Severe Community-Acquired Pneumonia: Validation of the Infectious Diseases Society of America/ American Thoracic Society Guidelines to Predict an Intensive Care Unit Admission

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(See the editorial commentary by Mandell on pages 386–8)

Background. The recent Infectious Disease Society of America/American Thoracic Society guidelines for the management of community-acquired pneumonia (CAP) in adults defined a predictive rule to identify patients with severe CAP to determine the need for intensive care unit (ICU) admission. We clinically validated this rule.

Methods. We analyzed 2102 episodes of CAP in consecutively hospitalized patients over a 7-year period. The predictive rule consists of at least 1 of 2 major severity criteria (septic shock and invasive mechanical ventilation) or at least 3 of 9 minor severity criteria. We assessed the association of the predictive rule with ICU admission and mortality.

Results. A total of 235 episodes of CAP (11%) occurred in patients who were admitted to the ICU, whereas the predictive rule identified 397 (19%) of 2102 episodes as severe CAP. The predictive rule and the decision for ICU admission agreed in 1804 (86%) of the episodes (κ coefficient, 0.45), with a sensitivity of 71% and a specificity of 88%, similar to the 2001 American Thoracic Society guidelines (sensitivity, 66%; specificity, 90%) in predicting ICU admission. Severe CAP criteria had higher sensitivity (58% vs. 46%) and similar specificity (88% vs. 90%), compared with the 2001 American Thoracic Society guidelines in predicting hospital mortality. Invasive mechanical ventilation was the main determinant for ICU admission, followed by septic shock. In the absence of major criteria, ICU admission was not related to survival of patients with minor severity criteria.

Conclusions. The predictive rule to identify severe CAP is accurate for ICU admission and improved the prediction of mortality, compared with the previous American Thoracic Society guidelines. The need for ICU admission derived from minor severity criteria alone is uncertain and deserves further investigation.

Community-acquired pneumonia (CAP) is a significant cause of morbidity and mortality in all age groups [1–4]. The assessment of severity is crucial in the management of CAP. To aid in deciding whether a given patient can be treated as an outpatient or should be admitted to the hospital, severity scores (such as the Pneumonia Severity Index [PSI] [5]; the confusion, elevated blood urea nitrogen level, respiratory rate, and blood pressure [CURB] score; and the CURB plus age $\geq$65 years [CURB 65] score [6, 7]) have been described; these scores stratify patients with CAP into mortality risk groups. These scores, however, were not developed to identify specifically those patients with severe CAP or to decide the site of inpatient care (ward or intensive care unit [ICU]) [5, 8].

Severe CAP has been defined as those cases that require admission to the ICU [9]. Direct admission to an ICU is required for patients with septic shock or acute respiratory failure requiring invasive mechanical ventilation, which are defined as major severity criteria

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Table 1. Criteria for severe community-acquired pneumonia according to the Infectious Diseases Society of America/American Thoracic Society guidelines.

Type of criteria	Severity criteria
Minor	Respiratory rate ⩾30 breaths/min[a]
	P_{AO_2}/F_{IO_2} ⩽250[a]
	Multilobar infiltrates
	Confusion and/or disorientation
	Uremia (BUN level ⩾20 mg/dL)
	Leukopenia (WBC count $<4 \times 10^9$ cells/L)
	Thrombocytopenia (platelet count $<100 \times 10^9$ platelets/L)
	Hypothermia (core temperature <36°C)
	Hypotension (SBP <90 mm Hg; requiring aggressive fluid resuscitation)
Major	Receipt of invasive mechanical ventilation
	Septic shock with the need for vasopressors[b]

NOTE. Adapted from Mandell et al. [11]. BUN, blood urea nitrogen; P_{AO_2}/F_{IO_2}, ratio of arterial oxygen tension to inspired oxygen fraction; SBP, systolic blood pressure.

[a] The need for noninvasive mechanical ventilation can substitute for respiratory rate ⩾30 breaths/min or P_{AO_2}/F_{IO_2} ⩽250.

[b] Septic shock was defined as sepsis-induced hypotension persisting despite adequate fluid replacement, in combination with hypoperfusion abnormalities [13].

in the modified score of the American Thoracic Society (ATS) guidelines that are used to define severe CAP [10]. Admission to an ICU was also recommended for patients with other minor severity criteria. However, none of those minor severity criteria adequately distinguish patients for whom ICU admission is necessary.

