Comparison of Severity Scoring Systems in Community-Acquired Pneumonia

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Abstract

Objective: The aim of this study was to compare the ability of CURB-65, pneumonia severity index and SMART-COP systems to predict 30-day mortality and the need for intensive respiratory and vasopressor support (IVRS).

Methods: We included 84 cases with community acquired pneumonia (CAP) and followed up for 30 days. The scores were calculated at admission and associated with the 30-day mortality and the need for intensive respiratory and vasopressor support.

Results: The mean age of patients was 58.6±18.7 years. The 30-day mortality level for CAP was 7.1%. Fourteen of 84 patients (16.7%) with CAP were followed in ICU. The area under curve (AUC) values of the three systems (CURB-65, PSI, and SMART-COP) for 30-day mortality were 0.89, 0.89 and 0.91, respectively, and for the need for IRVS was 0.88, 0.91 and 0.93, respectively.

Conclusion: The three systems accurately detected the need for IRVS and the 30-day mortality, but none individually demonstrated any advantage over the others.

Keywords: Community-acquired pneumonia, intensive care mortality, severity scores

INTRODUCTION

Community-acquired pneumonia (CAP) is one of the leading causes of high health care cost, hospitalization, and death (1-8). The incidence of CAP in the United States is reported as 5.6 million cases per year, with 915,000 classified as older patients. A total of 1.1 million of these cases required hospitalization, and this number seems to be increasing with time (9-11). CAP together with influenza is the seventh leading cause of mortality in the USA. Therefore, the assessment of disease severity is of crucial importance (12, 13). In our country, lower respiratory tract infections are the fifth leading cause of mortality, and they account for 4.2% of all deaths (1). There are a number of severity assessment tools, of which scoring systems are the most cost effective and easy to use. In our study, we compared the yields of three scoring systems (CURB-65, pneumonia severity index, and SMART-COP) in predicting 30-day mortality and the need for intensive respiratory and vasopressor support (IRVS).

METHODS

We prospectively analyzed 84 patients who were admitted to outpatient clinics and emergency rooms between May 1, 2009 and April 30, 2010 and who were diagnosed with CAP. The exclusion criteria are listed in Table 1. The demographic characteristics; comorbidities; physical examination, imaging, and laboratory findings; together with some important factors for treatment strategies were noted. Arterial blood gas sampling was performed in patients whose oxygen saturation was ≤90% with a pulse oximeter (≤93% in patients <50 years old) (13). Sputum smears with gram stain and culture and blood cultures were obtained from hospitalized patients. The serum procalcitonin levels, urine Legionella antigen levels, and PCR for H1N1 (nasopharyngeal smear) were studied in the indicated patients. The patients received treatment according to the national CAP guidelines (14) and were followed up for 30 days. At admission, the scores of the three systems were calculated and classified (Tables 2-4) and the results were associated with the 30-day mortality and the need for IRVS. The patients in whom invasive mechanical ventilation was indi-

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cated and in whom the systolic blood pressure stayed below 90 mmHg despite proper intravenous fluid resuscitation were followed-up in the intensive care unit (ICU). These criteria were defined as the need for IRVS.

Statistical Analyses

Statistical analyses were performed with Statistical Package for the Social Sciences for Windows 15.0 (SPSS Inc., Chicago, IL, USA), and single variables were compared with the Chi-square test. The yields of the three scoring systems were calculated and compared with receiver operating curve (ROC) analyses.

This study was approved by The Ethics Committee of our institute, and a written informed consent was obtained from every patient.

RESULTS

Eighty-four patients were enrolled in the study. The mean age of these patients was 58.6±18.7 years, and demographic characteristics, clinical findings, and follow-up data are presented in Table 5.

