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Original Article

Is SMaRTCOP really smart? Validity of SMaRTCOP in the Severity & Prognosis of Community Acquired Pneumonia in the Emergency Department

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Abstract

Objective: To evaluate the validity of the SMaRT-COP score, excluding the indigenous serum albumin levels, in the prognosis and severity of community-acquired pneumonia (CAP) in the emergency department (ED).

Methods: A prospective observational study of patients presenting with clinical signs and symptoms of pneumonia to ED of a tertiary care hospital. Without taking into consideration the albumin levels of the admitting patients with community acquired pneumonia, the sensitivity and specificity of the modified SMaRTCOP score for intensive respiratory & vasopressor support (IRVS) requirements and ICU admissions were determined.

Results: In this study, 55.6% and 44.4% of patients were males and females respectively. The mean age of patients was 53.49±15.84 years old. Among the participants, 41.6% required ICU care, and 70.2% received IRVS as part of their treatment. The SMaRTCOP score of 5 or higher demonstrated a sensitivity of 95.12% and a specificity of 85.45% for predicting the need for IRVS, while, for predicting ICU admission, the sensitivity and specificity were 51.22% and 98.18% respectively, with a p-value of 0.001.

Conclusion: Even without using the indigenous serum albumin levels, we can accurately predict the severity and prognosis of community-acquired pneumonia (CAP) using the SMaRTCOP score in the Emergency Department.

Keywords: Community-acquired pneumonia, Prognosis, Emergency Department

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Introduction

Oxygen stands at the very foundation for the survival of human life on Earth. The tissues responsible for its exchange and absorption tend to be vulnerable to the diseases that are carried along. Yes, we are talking about pneumonia, an infection of the lung parenchyma[1,2] usually resulting from the micro aspiration of upper respiratory pathogens into the sterile alveoli. The defence system of the host poses the primary challenge to invasion; once breached, invasive organisms proliferate, triggering an inflammatory cascade that leads to clinical symptoms.[1] Clinically, it comprises of a constellation of infections (fever, leukocytosis), localized respiratory signs or symptoms (dyspnea, chest pain, cough, variability in the amount or colour of the sputum, or abnormalities in the pulmonary examination), as well as radiographic evidence of consolidation[3]. Community-acquired pneumonia is the term used to describe an acute infection of the lung parenchyma that occurs outside of healthcare settings.[2,3] Its incidence in developing and developed countries is between 20-30% and 3-4% respectively.[4] It is amongst the most common causes of infection related with the highest mortality across the globe and considerable utilization of healthcare resources. Approximately one-fifth of patients with CAP require admission to critical care, while nearly 30% of patients necessitate hospitalization.[5]

Accurately assessing the severity of the disease is absolutely crucial for making informed and confident therapeutic decisions. These include choices regarding home management, in-patient vs ICU admissions, determining the suitability for discharge, conducting appropriate

investigations, and selecting the most effective antibiotics.[4,5] There are several different grading systems available to predict the severity and prognosis of pneumonia, and each of them comes with its pros and cons.

As part of the Pneumonia Outcomes Research Trial (PORT), Fine et al. developed the Pneumonia Severity Index (PSI), which gives an insight into the risk stratification of the patients based upon mortality. PSI is based on 20 variables rendering it difficult to use in emergency departments or primary care settings.[5] Moreover, it is formulated for predicting mortality in CAP-afflicted individuals who are low-risk and managed at home. From this perspective, this particular tool was developed with the primary goal of identifying individuals with a low risk of mortality. Therefore, it was not intended to serve as a determinant for the need for ICU care or to evaluate the severity of illness.[6,7]

CURB 65 score is the modified version of the original British Thoracic Society rule, which includes 5 parameters (confusion, increased blood urea nitrogen, respiratory rate above normal and decrease in systolic or diastolic blood pressure, and age).[7] The system is designed to provide a more user-friendly alternative to PSI, while effectively classifying patients into high and low-risk categories for mortality. Nevertheless, it is not a perfect model for isolating patients with multiple comorbid conditions, especially if these illnesses are exacerbated by pneumonia. CRB-65, a modification, is easier to use but the dilemma remains constant for not predicting the disease severity or need for ICU care with the score.[8,9] CURSI5, A-DROP9, and SCAP10 are other scoring systems for predicting mortality risk associated with CAP but still need external validation.

