood pressure, and age ≥65 years, the PSI is a comprehensive scoring system that integrates several demographic, clinical, and laboratory characteristics to evaluate mortality risk.[6,7] Both rating methods have significant drawbacks while being helpful in forecasting mortality and directing site-of-care choices. While CURB-65 is not sensitive enough to identify patients who need intense respiratory or vasopressor support (IRVS), PSI tends to overemphasize age and comorbidities, which may underestimate severity in younger patients.[8]

The SMART-COP scoring system was created to overcome these drawbacks by more precisely predicting the requirement for intensive respiratory or vasopressor assistance rather than just death. Systolic blood pressure, multilobar involvement on chest radiography, serum albumin, respiration rate, tachycardia, disorientation, oxygenation status, and arterial pH are among the important clinical and laboratory markers that are included in SMART-COP.[9] SMART-COP is especially intended to identify patients who are likely to need advanced supportive treatment, such as mechanical breathing or vasopressor therapy, as contrast to PSI and CURB-65, which mainly concentrate on mortality risk.

Numerous studies have shown how well SMART-COP predicts poor outcomes in CAP patients, especially when it comes to identifying individuals who need intensive therapies and ICU admission.[10] Early identification of these individuals enables better clinical outcomes, optimum resource allocation, and prompt escalation of care. Despite its benefits, SMART-COP is still not widely used in ordinary clinical practice, particularly in places with limited resources.

This study is to assess the efficacy of the SMART-COP score in predicting severe outcomes among patients with community-acquired pneumonia, given the need for precise and useful risk stratification methods. In order to identify patients who are at risk of needing intensive care treatments and suffering unfavorable outcomes, it also compares its prediction accuracy with well-known grading systems like PSI and CURB-65.

MATERIALS AND METHODS

Study Design: This study was a hospital-based cross-sectional observational study conducted to evaluate the role of the SMART-COP score in predicting severity outcomes among patients diagnosed with community-acquired pneumonia.

Study Setting: The study was carried out in the Department of General Medicine at ASRAM Medical College over a period of 18 months, from June 2023 to December 2024.

Study Population: Adult patients presenting with clinical features suggestive of pneumonia were screened for eligibility. A total of 100 patients who fulfilled the diagnostic criteria for community-acquired pneumonia were included in the study.

Inclusion Criteria

- Patients aged more than 18 years
- Diagnosis of community-acquired pneumonia based on:
  - Presence of clinical features (fever, cough, sputum production, breathlessness)
  - Radiological evidence of new infiltrates on chest X-ray within 24 hours of admission
- Patients who provided informed consent

Exclusion Criteria

- Hospital-acquired pneumonia (onset ≥48 hours after admission)
- Recent hospitalization within the previous 2 weeks
- Pregnant women
- Severely immunocompromised individuals
- Patients with known chronic pulmonary diseases (e.g., bronchiectasis, interstitial lung disease)
- Patients unwilling to participate

Sample Size and Sampling Method

Out of 250 patients screened, 100 eligible patients were enrolled using a combination of simple random sampling and consecutive sampling methods.

Data Collection Procedure: A detailed history and clinical examination were performed at the time of admission. Data collected included demographic details, presenting symptoms, comorbidities, and vital parameters.

Clinical and Laboratory Evaluation

All patients underwent the following investigations:

- Complete blood count
- Renal function tests (including blood urea)
- Liver function tests
- Serum electrolytes
- Serum albumin
- Arterial blood gas (ABG) analysis
- Chest radiography

Severity Assessment Tools

Severity of pneumonia was assessed using the following scoring systems:

1. CURB-65 Score

Based on:

- Confusion
- Urea >7 mmol/L
- Respiratory rate ≥30/min
- Blood pressure (SBP <90 mmHg or DBP ≤60 mmHg)
- Age ≥65 years

2. SMART-COP Score

Includes:

- Systolic blood pressure
- Multilobar infiltrates
- Serum albumin
- Respiratory rate
- Tachycardia
- Confusion
- Oxygenation parameters
- Arterial pH

3. Pneumonia Severity Index (PSI)

Used to stratify patients into risk classes based on mortality risk.

Outcome Measures

The primary and secondary outcomes assessed were:

- Need for intensive respiratory or vasopressor support (IRVS)
- ICU admission
- Requirement of invasive ventilation
- Requirement of non-invasive ventilation
- Vasopressor support
- 30-day mortality

Statistical Analysis: Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 26. Categorical variables were expressed as frequencies and percentages, while continuous variables were summarized as mean ± standard deviation or median with range, depending on data distribution. The chi-square test or Fisher's exact test was applied to assess associations between categorical variables. For continuous variables, comparisons between groups were performed using the independent t-test for normally distributed data and the Mann–Whitney U test for non-normally distributed data. Logistic regression analysis was carried out to identify independent predictors of disease severity. The predictive performance of the scoring systems was evaluated using Receiver Operating Characteristic (ROC) curve analysis. Additionally, sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy were calculated. A p-value of less than 0.05 was considered statistically significant.