Fourteen of the 84 patients (16.7%) with CAP were followed-up in the ICU. Twelve patients (85.7%) received invasive mechanical ventilation,

Table 1. Exclusion criteria

<18 years old
History of nursing at home or hospitalization longer than 24 h in the last 90 days
Patients received chemotherapy and/or radiotherapy in the last 30 days
Active tuberculosis
Cystic fibrosis
HIV infected
Patients receiving routine hemodialysis
Homeless people

Table 3. CURB-65 system (12)

Point	
Confusion	1
BUN>20 mg/dL	1
Respiratory rate>30 breaths/min	1
Systolic hypotension (<90 mmHg)	1
Age≥65	1

Group 1: 0 and 1 point
Group2: 2 points
Group 3: ≥3 points
BUN: Blood urea nitrogen

Table 2. Pneumonia Severity Index (11)

	Point		Point
Age		Laboratory findings	
Male	Years	BUN≥30 mg/dL	20
Female	Years-10	Na<130 mmol/L	20
Nursing home	10	Glucose≥250 mg/dL	10
Presence of comorbidity		Htc<30%	10
Neoplastic disease	30	Oxygenation	
Chronic liver disease	20	pH<7.35	30
Congestive heart failure	10	SpO_2<90%	10
ASHD/CVD	10	PaO_2<60 mmHg	10
Renal failure	10	Radiology	
Vital signs		Pleural fluid	10
Mental disorder	20		
RR≥30breaths/min	20		
Systolic BP<90 mmHg	20		
Temperature<35°C or ≥40°C	15		
HR≥125 beats/min	10		

ASHD: Atherosclerotic heart disease; BP: blood pressure; BUN: blood urea nitrogen; CVD: cerebrovascular disease; HR: heart rate; Htc: hematocrit; Na: sodium; PaO_2: partial pressure of oxygen in arterial blood; RR: respiratory rate; SpO_2: oxygen saturation by pulse oximeter
Staging:
Class I: age<50 years, no comorbidity, no abnormal vital sign
Class II: <70 points
Class III: 71–90 points
Class IV: 91–130 points
Class V: >130 points

Table 4. SMART-COP system (13)

	Point
Systolic blood pressure<90 mmHg	2
Multilobar infiltrates	1
Serum albumin level<3.5 g/dL	1
Respiratory rate (breaths/min)	1
≥25 (age≤50)	
≥30 (age>50)	
Heart rate≥125 beats/min	1
Confusion (new onset)	1
Hypoxemia	2
SpO_2≤93% or PaO_2<70 mmHg or PaO_2/FiO_2<333 (age≤50)	
SpO_2≤90% or PaO_2<60 mmHg or PaO_2/FiO_2<250 (age>50)	
Arterial pH<7.35	2

Group 1: 0-2 points
Group 2: 3-4 points
Group 3: 5-6 points
Group 4: ≥7 points

and vasopressor support was needed for 3 patients (21.4%). Nine patients (64.2%) were immediately hospitalized in the ICU after admission, and 5 of them (35.8%) were transferred from the general wards.

The 30-day mortality for CAP was 7.1% (6 cases), and all these patients were followed-up in the ICU with mechanical ventilation support. No mortality occurred in the patients who received vasopressor support.

The number of patients within the groups of the three scoring systems is shown in Table 6. All the patients followed up in the ICU were in classes IV and V according to PSI, and none of the patients in classes I, II, and III needed IRVS. However, according to the CURB-65 score, 35.7% of the cases followed-up in the ICU were in groups 1 and 2. The patients in group 3 and 4 according to the SMART-COP system constituted 92.8% of the ICU patients, and system scores ≥3 points were related to a predicted ICU stay of 100%.

All the patients who died within 30 days were in PSI class V. Five of these patients were in the SMART-COP group 4, and one was in group 3. Five patients (31.3%) in CURB-65 group 3 and one patient in group 2 eventually died.

The ROC analyses revealed that the three systems effectively predicted the 30-day mortality and the need for IRVS ($p<0.01$ and $p<0.01$, respectively). None of the systems individually demonstrated any advantage over the others (Figure 1, 2). The comparison of the scores is summarized in Tables 7 and 8.

DISCUSSION

The management of CAP requires an accurate prediction of the severity of the disease. The mortality level of CAP is approximately 1.5% and increases to 15.4% for severe disease that are followed-up in the ICU (15-17). In our study, the 30-day mortality was 7.1% in the studied population and 42.8% in the patients who were followed-up in the ICU. Mortality increases in the hospitalized cases (18).

