Section: Infectious Diseases

Original Research Article

COMPARATIVE EVALUATION OF SMART-COP AND CURB-65 SEVERITY SCORING SYSTEMS IN PREDICTING INTENSIVE CARE UNIT ADMISSION AND MORTALITY IN PATIENTS WITH COMMUNITY-ACQUIRED PNEUMONIA: A CROSS-SECTIONAL OBSERVATIONAL STUDY

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Received *: 12/02/2026*
Received in revised form *: 18/02/2026*
Accepted *: 01/03/2026*

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DOI: 10.70034/ijmedph.2026.3.328

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (3); 2051-2055

ABSTRACT

Background: Community-acquired pneumonia (CAP) is a leading cause of hospitalization and death worldwide. Early risk stratification is essential to guide decisions on level of care. CURB-65 was designed primarily to predict mortality and the need for hospitalization, whereas SMART-COP was developed specifically to predict the need for intensive respiratory or vasopressor support. Head-to-head comparisons of these two scores in Indian tertiary-care settings remain limited. The objective is to compare the performance of SMART-COP and CURB-65 in predicting ICU admission and in-hospital mortality among patients admitted with CAP.

Materials and Methods: This cross-sectional observational study included 118 adults admitted with CAP to the Department of Medicine of a tertiary-care teaching hospital. SMART-COP and CURB-65 scores were recorded at admission. ICU admission, need for ventilatory/inotropic support, duration of hospital stay, and in-hospital outcome were documented. Discriminative performance was assessed using receiver operating characteristic (ROC) curve analysis, with sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) calculated at standard cut-offs.

Results: Mean age was 57.2 ± 15.0 years; 56.8% were male. ICU admission occurred in 52/118 (44.1%) patients, and 23/118 (19.5%) died. Both SMART-COP and CURB-65 scores were significantly higher among patients who died and among those requiring ICU admission ($p<0.001$ for all comparisons). SMART-COP showed greater discriminative ability than CURB-65 for both mortality (AUC 0.932 vs 0.814) and ICU admission (AUC 0.898 vs 0.724). At a cut-off of ≥5, SMART-COP predicted ICU admission with 71.2% sensitivity and 92.4% specificity, and predicted mortality with 91.3% sensitivity and 77.9% specificity (negative predictive value 97.4%). Advancing age ($p=0.008$) and hypertension ($p=0.028$) were significantly associated with mortality.

Conclusion: In this cohort, SMART-COP outperformed CURB-65 in predicting both ICU admission and in-hospital mortality in CAP, supporting its use as a complementary bedside tool for early identification of patients likely to need a higher level of care.

Keywords: Community-acquired pneumonia; SMART-COP; CURB-65; ICU admission; mortality; severity score; ROC curve.

INTRODUCTION

Community-acquired pneumonia (CAP) remains one of the most common infectious causes of hospitalization and death worldwide, disproportionately affecting older adults, those with chronic comorbidities, and populations in low- and middle-income countries. Despite advances in antimicrobial therapy, vaccination, and critical care, the disease continues to impose a substantial burden on healthcare systems, with mortality ranging widely depending on disease severity at presentation and the timeliness of appropriate level-of-care decisions.

Accurate assessment of severity at the time of admission is central to the management of CAP. Under-triage of a severely ill patient to a general ward delays escalation of care and increases the risk of death, whereas over-triage to the intensive care unit (ICU) places unnecessary strain on critical care resources. Several clinical prediction tools have therefore been developed to support this decision, of which the CURB-65 score (Confusion, Urea, Respiratory rate, Blood pressure, age ≥65 years) and the SMART-COP score (Systolic blood pressure, Multilobar involvement, Albumin, Respiratory rate, Tachycardia, Confusion, Oxygenation, pH) are among the most widely used.