Ethical Considerations: The study was approved by the Institutional Ethics Committee. Written informed consent was obtained from all participants prior to inclusion in the study.

RESULTS

Table 1: Baseline Characteristics of Study Population (N = 100)

Variable	Category	n	%
Age (years)	Mean ± SD	57.44 ± 11.99	—
Gender	Male	62	62.0
	Female	38	38.0
Comorbidities	Diabetes Mellitus	37	37.0
	Smoking	32	32.0
Presenting Symptoms	Shortness of breath	61	61.0
	Cough	—	—

[Table 1] Baseline Characteristics of Study Population

[Table 1] summarizes the baseline demographic and clinical characteristics of the study population. A total of 100 patients with community-acquired pneumonia were included, with a mean age of 57.44 ± 11.99 years. There was a clear male predominance, with males constituting 62% of the study population, while females accounted for 38%. Among the predisposing factors, diabetes mellitus (37%) and smoking (32%) were the most common. Regarding presenting symptoms, shortness of breath was the predominant complaint, reported in 61% of patients, followed by cough. These findings indicate that CAP predominantly affects middle-aged to elderly males with significant comorbidity burden.

Table 2: Distribution of SMART-COP Risk Categories (N = 100)

SMART-COP Category	Score Range	n	%
Low Risk	0–2	57	57.0
Moderate Risk	3–4	13	13.0
High Risk	5–6	15	15.0
Very High Risk	≥7	15	15.0

[Table 2] depicts the distribution of patients according to SMART-COP risk categories. The majority of patients (57%) were classified as low risk (score 0–2), indicating a relatively lower probability of requiring intensive respiratory or vasopressor support. Moderate-risk patients (score 3–4) constituted 13% of the cohort. High-risk (score 5–6) and very high-risk (score ≥7) categories each accounted for 15% of patients. Notably, the need for intensive respiratory or vasopressor support was predominantly observed in the high-risk and very high-risk groups, highlighting the strong predictive capability of the SMART-COP scoring system in identifying patients at risk of clinical deterioration.

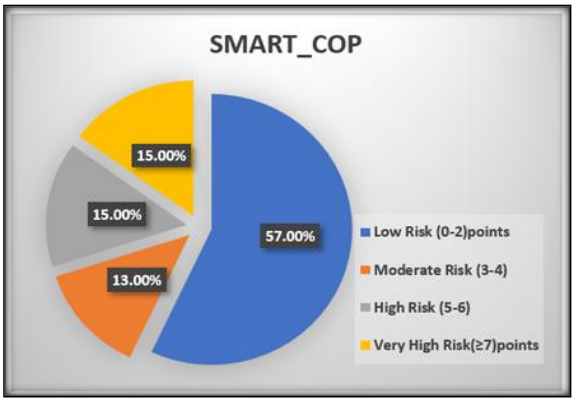

Figure 1: SMART-COP Risk Category Distribution.

Table 3: Major Clinical Outcomes in CAP Patients (N = 100)

Outcome	n	%
ICU Admission	31	31.0
IRVS / Vasopressor Support	22	22.0
Ventilatory Support	25	25.0
Invasive Ventilation	14	14.0
Non-Invasive Ventilation (NIV)	17	17.0
Mortality (30-day)	9	9.0

[Table 3] presents the major clinical outcomes observed among the study participants. ICU admission was required in 31% of patients, indicating a substantial proportion with severe disease. A total of 22% required intensive respiratory or vasopressor support (IRVS). Ventilatory support was needed in 25% of patients, of whom 14% required invasive mechanical ventilation and 17% were managed with non-invasive ventilation (NIV). The overall 30-day mortality rate was 9%. These findings reflect a significant burden of severe outcomes in CAP and underscore the importance of early risk stratification.

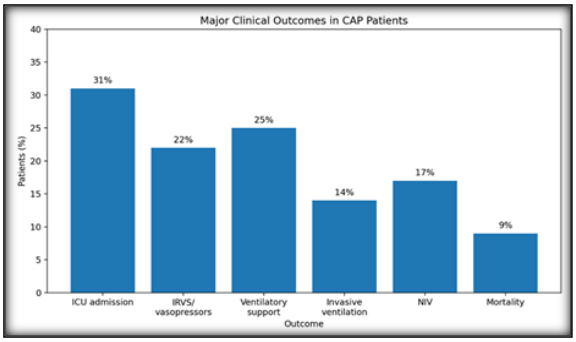

Figure 2: Major Clinical Outcomes in CAP Patients

Table 4: Predictive Performance (AUC) of Scoring Systems for ICU Admission

Scoring System	AUC
SMART-COP	0.973
PSI	0.961
CURB-65	0.919

[Table 4] compares the predictive performance of different severity scoring systems for ICU admission using the area under the receiver operating characteristic (ROC) curve. SMART-COP demonstrated the highest predictive accuracy with an AUC of 0.973, followed closely by PSI with an AUC of 0.961, while CURB-65 showed comparatively lower predictive ability with an AUC of 0.919. These results indicate that SMART-COP is superior in identifying patients who are likely to require ICU care.