In an Australian study, 10.3% of the patients needed IRVS (13), whereas in our study, this value was 16.7%. The values for the 30-day mortality and the need for IRVS in our study were high compared with other studies but seem closer to the values from studies using scoring systems (13, 15-18). This result may be attributed to the use of inclusion criteria. In practice, pulmonologists may consider social factors (e.g., homeless people) into the hospitalization criteria leading to hospitalized patients with decreased disease severity and mortality. However, as we excluded such cases, our study population may consist of more severely diseased patients. Additionally, we had a relatively higher number of patients with pulmonary diseases such as chronic obstructive pulmonary disease (COPD). This would have effect on the need for respiratory support. As we know, the need for invasive mechanical ventilation is higher in patients having COPD complicated with pneumonia (19). Additionally, as a tertiary care hospital, the referral of patients with severe disease increased the number of patients who required ICU care.

A study investigating the microbiological etiology of CAP from our country reported an etiology in 62.8% of the cases (20), and *Streptococcus pneumoniae* constituted 19.2% of them. In our study, we showed an etiology in 46.5% of the patients, and furthermore, *S. pneumoniae* was the most common bacteria with an etiology of 25.6%.

The PSI and CURB-65 systems were designed to predict CAP mortality; however, they are less effective in predicting the need for IRVS (21, 22). However, the SMART-COP system was developed in a study to investigate the need for IRVS (13). There are conflicting results between some studies on the PSI and CURB-65 systems regarding which method is superior for predicting mortality (15, 23-26). Many authors reported a continued reliance on clinical judgment (27). Some studies revealed that PSI is better in young and otherwise healthy people, whereas the CURB-65 system works well in older patients and cases of severe disease (11, 12, 28). In another study, the sensitivity, specificity, and positive and negative predictive values of PSI (classes IV and V) on predicting mortality were 95%, 49%, 21%, and 99%; those of PSI (class V) were 50%, 92%, 29%, and 92%; and those of CURB-65 (≥2 points) were 50%, 75%, 22%, and 91%, respectively (29). Davis et al. enrolled 184 patients with CAP in their study and found that 38 (21%) patients needed IRVS and 18 (10%) died within 30 days. The sensitivity of the SMART-COP system (≥3 points) in predicting the need for IRVS and the 30-day mortality was 71% and 67%, respectively. Additionally, the report stated that SMART-COP underestimates the severity of CAP within this population (30). In comparison with other studies, the area under the curve (AUC) value of the SMART-COP system on predicting mortality in our study was found to be higher (0.91 vs. 0.69) (31). No mortality was detected in PSI classes I–III and a SMART COP value of <3 points; however, one patient died in the CURB-65 group 2, indicating that the 30-day mortality within this group was 6.25%.

Table 5. Characteristics of patients with community-acquired pneumonia

	n (%)		n (%)
Mean age (years)	58.6±18.7	Erythrocyte sedimentation rate≥20 mm/h	51/62 (82.3)
Age>50 years	61 (72.6)	Multilobar infiltration on chest roentgenogram	39 (46.4)
Sex (M/F)	53/31	Pleural fluid on chest roentgenogram	18 (21.4)
Comorbidities		Sputum culture	
Malignancies	4 (4.8)	No microorganism detected	21/39 (53.8)
Cerebrovascular disease	3 (3.6)	*Streptococcus pneumoniae*	10/39 (25.6)
Congestive heart failure	11 (13.1)	*Pseudomonas aeruginosa*	4/39 (10.2)
Chronic renal failure	8 (9.5)	Methicillin resistant *Staphylococcus aureus*	2/39 (5.1)
Chronic obstructive pulmonary disease	22 (26.2)	*Escherichia coli*	1/39 (2.5)
Diabetes mellitus	12 (14.4)	*Enterobacter* spp.	1/39 (2.5)
Atherosclerotic heart disease	10 (12)	Positive result for urine Legionella antigen	0/8
History of pneumonia in last year	3 (3.6)	Positive H1N1 PCR	2/9
Alcohol consumption	3 (3.6)	The need for IRVS	14 (16.7)
Malnutrition (Body mass index<17 kg/m^2)	16 (19)	Patients received invasive mechanical ventilation	12 (14.3)
Antibiotic usage before admission	20 (23.8)	Patients received vasopressor support	3 (3.6)
History of viral disease before admission	11 (13.1)	30-day mortality	6 (7.1)
Clinical findings		Severity scores	
Confusion	15 (17.9)	CURB-65 groups	
Temperature<35°C or ≥40°C	42 (50)	1	52 (61.9)
Heart rate≥125 beats/min	11 (13.1)	2	16 (19)
Systolic heart failure<90 mmHg	3 (3.6)	3	16 (19)
Tachypnea[b]	29 (34.5)	PSI classes	
SpO_2≤%90[c]	41 (48.8)	I	16 (19)
pH<7.35	16/41 (39)	II	19 (22.6)
Hypoxemia[c]	40/41 (97.6)	III	8 (9.5)
PaO_2/FiO_2<250	12/41 (29.2)	IV	18 (21.4)
Serum albumin level<3.5g/dL	49 (58.3)	V	23 (27.4)
Glucose≥250 mg/dL	5 (6)	SMART-COP groups	
Sodium<130 mmol/L	4 (4.8)	1	38 (45.2)
High blood urea nitrogen level[c]	15 (17.9)	2	17 (20.2)
Hematocrit<30%	3 (3.6)	3	11 (13.1)
Serum C-reactive protein level≥10 mg/dL	56/61 (91.8)	4	18 (21.4)
Procalcitonin≥0.25 ng/mL	2/9 (22.2)		