CURB-65 was derived and validated as a simple, rapidly calculable tool to predict 30-day mortality and to guide the decision to hospitalize a patient with CAP.[1] While it performs well for mortality prediction and is easy to apply at the bedside, several studies have noted that it was not specifically designed to identify patients who will require intensive respiratory or vasopressor support (IRVS), and it may under-recognize younger patients who deteriorate rapidly despite a low age-related score. SMART-COP was subsequently developed and validated by Charles et al. specifically to predict the need for IRVS in CAP, incorporating physiological parameters — including hypotension, multilobar infiltrates, hypoalbuminemia, tachypnoea, tachycardia, confusion, hypoxaemia and acidaemia — that more directly reflect the pathophysiology of respiratory and haemodynamic decompensation.[2] In its derivation cohort, SMART-COP demonstrated substantially higher sensitivity for predicting IRVS than CURB-65.[2]

Subsequent comparative studies in varied clinical settings have shown that the relative performance of these two scores can differ by population and by the outcome being predicted, with some studies favouring SMART-COP for ICU-level outcomes and others finding CURB-65 comparably useful for mortality prediction.[1,2] Comparative data on the performance of these two scores from Indian tertiary-care hospitals remain relatively limited. Given that resource availability, case mix, and comorbidity burden in Indian settings may differ from the populations in which these scores were originally derived and validated, a local comparative assessment is clinically relevant.[3,4]

The present study was undertaken to compare the discriminative performance of SMART-COP and CURB-65 in predicting ICU admission and in-hospital mortality among patients admitted with CAP to a tertiary-care teaching hospital, and to examine the association of baseline demographic and clinical factors with these outcomes.

MATERIALS AND METHODS

Study design and setting: This was a cross-sectional observational study conducted in the Department of Medicine of a tertiary-care teaching hospital (Bangalore Medical College and Research Institute, Bengaluru) over the study period from December 2025 to January 2026.

Study population: A total of 118 consecutively admitted adult patients with a clinico-radiological diagnosis of community-acquired pneumonia were enrolled in the study.

Inclusion criteria

Adults ≥18 years admitted with clinical and radiographic features consistent with CAP.

Exclusion criteria

Hospital-acquired or ventilator-associated pneumonia, active pulmonary tuberculosis, and patients with incomplete clinical records. [Note: exact inclusion/exclusion criteria, ethics approval details, and sampling method should be verified and completed by the study authors before submission.]

Data collection: For each patient, demographic details (age, gender), comorbidities (diabetes mellitus, hypertension, thyroid disorder, asthma, cardiac illness, HIV infection), and habits (alcohol use, smoking, substance abuse) were recorded at admission. SMART-COP and CURB-65 scores were calculated at the time of admission using standard published criteria by the treating clinical team. Patients were followed during their hospital course, and the following outcome variables were recorded: need for ICU admission, requirement for invasive mechanical ventilation, non-invasive ventilation (NIV), or inotropic/vasopressor support, duration of hospital stay, and final in-hospital outcome (discharge or death).

Statistical analysis: Data were compiled and analysed using standard statistical software. Continuous variables are expressed as mean ± standard deviation (SD) and were compared between groups using the independent-samples t-test (or Mann-Whitney U test where appropriate). Categorical variables are expressed as frequencies and percentages and were compared using the chi-square test. Receiver operating characteristic (ROC) curve analysis was performed to evaluate and compare the discriminative ability (area under the curve, AUC) of SMART-COP and CURB-65 for predicting ICU admission and in-hospital mortality. Sensitivity, specificity, positive predictive value

(PPV), and negative predictive value (NPV) were calculated at clinically relevant cut-off values for each score. A two-tailed p-value <0.05 was considered statistically significant.

RESULTS

Baseline characteristics: Of the 118 patients included, the mean age was 57.2 ± 15.0 years (range 19–88 years). There were 67 males (56.8%) and 51 females (43.2%). The most common comorbidities were diabetes mellitus (43.2%), hypertension (34.7%), and cardiac illness (27.1%); thyroid disorder and asthma were each present in 8.5% of patients. Thirty-nine patients (33.1%) were current smokers and 14 (11.9%) reported regular alcohol use. The mean duration of hospital stay was 6.0 ± 2.5 days (range 1–14 days). Fifty-two patients (44.1%) required ICU admission, and the overall in-hospital mortality was 19.5% (23/118) [Table 1].