The recent Infectious Diseases Society of America (IDSA)/ATS guidelines for the treatment of adults with CAP retained the same major severity criteria and developed a new set of minor severity criteria on the basis of data on individual risks to identify patients with severe CAP [11]. Whether each of the minor severity criteria is of equal weight is not clear. Therefore, the guidelines recommended a prospective validation of this set of criteria but consideration of ICU admission if ⩾3 minor severity criteria were present [11].

Because ICU resources are often scarce in many institutions, admission of patients with CAP who would not benefit from ICU care is problematic. Moreover, the predictive potential of this rule, particularly the importance of the individual minor severity criteria, has not been validated in an individual hospital setting. Therefore, we assessed whether this predictive rule fits with the clinical practice of our institution (Hospital Clinic, Universitat de Barcelona; Barcelona, Spain), as well as the relevance of minor severity criteria in the need for ICU admission.

METHODS

Study population. We prospectively observed consecutive patients aged >15 years who were admitted to the emergency department for >12 h in an 850-bed tertiary care university hospital from January 2000 through January 2007 and who received a diagnosis of CAP. Pneumonia was defined as a new pulmonary infiltrate found on the hospital admission chest radiograph and symptoms and signs of lower respiratory tract infection. We excluded patients with immunosuppression (e.g., patients with neutropenia after chemotherapy or bone marrow transplantation, patients with drug-induced immunosuppression as a result of solid-organ transplantation or corticosteroid or cytotoxic therapy, and patients with HIV-related disorders) [12]. The decision for admission to an ICU or ward was made by the attending physicians in all cases.

Data collection and evaluation. The following parameters were recorded at admission: age, sex, tobacco use, alcohol and drug consumption, comorbidities (heart, renal, liver, lung, neurological, and neoplastic diseases, diabetes mellitus, and hypertension), previous use of antibiotics, treatment with corticosteroids, clinical symptoms and features (fever, cough, pleuritic chest pain, dyspnea, mental confusion, and aspiration), clinical signs (blood pressure, body temperature, respiratory rate, and heart rate), arterial blood gas measurements, chest radiograph findings (number of lobes affected, pleural effusion, and atelectasis), laboratory parameters (hemoglobin level, WBC count, platelet count, serum creatinine level, C-reactive protein level, and other biochemical parameters), diagnostic procedures, and therapy. Septic shock [13], the need for invasive mechanical ventilation, complications, duration of treatment, length of hospital stay, and 30-day in-hospital mortality were noted. We also calculated the PSI [5] and the CURB 65 [7] scores at hospital admission.

Definition of severe CAP. According to the prediction rule of the IDSA/ATS guidelines [11], those cases that met at least 1 of 2 major severity criteria or 3 of 9 minor severity criteria (table 1) at hospital admission were defined as severe CAP. Because blood urea nitrogen level is not systematically deter-

mined in our hospital, we accepted, in its place, serum creatinine level >2 mg/dL, as in previous studies [14, 15].

Statistical analysis. For comparisons between groups, qualitative or categorical variables were compared with use of the χ^2 or Fisher's exact tests, when appropriate. Quantitative continuous variables were compared using the unpaired Student's *t* test. All data were analyzed and processed using SPSS software, version 14.0 (SPSS). The level of statistical significance was set at $P = .05$ (2-tailed).

To determine the predictive capacity of severe CAP criteria for ICU admission and hospital mortality, we determined sensitivity, specificity, and positive and negative likelihood ratio [16], and we compared the findings with the modified score of the ATS guidelines [10]. The coincidence between the predictive rule and the clinical decision for ICU admission was assessed with the κ coefficient of agreement. The univariate association of the predictive rule and of each of the severity criteria with ICU admission or mortality are expressed as the relative risk and the 95% CI.

Impact of ICU admission on hospital mortality for patients with minor severity criteria only. All patients with minor severity criteria and without major severity criteria were categorized on the basis of the number of individual minor severity criteria. The mortality rates of patients with different numbers of minor severity criteria who were hospitalized in the ICU and not hospitalized in the ICU were compared.