SMARTCOP score, developed by Charles et al., includes several clinical parameters, which are systolic blood pressure (SBP) below 90 mmHg, multiple lobar involvements on chest X-ray, albumin level less than 3.5 g/dL, respiratory rate (RR) above 30 breaths per minute, tachycardia (heart rate (HR)) greater than 125 beats per minute, new onset confusion, oxygen saturation (SpO2) below 90%, and potential hydrogen (pH) below 7.35. It was formulated to predict disease severity and ICU admissions, having a sensitivity of 92% compared to 74% for PSI and 39% for CURB-655. The SMARTCOP score system assigns 2 points each to abnormalities in systolic blood pressure, oxygenation, and arterial pH, while the remaining five criteria are valued at 1 point each. A score of at least 3 points on the SMARTCOP scale has been found to accurately predict the need for IRVS (Intensive Respiratory or Vasopressor Support).[8] It is a clinical prediction that emphasizes isolating the patients that will benefit most from the ICU referral. It is easy to use and identifies the need for IRVS in all age groups of adult population.[9,10]

Karen et al. compared SMARTACOP with SMARTCOP having an additional point for serum albumin levels in CAP but found no statistically significant advantage.[11] The SMARTCOP tool is deemed most effective in predicting the severity of community-acquired pneumonia (CAP) in the emergency department (ED). Its utilization in this setting is associated with a reduction in the ED length of stay and earlier decision-making with regard to patient disposition. Such expeditious management of patients leads to a more efficient use of resources in developing countries.[12-13]

In the current study, we determined the validity of the SMaRT-COP Score, without using the serum albumin levels, (small a for albumin status not counted) in the ED of a tertiary care hospital. The attending physicians are required to await the serum albumin levels before determining the appropriate disposition as the reporting of the serum samples usually takes 4 to 6 hours. The primary cohort of patients seeking emergency department (ED) care present with critical illness, compounded by comorbidities. Unfortunately, delays in obtaining metabolic profile results leads to squandering the vital "golden hour" of resuscitation. This critical time period is essential for prompt diagnosis and timely intervention, which can significantly impact patient outcomes. Such tools that code patients according to their severity, are a crucial component of a healthcare system. By rapidly assigning patients to intensive care slots, these scores help to minimize the length of an ED stay. Moreover, they enable healthcare providers to intervene as early as possible, thereby improving well-being of the patients.

Methods

We conducted a prospective cohort study on patients who presented to the Emergency Department of Mayo Hospital Lahore with suspected community-acquired pneumonia (CAP) from Oct.2023 to Jan.2024. Non-probability convenient sampling was done. The participants provided their formal consent and the study was duly approved by the Institutional Review Board (IRB).

Our inclusion criteria for this study required participants to be over 18 years old and exhibit a minimum of three characteristic clinical manifestations and pneumonia symptoms or signs. These included presence of cough with sputum, pleurisy, shortness of breath, pyrexia, hypoxia, lung auscultation in favour of pneumonia, or leukocytosis. The attending emergency team reported the diagnosis, which were validated by a chest X-ray. The study excluded patients who were immunocompromised or taking oral steroids, undergoing treatment for any malignancy, organ transplantation in the last 6 months, suspicion of aspiration pneumonia, or hospital admission in the last 2 weeks.

Non-probability convenient sampling was done. All

participants provided informed written consent. In our study, a score less than 2 was labelled as "low risk", 3-4 as "moderate risk"' 5-6 as "high risk "and 7+ as "very high risk".

Determining the validity of the SMaRT-COP score (without albumin levels) in predicting the pneumonia severity (IRVS needing rate) in the ED was the primary endpoint. The secondary endpoints included calculation of the sensitivity and specificity of this score and the ICU admission rate. Statistical analysis was done using SPSS 20. A sample size of 175 was calculated[16] by taking a confidence level of 95%, absolute precision of 10%, and expected sensitivity of IRVS needed as 93.2%[13] and specificity as 71.7%.[13]

Results

We evaluated 178 patients from October 2023 to January 2024 who had a suspicion of CAP. In our study, 99 patients (55.6%) were male and 79 (44.4%) were female. The mean age of the study population was 53.49± 15.84 years old. The frequency of the study variables is shown in Table 1.