Table 1: Baseline demographic and clinical characteristics of the study population (N = 118)

Variable	Value
Age, years (mean ± SD)	57.2 ± 15.0
Male, n (%)	67 (56.8)
Female, n (%)	51 (43.2)
Diabetes mellitus, n (%)	51 (43.2)
Hypertension, n (%)	41 (34.7)
Cardiac illness, n (%)	32 (27.1)
Thyroid disorder, n (%)	10 (8.5)
Asthma, n (%)	10 (8.5)
Smoking, n (%)	39 (33.1)
Alcohol use, n (%)	14 (11.9)
Duration of hospital stay, days (mean ± SD)	6.0 ± 2.5
ICU admission, n (%)	52 (44.1)
In-hospital mortality, n (%)	23 (19.5)

SMART-COP and CURB-65 scores by outcome: Both SMART-COP and CURB-65 scores were significantly higher in patients who died compared with those who were discharged, and in patients who required ICU admission compared with those who did not [Table 2]. The mean SMART-COP score was more than double in patients who died (6.96 ± 1.61) compared with those discharged (3.35 ± 1.60; p<0.001), and was similarly higher in patients admitted to ICU (5.69 ± 1.81) compared with those not requiring ICU care (2.76 ± 1.37; p<0.001). CURB-65 followed the same pattern, though with a smaller absolute separation between groups.

Table 2: Comparison of SMART-COP and CURB-65 scores according to in-hospital outcome and ICU admission status

Score	Group	Mean ± SD	n	p-value
SMART-COP	Death	6.96 ± 1.61	23	
	Discharge	3.35 ± 1.60	95	<0.001
CURB-65	Death	2.35 ± 1.19	23	
	Discharge	1.02 ± 0.76	95	<0.001
SMART-COP	ICU admission	5.69 ± 1.81	52	
	No ICU admission	2.76 ± 1.37	66	<0.001
CURB-65	ICU admission	1.77 ± 1.17	52	
	No ICU admission	0.89 ± 0.64	66	<0.001

Diagnostic performance: On ROC curve analysis, SMART-COP demonstrated greater discriminative ability than CURB-65 for predicting both in-hospital mortality (AUC 0.932 vs 0.814) and ICU admission (AUC 0.898 vs 0.724) [Figure 1]. At a cut-off of ≥5, SMART-COP predicted the need for ICU admission with a sensitivity of 71.2% and specificity of 92.4% (PPV 88.1%, NPV 80.3%), and predicted mortality with a sensitivity of 91.3% and specificity of 77.9% (PPV 50.0%, NPV 97.4%). For CURB-65, a cut-off of ≥2 predicted mortality with 78.3% sensitivity and 78.9% specificity, while a higher cut-off of ≥3 improved specificity (95.8%) at the expense of sensitivity (47.8%) [Table 3].

Table 3: Diagnostic performance of SMART-COP and CURB-65 for predicting ICU admission and in-hospital mortality

Outcome	Score (cut-off)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	AUC
ICU admission	SMART-COP ≥5	71.2	92.4	88.1	80.3	0.898
ICU admission	CURB-65 (overall)	—	—	—	—	0.724
Mortality	SMART-COP ≥5	91.3	77.9	50.0	97.4	0.932
Mortality	CURB-65 ≥2	78.3	78.9	47.4	93.8	0.814
Mortality	CURB-65 ≥3	47.8	95.8	73.3	88.3	0.814

Factors associated with mortality

Patients who died were significantly older than those discharged (63.0 ± 10.0 years vs 55.8 ± 15.7 years; p=0.008). Among comorbidities, hypertension was significantly associated with in-hospital death (p=0.028), whereas diabetes mellitus (p=0.095),

cardiac illness (p=0.509), and smoking (p=0.960) did not reach statistical significance in this cohort.

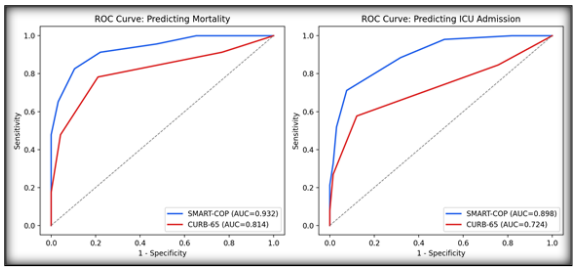

Figure 1: Receiver operating characteristic (ROC) curves comparing SMART-COP and CURB-65 for predicting in-hospital mortality (left) and ICU admission (right).

