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Performance of PSI, CURB-65, and SCAP scores in predicting the outcome of patients with community-acquired and healthcare-associated pneumonia

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Abstract The objective was to compare three score systems, pneumonia severity index (PSI), the Confusion-Urea-Respiratory Rate-Blood pressure-65 (CURB-65), and severe community-acquired pneumonia (SCAP), for prediction of the outcomes in a cohort of patients with community-acquired (CAP) and healthcare-associated pneumonia (HCAP). Large multi-center, prospective, observational study was conducted in 55 hospitals. HCAP patients were included in the high classes of CURB-65, PSI and SCAP scores have a mortality rate higher than that of CAP patients. HCAP patients included in the low class of the three severity rules have a significantly higher incidence of adverse events, including development of septic shock, transfer into an ICU, and death ($p < 0.01$). At multivariate Cox regression analysis, inclusion in the severe classes of PSI, CURB-65, or SCAP scores and receipt of an empirical therapy not adherent to international guidelines prove to be risk factors independently associated with poor outcome. PSI, CURB-65, and SCAP score have a good performance in patients with CAP but are less useful in patients with HCAP, especially in patients classified in the low-risk classes.

Keywords Community-acquired pneumonia · Healthcare-associated pneumonia · PSI · CURB 65

For the Italian Society of Internal Medicine (SIMI).

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Introduction

Traditionally, pneumonia occurring in patients living in the community has been categorized as community-acquired pneumonia (CAP). However, the designation of healthcare-associated pneumonia (HCAP) has been recently introduced to include a population of nursing-home residents, patients receiving home- or hospital-based intravenous therapy, undergoing dialysis, or with a history of recent hospitalization [1]. Patients with HCAP have a more severe disease with longer hospital stay and higher mortality rates [1, 2], and inclusion criteria for HCAP have been associated with an increased risk for multidrug-resistant (MDR) pathogens [3].

The two most widely used predictive score systems for CAP are the pneumonia severity index (PSI) [4] and the Confusion-Urea-Respiratory Rate-Blood pressure-65 (CURB-65) score [5]. Recently, a new clinical prediction rule for severe CAP, the severe community-acquired pneumonia (SCAP) score, has been developed [6]. Few studies have examined their performance in predicting outcome of patients with HCAP [7].

The aim of this study was to compare PSI, CURB-65, and SCAP scores for prediction of outcomes in a cohort of patients with CAP and HCAP.

Methods

Setting and patients

This cohort study was performed prospectively in 59 divisions of internal medicine in 55 Italian hospitals [1]. An institutional review board of the Italian Society of Internal Medicine (SIMI) approved the study. We classified

patients as having HCAP if they had attended a hospital or hemodialysis clinic or received intravenous chemotherapy in the past 30 days, had been admitted to an acute-care hospital for at least 2 days or had surgery in the past 180 days, or resided in a nursing home or long-term care facility. CAP was defined as a diagnosis of pneumonia in patients living in the community who did not meet any of the criteria for HCAP. We stratified patients into risk classes using the PSI [4], CURB-65 [5], and SCAP scores [6]. This analysis was not designed in the original study protocol, but is a post hoc analysis using prospectively collected data. At the clinical end points, we retrieved the variables of septic shock, need for transfer into an intensive care unit (ICU), and in-hospital death.

Antimicrobial treatment evaluation

We defined empirical antibiotic therapy as antibiotics administered on the first day of therapy for pneumonia. We considered the antibiotic regimen as adherent to guidelines if it was concordant with the available American Thoracic Society and Infectious Diseases Society of America guidelines for CAP and HCAP [8, 9]

Statistical analysis

Data are showed as mean [95% Confidence Intervals (CI)] for quantitative variables and as relative frequencies (95% CI) for categorical variables. We performed nonparametric tests for group comparison and the generalized Fisher exact test for contingency table analysis.

The Cox regression analysis was performed to find the model that best predicted in-hospital death or the combined outcome (septic shock, need of transfer into an ICU, and in-hospital death) using fractional polynomial regression to study relationships between independent quantitative variables and outcome. After univariate analysis, independent variables at p value level of 0.20 were chosen and included in the model with an afterward selection process. Clinical variables already included in the three severity rules (PSI, CURB-65, and SCAP score) were not further considered. Finally, a cluster procedure was used to validate the best-fit regression model and adjust standard errors for intragroup correlation. Hazard ratios and their 95% CI were computed. STATA/SE, version 9.2 for Windows (Stata Corp, College Station, TX) was used to analyze the data.