Table 1: *Frequency of the Study Variables*

Variable		Frequency	Percentage (%)
Systolic Blood Pressure (SBP) <90mmHg		59	33.1
Multilobar involvement on CXR		106	59.6
Respiratory Rate > 30 breaths/min		48	27
Tachycardia (HR>125/min)		90	50.6
Confusion (New Onset)		53	29.8
Oxygen Saturation <90%		148	83.1
pH < 7.35		118	66.3
Intensive Respiratory or Vasopressor support		125	7 0.2
SMaRT COP	Low Risk (0-2)	24	13.5
	Moderate Risk (3-4)	31	17.4
	High Risk (5-6)	52	29.2
	Very High Risk (7 or above)	71	39.9
Disposition	ICU	64	35.9
	HDU	57	32.0
	Ward	39	21.9
	Discharge	18	10.1

Our results showed that SMaRTCOP had a statistically significant impact on ICU admission or IRVS requirements. It accurately predicted the need for IRVS and ICU admissions. In our hospital as ICU beds are not available in an easy way, many patients are shifted to the HDU if invasive ventilation is not required. SMaRTCOP score of ≥ 5 was the best cut-off point for predicting ICU/HDU admissions and IRVS requirements given in Table 2.

Table 2: *Association of SMaRTCOP in CAP Prognosis*

SMaRTCOP (Risk)	Intensive Respiratory or Vasopressor Support need	ICU Admission
Low (0-2)	0	0
Moderate (3-4)	8 (6.4%)	1
High (5-6)	46 (36.8%)	4
Very High (7 or above)	71 (56.8%)	59
P-Value	0.001	0.001

As most of our patients with a score of ≥5 (high risk) needed IRVS during the study, we calculated sensitivity and specificity using it as a cut off value given in Table 3.

Discussion

Community acquired pneumonia is among the leading infectious causes of mortality and ICU admissions. Over 4 million adult population present with pneumonia annually and 20% die among hospitalized individuals. The incidence of pneumonia is growing day by day with various factors contributing to its prevalence. These include the administration of immunosuppressive drugs in the treatment of malignancy, transplantation, or autoimmune diseases, the widespread use of smoking and alcohol, the emergence of new pathogens such as sars-cov-2, increasing antibiotic resistance, and a growing emphasis on cost-effective and outpatient management[1,2]. The economic burden is more than 17 billion in the developed world[1] and it is far more in the developing countries.

Our study unequivocally shows that patients afflicted with community-acquired pneumonia, having low risk

Table 3: *Validity of High Risk SMaRTCOP in CAP Prognosis*

Variable	Sensitivity	Specificity	Positive predictive value	Negative predictive value
Intensive Respiratory or Vasopressor Support need	95.12% (89.68% to 98.19%)	85.45% (73.34% to 93.50%)	93.60% (88.50% to 96.53%)	88.68% (78.08% to 94.51%)
ICU admission	51.22% (42.05% to 60.33%)	98.18% (90.28% to 99.95%)	98.44% (89.97% to 99.77%)	47.37% (42.80% to 51.98%)

Considering SMaRTCOP Score ≥5 as cutoff & Confidence Interval (CI) ≥95%

score for SMaRT-COP exhibit remarkably decreasing trend of IRVS need and ICU admission. Similarly, by increasing the severity & high-risk SMaRTCOP score, IRVS and ICU requirements were significantly increased (p-value: 0.001). Patients having a SMaRTCOP score of ≥ 5 have high sensitivity and specificity for IRVS needs and once the score goes beyond 7, ICU admission becomes inevitable.