RESULTS

Patient characteristics. We identified 2391 episodes of CAP among patients admitted to our hospital during the study period. Complete data to evaluate the IDSA/ATS prediction rule to define severe CAP were available for 2102 episodes. According to the attending physicians, 235 (11%) of the episodes occurred in patients who were admitted to an ICU, 194 (9%) occurred in patients treated in the emergency department, and 41 (2%) occurred in patients from other wards who experienced clinical deterioration. Patient characteristics are shown in table 2. The patients who were admitted to the ICU were younger; were more likely to have a smoking history, consume alcohol, and abuse drugs; were more likely to have pleural effusion; had higher C-reactive protein levels; had worse oxygenation; had higher PSI and CURB 65 risk classes; and had a longer mean length of hospital stay, compared with patients who were not admitted to the ICU.

The predictive rule identified 397 (19%) of the patients as having severe CAP; 8 (2%) had major severity criteria only, 219 (55%) had minor severity criteria only, and 170 (43%) had both major and minor severity criteria. Of those 397 patients who were defined as having severe CAP, 167 were admitted to the ICU. Only 68 (4%) of the 1705 patients who were defined as not having severe CAP were admitted to the ICU.

Severe CAP and prediction of ICU admission. The predictive rule and the decision for ICU admission agreed in 1804 (86%) of the episodes (table 3); the κ coefficient was 0.45 ($P < .001$). The predictive rule overestimated ICU admission; although 230 patients with severe CAP criteria were not admitted to ICUs, 68 patients with nonsevere CAP criteria were admitted to ICUs. As expected, severe CAP and all severity criteria, except hypothermia, were more frequent among patients who were admitted to the ICU.

The sensitivity for ICU admission was 71%, and the specificity was 88%. When considering admission to the ICU directly from the emergency department, the sensitivity (75%) and specificity (87%) were similar. The likelihood ratios show that severe CAP was 5.77-fold more frequent among patients admitted to the ICU than it was among those not admitted to the ICU; likewise, the probability that patients hospitalized in the ICU, compared with those who were not hospitalized in the ICU, had nonsevere CAP was only 33%. Patients with severe CAP, compared with patients with nonsevere CAP, had a relative risk of being admitted to an ICU of 17.5. In our population, the criteria of the modified score of the 2001 ATS guidelines [10] yielded a sensitivity (66%) and specificity (90%) that were similar to those of the IDSA/ATS prediction rule.

Severe CAP and prediction of mortality. The 30-day hospital mortality was higher among patients admitted to the ICU than it was among those who were not admitted to the ICU ($P < .001$; table 2). Mortality, assessed at 7 days and 30 days, was similar among patients with severe CAP criteria, regardless of whether they were admitted to the ICU; mortality was similar among patients with no criteria of severe CAP and was lower for such patients than it was among patients with severe CAP, regardless of whether the patient was admitted to an ICU (table 4).

The association between the predictive rule and mortality is shown in table 5. Severe CAP and the presence of either of the 2 major severity criteria had the strongest association with mortality. Not all of the minor severity criteria were individually predictive of death. The presence of hypotension, thrombocytopenia, and multilobar involvement were not associated with mortality. However, the remaining minor severity criteria were significantly associated with death.

The sensitivity of severe CAP criteria in predicting hospital mortality was 58%, and the specificity was 88%. The modified score of the 2001 ATS guidelines [10] had a lower sensitivity (46%) and a similar specificity (90%) in predicting hospital mortality.

Severity criteria and outcome variables for patients admitted and patients not admitted to the ICU. The major severity criteria had the highest association with ICU admission; in particular, all patients who received invasive mechanical ventilation except 1 were admitted to an ICU. However, 57 (43%)

Table 2. Characteristics of the study population.