Results

The sample included 313 patients with pneumonia, 223 (71.2%) classified as having a CAP and 90 (28.8%) as having a HCAP. The two groups did not significantly differ in terms of mean age, gender distribution, and presence of comorbidities [1]. Table 1 summarizes some baseline characteristics of patients with CAP and HCAP included in the study. When compared to patients with CAP, HCAP patients were less frequently included in low-risk classes of PSI (23.3 vs 8.9%, $p = 0.004$), CURB-65 (43.9 vs 34.4%, $p = 0.01$), and SCAP score (41.7 vs 23.3%, $p = 0.004$), and less frequently treated with an empirical therapy that was consistent with available guidelines (26.7 vs. 58.7%, $p < 0.001$). The overall mortality rate was 9.9%, and was significantly higher in patients with HCAP (17.8%) than with CAP (17.8 vs. 6.7%, $p < 0.01$).

Differences in the proportion of in-hospital mortality in each severity class, as assessed by PSI, CURB-65 and SCAP score, are presented in Table 2. HCAP patients included in the low class of the three severity rules had

Table 1 Baseline clinical characteristics of patients with CAP and HCAP

	CAP $n = 223$	HCAP $n = 90$	P
Respiratory rate >30 breaths/min	73 (32.8%)	31 (34.4%)	0.7
Systolic blood pressure <90 mmHg	6 (2.7%)	6 (6.7%)	0.1
Pulse >125/min	73 (32.7%)	35 (38.9%)	0.2
Altered mental status	44 (19.8%)	24 (26.7%)	0.3
Blood urea nitrogen >30 mg/dl	69 (30.9%)	40 (44.4%)	**0.02**
$PaO_2/FiO_2 < 300$	59 (26.5%)	38 (42.2%)	**0.01**
Bilirubin >1.5 mg/dL	26 (11.7%)	13 (14.4%)	0.5
Hematocrit >30%	95 (42.6%)	60 (66.7%)	**<0.01**
Glucose >250 mg/dl	34 (15.2%)	22 (24.4%)	0.07

Bold values are those statistically significant

Table 2 In-hospital mortality in each severity class assessed by PSI, CURB-65 and SCAP scores in patients with CAP and HCAP

	CAP	HCAP	P
PSI class			
Low (I)	0	12.5 (0–36.6)	0.133
Intermediate (II)	4.6 (0.6–8.5)	11.1 (3.9–18.3)	0.157
High (III)	16.1 (7.7–24.6)	27 (13.9–40.1)	0.206
CURB-65 Class			
Low (I)	3.1 (0–7.1)	12.9 (2.6.–23.2)	0.057
Intermediate (II)	10 (3.9–16.1)	12.5 (1.8–23.2)	0.742
High (III)	8.6 (0–18.6)	29.6 (12.2–47)	**0.045**
SCAP Class			
Low (I)	2.1 (0–5.8)	9.5 (0–20.8)	0.154
Intermediate (II)	8.7 (2.8–14.7)	12.2 (3–21.4)	0.538
High (III)	12 (1.7–22.3)	32.1 (16–48-2)	**0.039**

Data are shown as percentage (95% CI)

Bold values are those statistically significant

higher mortality rates (range 9.5–12.9%) than CAP ones (range 0–3.1%).

Outcome of HCAP and CAP patients was also evaluated in terms of cumulative incidence of adverse events, including development of septic shock, transfer into an ICU, and death. As described in Table 3, the incidence of adverse events is significantly higher among HCAP patients included in the low class of PSI ($p = 0.01$), CURB-65 ($p = 0.01$), and SCAP score ($p = 0.04$). Among HCAP patients, inclusion in the low-risk classes is not associated with higher percentages of empirical antibiotic therapy not adherent to international guidelines (data not shown).

Results of the multivariate Cox regression analysis are described in Tables 4 and 5. Inclusion in the severe classes of PSI, CURB-65, and SCAP scores and receipt of an empirical therapy not adherent to international guidelines prove to be risk factors independently associated with intra-hospital mortality or development of adverse events.