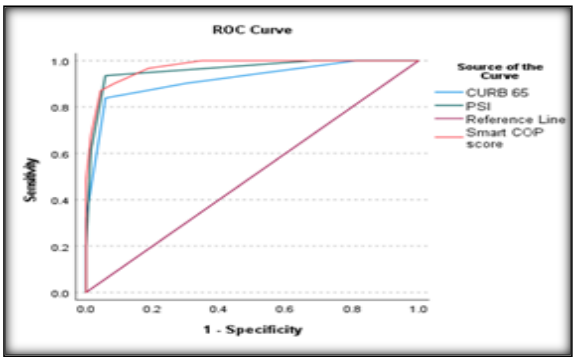

Figure 3: ROC Curve for Predicting ICU Admission

Table 5: SMART-COP Predictive Accuracy for Key Severity Outcomes

Outcome	AUC
Intubation (Mechanical Ventilation)	0.998
IRVS Requirement	0.991
ICU Admission	0.973
Mortality	0.949
NIV Requirement	0.792

[Table 5] illustrates the diagnostic performance of the SMART-COP score for various critical outcomes. The score showed excellent predictive accuracy for intubation (AUC = 0.998) and IRVS requirement (AUC = 0.991), indicating near-perfect discrimination. It also demonstrated high accuracy for predicting ICU admission (AUC = 0.973) and mortality (AUC = 0.949). However, the predictive performance for non-invasive ventilation was comparatively lower, with an AUC of 0.792, though still within acceptable limits. Overall, these findings confirm that SMART-COP is a highly reliable tool for predicting severe clinical outcomes in CAP patients.

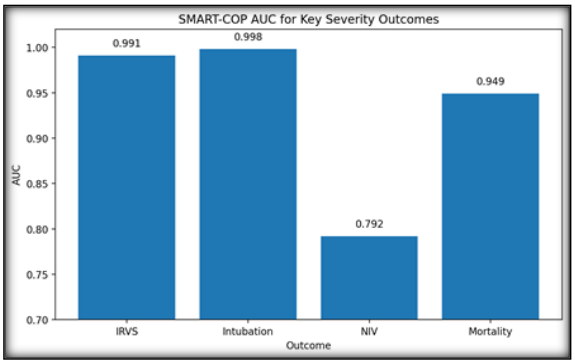

Figure 4: SMART-COP Area Under Curve for Key Outcomes.

Table 6: Diagnostic Performance of SMART-COP vs CURB-65 and PSI

Parameter	SMART-COP	CURB-65	PSI
Sensitivity (Mortality)	100%	—	—
Specificity (Mortality)	—	97.8%	—
PPV (Mechanical Ventilation)	93.33%	46.67%	14%

Overall, the results demonstrate that increasing severity as assessed by SMART-COP is strongly associated with adverse clinical outcomes, including ICU admission, need for ventilatory support, and mortality. Among the evaluated scoring systems, SMART-COP consistently showed superior predictive performance, particularly for identifying patients requiring intensive respiratory or vasopressor support.

DISCUSSION

The present study evaluated the utility of the SMART-COP scoring system in predicting severity outcomes among patients with community-acquired pneumonia (CAP), with comparison to established tools such as CURB-65 and Pneumonia Severity Index (PSI). The results of this study show that SMART-COP is a better predictor of key outcomes such as the requirement for mechanical ventilation, ICU admission, and intense respiratory or vasopressor support (IRVS). As indicated in [Table 1], the average age of the patients in this research was 57.44 ± 11.99 years, with a definite male predominance (62%). These results are in line with earlier research that found that older persons and men had a greater prevalence of CAP. According to Jain et al,[1] and Musher and Thorner,[4] CAP is more common in older people because of a larger load of comorbidities and deteriorating immunity.

The prevalence of smoking (32%) and diabetes mellitus (37%) as important risk factors in this study is also consistent with international research, which shows that smoking and metabolic disorders are known to enhance the risk and severity of pneumonia.[11,12] Shortness of breath is the most prevalent presenting symptom, which is consistent with research by Restrepo et al,[5] highlighting its significance as a measure of the severity of the illness.