[a]Refers to 84 patients unless stated otherwise.
[b]Look at Tables 2–4 for scoring
[c]SpO_2≤93% (for patients<50 years old)

The PSI and CURB-65 systems are described to be ineffective in predicting the need for IRVS (27). Kontou et al. (29) reported the sensitivity, specificity, and positive and negative predictive values of PSI (classes IV and V) on predicting the need for IRVS as 81%, 50%, 28%, and 91%; those of PSI (class V) as 45%, 83%, 40%, and 90%; and those of CURB-65 (≥2 points) as 58%, 79%, 40%, and 89%, respectively. A study from France stated that the PSI and CURB-65 systems work well in predicting the mortality and that the SMART-COP system is better at predicting the need for IRVS (32). The sensitivity, specificity, and positive and negative predictive values of SMART-COP (≥3 points) in predicting the need for IRVS were reported as 92.3%, 62.3%, 22% and 98.6%, respectively. The PSI and CURB-65 systems were less effective with 74% and

39% sensitivity and 48% and 74% specificity, respectively. The SMART-COP system is reported to work well for patients who were directly hospitalized into the ICU and for those who were transferred from the general wards (13). In a recent study, PSI was found to be successful in predicting the 30-day mortality compared with the SMART-COP system with AUC values of 0.78 and 0.69, respectively, and the SMART-COP system was the most effective in predicting the need for IRVS (AUC 0.73) (31). Davis et al. (30) reported the sensitivity of SMART-COP (≥3 points) in predicting the need for IRVS as 71%. In our study, the

Table 6. 30-day mortality and the need for IRVS according to groups of three scoring systems

	n=84	Need for IRVS n (%)	30-day mortality n (%)
CURB-65 groups			
1	52	1 (1.9)	0 (0)
2	16	4 (25)	1 (6.3)
3	16	9 (56.3)	5 (31.3)
PSI classes			
I	16	0 (0)	0 (0)
II	19	0 (0)	0 (0)
III	8	0 (0)	0 (0)
IV	18	1 (5.6)	0 (0)
V	23	13 (56.5)	6 (26.1)
SMART-COP groups			
1	38	0 (0)	0 (0)
2	11	1 (5.9)	0 (0)
3	17	2 (18.2)	1 (9.1)
4	18	11 (61.1)	5 (27.8)

IRVS: Intensive respiratory and vasopressor support; PSI: pneumonia severity index