Table 3 Cumulative incidence of adverse events (septic shock, ICU transfer, and death) in each severity class assessed by PSI, CURB-65, and SCAP scores in patients with CAP and HCAP

	CAP	HCAP	*P*
PSI class			
Low (I)	0	25 (0–51.9)	**0.016**
Intermediate (II)	7.3 (2.8–11.9)	15.5 (7.1–24)	0.139
High (III)	21 (12.4–29.5)	29.7 (16.6–42.8)	0.342
CURB-65 Class			
Low (I)	3.1 (0–7.1)	16.1 (5.2.–27.1)	**0.019**
Intermediate (II)	11.1 (5–17.2)	15.6 (3.6–27.7)	0.536
High (III)	22.9 (7.1–38.7)	37 (18.8–55.2)	0.267
SCAP Class			
Low (I)	2.1 (0–5.8)	14.3 (1.6–26.9)	**0.043**
Intermediate (II)	10 (3.7–16.3)	14.6 (4.5–24.8)	0.550
High (III)	22 (9.9–34.1)	39.3 (23–55.5)	0.122

Data are shown as percentage (95% CI)

Bold values are those statistically significant

Discussion

This study has evaluated the performance of three severity rules, PSI, CURB-65, and SCAP score, in predicting the outcomes of patients with CAP and HCAP. We find no significant differences regarding the cumulative incidence of adverse events (death, septic shock, and need of transfer into an ICU) in patients included in the severe classes of the three scores. Cox regression analysis confirms that inclusion in severe classes is a factor significantly associated with death or development of complications. However, in the low classes, the incidence of adverse events is significantly higher in HCAP patients than in CAP ones. Thus, the three severity rules fail to detect a considerable amount of HCAP cases at increased risk of complicated outcome.

Several studies suggest that HCAP should be considered as a single clinical entity, different from CAP in terms of clinical presentation and outcome [1–3]. Our HCAP patients have a worse prognosis as compared to CAP despite no significant differences in terms of mean age or comorbid conditions between the two groups [1]. The poor prognosis of HCAP patients is related to a greater severity of disease (demonstrated by higher mean SOFA scores and by more frequent bilateral and multilobar lung involvement), and to the receipt of an initial antibiotic treatment not recommended by international guidelines [1]. These findings confirm previous studies alerting physicians to the greater likelihood of HCAP patients to receive inappropriate initial antibiotic treatment and their greater risk of in-hospital mortality [10]. Compared to CAP patients, those with HCAP are reported as frequently infected by MDR pathogens [2, 11]. This finding has been recently confirmed by a sub-analysis of our published prospective study, which shows a high frequency of *S. aureus* etiology in the HCAP group (the rate of methicillin resistance is 63.6%) while *S. pneumoniae* predominates in the CAP group [12]. Thus, a critical factor influencing the in-hospital mortality is the receipt of an initial inappropriate

Table 4 Factors associated with intra-hospital mortality as assessed by multivariate Cox regression analysis

Three models are showed using each of the predictive score systems; the first class was used as reference

Bold values are those statistically significant

	Hazard ratio	95% CI	*P*
CURB-65 class II	3.1	1.1–8.8	**0.03**
CURB-65 class III	3.7	1.3–10.8	**0.01**
Empirical therapy not adherent to guidelines	11.1	3.2–37.8	**<0.001**
PSI class II	2.9	1.4–11.7	0.28
PSI class III	6.7	1.2–36.9	**0.03**
Empirical therapy not adherent to guidelines	10.7	3.1–37.2	**<0.001**
SCAP class II	1.7	0.5–5.5	0.40
SCAP class III	3.4	0.9–12.2	0.06
Empirical therapy not adherent to guidelines	11.2	3.2–39.5	**<0.001**

Table 5 Factors associated with complicated outcome (combined endpoint) as assessed by multivariate Cox regression analysis

Three models are showed using each of the predictive score systems; the first class was used as reference

Bold values are those statistically significant

	Hazard ratio	95% CI	*P*
CURB-65 class II	2.9	1.6–7.2	**0.02**
CURB-65 class III	4.7	1.9–11.1	**0.001**
Empirical therapy not adherent to guidelines	5.3	2.3–12.1	**<0.001**
PSI class II	2.0	0.5–7.6	0.30
PSI class III	4.1	1.4–11.7	**0.009**
Empirical therapy not adherent to guidelines	5.3	2.3–12.3	**<0.001**
SCAP class II	1.5	0.6–3.8	0.40
SCAP class III	4	1.3–12.3	**0.01**
Empirical therapy not adherent to guidelines	5.4	2.3–12.6	**<0.001**

antibiotic therapy, a risk clearly higher in HCAP patient where MDR pathogens are more frequently isolated.