DISCUSSION

In this cohort of 118 patients hospitalized with community-acquired pneumonia, SMART-COP outperformed CURB-65 in predicting both ICU admission and in-hospital mortality, with consistently higher AUC values for both outcomes. These findings are in keeping with the original derivation study by Charles et al., in which SMART-COP demonstrated markedly higher sensitivity for identifying patients requiring intensive respiratory or vasopressor support than CURB-65-based classification.[2] They are also consistent with the observations of Pachucki et al., who found that SMART-COP identified the need for ICU-level support with greater accuracy than CURB-65 in a district general hospital setting, and that increasing SMART-COP scores correlated with the duration of inotropic and ventilatory support required.[4]

The superior performance of SMART-COP for ICU-related outcomes in our cohort is biologically plausible: unlike CURB-65, which relies heavily on age, renal function, and a binary assessment of confusion and blood pressure, SMART-COP incorporates parameters that more directly capture the physiology of respiratory and haemodynamic failure — hypoxaemia, tachypnoea, tachycardia, multilobar involvement, and hypoalbuminemia — that are proximate mechanisms of clinical deterioration in severe pneumonia. This may explain why a relatively younger patient with severe hypoxaemia or shock, who might score low on CURB-65 by virtue of age alone, is more readily flagged as high-risk by SMART-COP.

Notably, CURB-65 in our study still performed reasonably well for mortality prediction (AUC 0.814), which is consistent with its original purpose as a mortality-focused, hospitalization-triage tool rather than an ICU-triage tool.[1] A systematic review and meta-analysis by Marti et al. similarly found that while several severity scores, including SMART-COP, showed good sensitivity for severe CAP, their specificity was comparatively modest, and considerable heterogeneity existed across study populations and outcome definitions — a pattern reflected in the relatively low PPV but high NPV for SMART-COP observed in our cohort.[3] This suggests that SMART-COP in our population is more useful for reliably ruling out low-risk patients than for precisely ruling in which patients will die, and should be interpreted alongside overall clinical assessment rather than in isolation.

Advancing age and hypertension were independently associated with in-hospital death in our cohort, consistent with the well-established observation that older patients and those with cardiovascular comorbidity tolerate the physiological stress of severe pneumonia less well. The lack of a statistically significant association between diabetes, cardiac illness, or smoking and mortality in this analysis may reflect the modest number of deaths (n=23) rather than a true absence of association, and should be interpreted with caution.

From a clinical standpoint, these findings support using SMART-COP as a complementary bedside tool alongside CURB-65 in the initial assessment of CAP, particularly to help identify patients who may need escalation to a higher level of care despite an unremarkable CURB-65 score. Given its high negative predictive value for mortality in this cohort, a low SMART-COP score may be particularly reassuring in ruling out patients unlikely to require ICU-level care.

Limitations: This study has several limitations. It was conducted at a single tertiary-care centre over a relatively short period, which may limit generalisability. The sample size, while adequate for the primary comparisons performed, resulted in a modest number of death events (n=23), limiting the power of subgroup and multivariable analyses. Individual physiological components used to calculate SMART-COP and CURB-65 (such as arterial blood gas values, serum albumin, and blood pressure at admission) were not independently available for re-verification in this analysis; scores as recorded by the treating clinical team at admission were used. Long-term outcomes beyond hospital discharge (e.g., 30-day mortality) were not assessed. Finally, as an observational study, causal inferences cannot be drawn from the associations identified.

CONCLUSION

In this cohort of patients admitted with community-acquired pneumonia, SMART-COP demonstrated superior discriminative ability compared with CURB-65 for predicting both ICU admission and in-hospital mortality. While CURB-65 remains a rapid, simple bedside tool for mortality risk stratification and hospitalization decisions, incorporating SMART-COP into routine assessment may improve early identification of patients likely to require a higher level of care, particularly in younger patients whose CURB-65 score may underestimate true severity. Larger, multicentric, prospective studies are

warranted to validate these findings and to refine cut-off values for local populations.

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