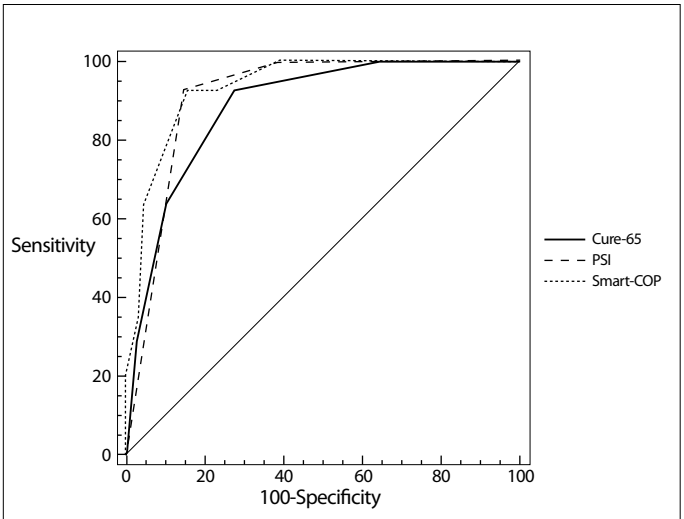

Figure 1. ROC analysis of scoring systems on the need for IRVS

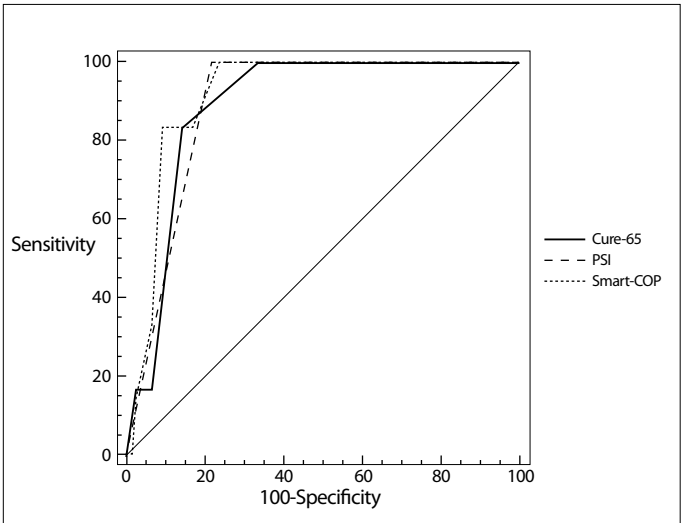

Figure 2. ROC analysis of scoring systems on 30-day mortality

Table 7. Compared yields of scoring systems on the need for IRVS

	Sensitivity	Specificity	PPV	NPV	AUC	p value
CURB-65 group 3	64.2	90	56.3	92.6	0.887	<0.01
PSI classes IV and V	92.8	85.7	56.5	98.4	0.915	<0.01
SMART-COP≥3 points	100	54.2	30.4	100	0.937	<0.01

AUC: Area under the curve; NPV: negative predictive value; PPV: positive predictive value; PSI: pneumonia severity index

Table 8. Compared yields of scoring systems on 30-day mortality

	Sensitivity	Specificity	PPV	NPV	AUC	p value
CURB-65 group 3	83.3	85.9	31.2	98.5	0.890	<0.01
PSI classes IV and V	100	78.2	26.1	100	0.891	<0.01
SMART-COP≥3 points	100	48.7	13.0	100	0.918	<0.01

AUC: Area under the curve; NPV: negative predictive value; PPV: positive predictive value; PSI: pneumonia severity index

values for PSI and CURB-65 in predicting the need for IRVS were more accurate than other comparable studies, but the values for SMART-COP were similar to those reported in the literature (13). Although the SMART-COP system was specifically designed to predict the need for IRVS, we did not observe this difference in our study, possibly because of the relatively low number of cases.

In some studies, the need for IRVS was found to be 27%–37% within the low risk classes of PSI (classes I–III) (33-36). In our study, no requirement for IRVS was observed in PSI classes I–III and the low risk group of SMART-COP (<3 points), but one patient in CURB-65 group 1 and four patients in group 2 were followed-up in the ICU.

The main limitation of this study was the number of the included patients, which is relatively low to achieve a reliable conclusion. This may be partly because of strictly followed exclusion criteria.

In this paper, we compared the yields of three severity scores in CAP, but we do believe that the doctors should not search for a "crystal ball" to see the prognosis of a patient or a "magic wand" to heal. We agree with Dr. Filipe Froes; these scores cannot or should not substitute a detailed professional evaluation by an experienced physician (SMART-DOCTORS), rather, are useful supplementary information (37).

CONCLUSION

The CURB-65, PSI, and SMART-COP scoring systems used to predict mortality and the need for IRVS were all found to be equally effective for this purpose in this study. The mortality and the need for IRVS are usually high in some studies that were conducted to compare scoring systems, possibly because of the inclusion criteria. Although more reliable scoring systems are proposed, clinical assessments are still crucial to predict CAP disease mortality and the requirement for IRVS.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Atatürk Chest Diseases and Thoracic Surgery Training and Research Hospital.

Informed Consent: A written informed consent form was obtained from every patient.

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