Shindo et al. [11], using a scoring system proposed by the Japanese Respiratory Society, find significant differences in the in-hospital mortality and occurrence of MDR pathogens between HCAP and CAP patients included in the moderate risk class, but not in the severe classes. In our series, the three severity rules underestimate the risk of death of HCAP patients included in the low-risk classes. This finding may be related to a high incidence of MDR pathogens in the low-risk classes. However, the lack of extensive microbiological data confirms the need for new studies focussed on microbiology and therapy of HCAP, to recognize those patients with HCAP who are misdiagnosed as having CAP, and thus treated initially with antibiotic regimens that do not cover the causative pathogens.

In conclusion, our study demonstrates that PSI, CURB-65, and SCAP score have a good performance in patients with CAP but are less useful in patients with HCAP, especially in patients classified in the low-risk classes. The receipt of an initial antibiotic therapy not recommended in the ATS/IDSA guidelines seems to be a crucial factor associated with intra-hospital mortality or development of adverse events. Future studies are needed to clarify if implementation of international pneumonia treatment guidelines is useful in improving the outcomes of hospitalized patients with HCAP.

Conflict of interest None.

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References

1. Venditti M, Falcone M, Corrao S et al (2009) Comparison of the outcomes of patients hospitalized with community-acquired, health care-associated, and hospital-acquired pneumonia. Ann Intern Med 150:19–26
2. Zilberberg MD, Shorr AF, Micek ST et al (2008) Antimicrobial therapy escalation and hospital mortality among patients with health-care-associated pneumonia: a single-center experience. Chest 134:963–968
3. Shorr AF, Zilberberg MD, Micek ST, Kollef MH (2008) Prediction of infection due to antibiotic-resistant bacteria by select risk factors for health care-associated pneumonia. Arch Intern Med 168:2205–2210
4. Fine MJ, Auble TE, Yealy DM et al (1997) A prediction rule to identify low-risk patients with community-acquired pneumonia. N Engl J Med 336:243–250
5. Lim WS, van der Eerden MM, Laing R et al (2003) Defining community acquired pneumonia severity on presentation to hospital: an international derivation and validation study. Thorax 58:377–382
6. Espana PP, Capelastegui A, Gorordo I et al (2006) Development and validation of a clinical prediction rule for severe community-acquired pneumonia. Am J Respir Crit Care Med 174:1249–1256
7. Shindo Y, Sato S, Maruyama E et al (2008) Comparison of severity scoring systems A-DROP and CURB-65 for community-acquired pneumonia. Respirology 13:731–735
8. Mandell LA, Wunderink RG, Anzueto A et al (2007) Infectious Diseases Society of America. Infectious Diseases Society of America/American Thoracic Society consensus guidelines on the management of community-acquired pneumonia in adults. Clin Infect Dis 44(Suppl 2):S27–S72

9. American Thoracic Society, Infectious Diseases Society of America (2005) Guidelines for the management of adults with hospital-acquired, ventilator-associated, and healthcare-associated pneumonia. Am J Respir Crit Care Med 171:388–416
10. Micek ST, Kollef KE, Reichley RM et al (2007) Health care-associated pneumonia and community-acquired pneumonia: a single-center experience. Antimicrob Agents Chemother 51:3568–3573
11. Shindo Y, Sato S, Maruyama E et al (2009) Health-care-associated pneumonia among hospitalized patients in a Japanese community hospital. Chest 135:633–640
12. Falcone M, Venditti M, Corrao S, Serra P for the SIMI (2011) Role of multidrug-resistant pathogens in health care-associated pneumonia. Lancet Infect Dis 11:12–13