There are many scoring systems including PSI, CURB-65, CURSI, and ADROP for predicting mortality or complications associated with pneumonia but none of them defines the term "severe pneumonia". SMART-COP score was first utilized by Charles et al. in 2008 and proved its validity in the severity prediction of pneumonia. It initially used a cutoff value of ≥ 3 and found that IRVS was needed in 92% of the patients. It also included those individuals who were not admitted in the ICUs straightaway. Later on, only 10.3 % of patients received IRVS.[17]

Robins-Bowne et al, in 2012, conducted a study taking 367 patients over a year, with CAP. Out of them 10% needed IRVS and mortality was 2.8%. They used a cut-off value of SMARTCOP score ≥3 and found that it has a high sensitivity and negative predictive value of CAP risk stratification in the ED.[15]

Our study used a cutoff of ≥5 for this purpose and was found to have a sensitivity of up to 95% and a negative predictive value of up to 88%. In our resource-limited setup, the availability of ICU beds is insufficient. Consequently, critical care measures such as intensive respiratory support, mechanical ventilation, and vasopressor support are routinely carried out in the ED. Many patients who do not require invasive ventilation but are critically ill, are moved to High Dependency Units (HDUs) in the medical units, due to limited bed availability in the ICUs. In these situations, calculating scores are crucial to predict the prognosis, and hence appropriate interventions are applied in the Emergency Department (ED). This helps avoid unnecessary admissions to ICUs and ensures that patients receive appropriate care as soon as possible. The 2018 prospective study by Ehsanpoor et al.[13] revealed results that were similar to our own study, which was carried out on a comparable demographic cohort.

Marti et al. published their meta-analysis on numerous scoring systems predicting the prognosis of CAP in 2012. They concluded that SMARTCOP, ATS/IDSA 2007 minor criteria[10] are better predictors of IRVS need and ICU admissions as compared to the previously known PSI and CURB-6518.

Davis et al. conducted a retrospective study in 2010 and found that SMART-COP underestimated the pneumonia severity, so they increased the weightage of hypoalbuminemia, changing the scoring system to SMARTACOP. According to them, SMARTACOP has higher sensitivity than the previous one.[14] The prospective studies of Karen et al.[11] and Robins-Browne et al.[15] found similar results for both scoring systems.

Our study did not give any prognostic value to the serum albumin levels at the time of presentation, calculated the SMaRTCOP score, (small a for albumin status not counted), and found similar results for IRVS requirements. Our ED is one of the busiest in the city and the lack of human resources always poses a greater challenge in patient management, besides, there are queues at the laboratory to receive the results due to unavailability of the online systems. As our study shows if we skip the indigenous albumin status of the patient, we still can predict the IRVS need in community-acquired pneumonia.

The accurate prediction of the severity of pneumonia is undoubtedly reliant on clinical judgment. Nonetheless, emergency physicians can leverage the use of highly sensitive scoring systems for risk stratification to enhance their ability to identify critical patients who may be at the precipice of deterioration.

This approach enables physicians to remain vigilant and respond promptly, thereby facilitating closer monitoring and more aggressive management of critically ill patients. In this study, it became evident that using the SMaRTCOP tool can effectively predict the CAP prognosis. It can reliably be applied in our centre thereby identifying patients who are at the verge of severe pneumonia necessitating immediate intervention. It is a single tertiary center-based study which may restrict the applicability of the findings to other settings or populations. Moreover, the mean age was above 50 years, the younger population was underrepresented.

Conclusion

The SMaRTCOP score, a derivative of the SMARTCOP protocol, was found to perform exceptionally well in a patient population in which indigenous albumin status was not considered. The score demonstrated a high degree of sensitivity and negative predictive value and skillfully predicted patients with community-acquired pneumonia (CAP) who would require intensive respiratory or vasopressor support (IRVS) and/or ICU interventions. These findings suggest that the SMaRTCOP score may serve as a valuable prognostic tool in the clinical management of CAP patients. Predicting outcomes in community-acquired pneumonia (CAP) is crucial for physicians to intervene timely. Severity risk stratification is imperative for accurate predictions.

Ethical Approval: The IRB/EC approved this study via letter no 434/RC/KEMU dated October 17, 2023.

Conflict of Interest: None

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Authors' Contribution

SA: Conceptualization of the project.

YM, HMSJ: Design of the work.

MAAK, SNKN, MNS: Data acquisition, analysis, or interpretation.

YM, MAAK, SNKN, HMSJ: Draft the work.

SA, MNS: Critical review of important intellectual content.

All authors approve the version to be published.

All authors agree to be accountable for all aspects of the work.

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