The distribution of patients across SMART-COP risk categories is seen in [Table 2], with 57% of patients categorized as low risk and 30% as high or very high risk. Crucially, the need for IRVS was mostly seen in these higher-risk groups, demonstrating SMART-COP's potent discriminating power. The initial research by Charles et al,[9] which showed that SMART-COP successfully identifies patients in need of intense respiratory or vasopressor support, is in line with this observation. Marti et al,[10] observed similar results, concluding that SMART-COP works better than conventional grading systems in predicting severe CAP outcomes. [Table 3] clinical results, which show that 31% of patients needed ICU admission, 22% needed IRVS, and 25% needed ventilatory support, further corroborate the severe burden of CAP. The study's 9% death rate is similar to earlier reports of hospitalized CAP patients' mortality rates, which range from 5% to 15%.[1,6] Notably, all of the study's fatal patients had higher severity ratings and needed to be admitted to the intensive care unit, underscoring the need of early risk classification for prognosis. In their validation of the CURB-65 score, Lim et al,[9] reported similar correlations between severity scores and mortality.

[Table 4] shows that SMART-COP had the best predictive accuracy for ICU admission (AUC = 0.973), followed by CURB-65 (0.919) and PSI (0.961). These results are consistent with earlier comparative research in which SMART-COP demonstrated better prediction accuracy for severe outcomes. According to Chalmers et al. [10], CURB-65 is not sensitive enough to indicate the requirement for critical care, whereas PSI is helpful in predicting death but tends to underestimate severity in younger patients.

This study's greater AUC for SMART-COP indicates that it is more effective in identifying patients who need aggressive treatment. The outstanding diagnostic efficacy of SMART-COP in predicting important severity outcomes, such as intubation

(AUC = 0.998) and IRVS (AUC = 0.991), is seen in [Table 5]. Similar to studies by Charles et al,[9] where SMART-COP showed great sensitivity for predicting intensive care requirements, these near-perfect AUC values show exceptional discrimination. Physician judgment and institutional norms may have an impact on clinical decision-making for non-invasive ventilation, as seen by the comparatively lower AUC for NIV (0.792). Furthermore, SMART-COP's strong mortality prediction accuracy (AUC = 0.949) validates its function as a thorough severity assessment tool.

Additionally, compared to PSI and CURB-65, SMART-COP showed better sensitivity (100%) for mortality prediction and a larger positive predictive value for mechanical ventilation. These findings are in line with those of Marti et al,[10] who highlighted that SMART-COP is especially useful in forecasting the need for intensive treatments as opposed to mortality alone. CURB-65's lower sensitivity restricts its use in the early detection of high-risk individuals, despite its better specificity for death.

CONCLUSION

This study demonstrates that the SMART-COP scoring system is a highly effective and reliable tool for predicting severity outcomes in patients with community-acquired pneumonia. The results demonstrate a substantial correlation between rising SMART-COP scores and unfavorable clinical outcomes, such as the requirement for intense respiratory or vasopressor support, ICU admission, mechanical ventilation, and death. SMART-COP had better predictive accuracy than traditional grading systems like CURB-65 and Pneumonia Severity Index, especially when it came to identifying patients who needed early intensive care treatments. SMART-COP's clinical value in emergency and inpatient settings is highlighted by its excellent sensitivity and diagnostic accuracy for predicting key outcomes like intubation and IRVS. Clinicians may make prompt judgments about patient triage, care level, and resource allocation by employing SMART-COP for early risk assessment. This is particularly significant in environments with limited resources, when making the most use of intensive care units is essential. All things considered, integrating SMART-COP into standard clinical practice will help identify high-risk CAP patients earlier, enable timely management, and ultimately improve patient outcomes while lowering the morbidity and mortality linked to severe pneumonia.

Limitations of the study

The present study has several limitations that should be considered while interpreting the findings. First off, the study was carried out at a single tertiary care facility, which would restrict how broadly the findings can be applied to other healthcare environments or populations with distinct clinical and demographic characteristics. Second, the results may have less statistical power and external validity due to the small sample size (n = 100). The capacity to determine causal correlations between severity levels and clinical outcomes is further limited by the cross-sectional study design. Furthermore, not every patient underwent a thorough microbiological investigation, which may have yielded further information about the severity and consequences of a particular disease. Selection bias may also exist since hospital-based sampling typically includes more severe pneumonia cases. Moreover, outcome evaluation may have been impacted by differences in clinical treatment approaches, especially in choices about ICU admission and non-invasive ventilation. Notwithstanding these drawbacks, the study offers insightful information on the SMART-COP scoring system's therapeutic usefulness in predicting severe outcomes in patients with community-acquired pneumonia.

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