Variable	Patients not hospitalized in the ICU (n = 1867)	Patients hospitalized in the ICU (n = 235)	P
Age, mean years ± SD	67 ± 18	64 ± 17	.006
Sex, M/F	1147/720	144/91	>.99
History of smoking	1060 (57)	161 (69)	<.001
History of alcohol abuse	282 (16)	57 (26)	.001
History of injection drug abuse	8 (0.4)	4 (1.7)	.034
Comorbidity			
Chronic heart failure	372 (20)	41 (18)	.43
Chronic renal failure	133 (7)	17 (7)	>.99
Chronic liver disease	74 (4)	15 (6)	.12
Chronic pulmonary disease	834 (45)	109 (47)	.56
Diabetes mellitus	352 (19)	48 (21)	.59
Neurological disease	359 (19)	45 (19)	>.99
Cancer	131 (7)	12 (5)	.34
Clinical and laboratory characteristics at hospital admission			
C-reactive protein level, mean mg/dL ± SD	18 ± 12	23 ± 14	<.001
WBC count, mean value × 10^9 cells/L ± SD	14.2 ± 7.0	14.2 ± 7.8	.93
Platelet count, mean value × 10^9 platelets/L ± SD	249 ± 107	255 ± 128	.49
Pa_{O_2}/Fi_{O_2}, mean value ± SD	301 ± 68	231 ± 81	<.001
Pleural effusion	252 (14)	61 (26)	<.001
Aspiration	200 (11)	26 (11)	.91
Cavitation	22 (1.2)	4 (2)	.53
Atelectasis	61 (3)	11 (5)	.33
Length of hospital stay, mean days ± SD	7.1 ± 6.5	18.0 ± 14.8	<.001
Hospital mortality			
At 30 days	79 (4)	30 (13)	<.001
At 7 days	44 (2)	6 (3)	>.99
Pneumonia Severity Index			
Mean value ± SD	97 ± 40	120 ± 38	<.001
Risk class I-III	875 (47)	50 (22)	
Risk class IV	620 (34)	91 (39)	
Risk class V	353 (19)	91 (39)	
CURB 65 score, mean value ± SD	1.2 ±1.0	1.8 ± 1.0	<.001
Etiologic diagnosis			
Any	737 (40)	102 (43)	.28
Polymicrobial	88/737 (12)	22/102 (22)	
Streptococcus pneumoniae	410/737 (56)	59/102 (58)	
Viruses	126/737 (17)	17/102 (17)	
Legionella pneumophila	61/737 (8)	13/102 (13)	
Haemophilus influenzae	46/737 (6)	7/102 (7)	
Mycoplasma pneumoniae	40/737 (5)	2/102 (2)	
Chlamydia pneumoniae	23/737 (3)	4/102 (4)	
Staphylococcus aureus	18/737 (2)	7/102 (7)	
Pseudomonas aeruginosa	17/737 (2)	3/102 (3)	
Other	90/737 (12)	15/102 (15)	

NOTE. Data are no. (%) of episodes, unless otherwise indicated. ICU, intensive care unit; Pa_{O_2}/Fi_{O_2}, ratio of arterial oxygen tension to inspired oxygen fraction; CURB 65, confusion, urea, respiratory rate, blood pressure plus age ⩾65 years.

Table 3. Infectious Diseases Society of America/American Thoracic Society guidelines criteria for severe community-acquired pneumonia (CAP) and operative indices to predict intensive care unit (ICU) admission.

Variable	No. (%) of patients		Sensitivity, %	Specificity, %	Likelihood ratio		Risk ratio (95% CI)	*P*
	Not hospitalized in the ICU (*n* = 1867)	Hospitalized in the ICU (*n* = 235)			Positive	Negative		
Severe CAP	230 (12)	167 (71)	71	88	5.77	0.33	17.5 (12.8–23.9)	<.001
Nonsevere CAP	1637 (88)	68 (29)						
Major severity criteria								
Receipt of mechanical ventilation	1 (0.1)	86 (37)	37	99.9	683.24	0.63	1077 (149–7788)	<.001
Septic shock	57 (3)	75 (32)	32	97	10.45	0.70	14.9 (10.2–21.8)	<.001
Minor severity criteria								
SBP <90 mm Hg	57 (3)	28 (12)	12	97	3.90	0.91	4.3 (2.7–6.9)	<.001
Respiratory rate >30 breaths/min	485 (26)	128 (55)	55	74	2.10	0.62	3.4 (2.6–4.5)	<.001
P_{AO_2}/F_{IO_2} <250	398 (21)	144 (61)	61	79	2.87	0.49	5.8 (4.4–7.8)	<.001
Temperature <36°C	74 (4)	15 (6)	6	96	1.61	0.97	1.7 (0.93–2.9)	.12
WBC count <4000 cells/mm^3	25 (1)	18 (8)	8	99	5.72	0.94	6.1 (3.3–11.4)	<.001
Platelet count <100,000 platelets/mm^3	44 (2)	14 (6)	6	98	2.53	0.96	2.6 (1.4–4.9)	.003
Creatinine level >2 mg/dL	171 (9)	49 (21)	21	91	2.28	0.87	2.6 (1.8–3.7)	<.001
Multilobar involvement	401 (22)	116 (49)	49	78	2.30	0.64	3.6 (2.7–4.7)	<.001
Mental confusion	345 (19)	79 (34)	34	81	1.82	0.81	2.2 (1.7–3.0)	<.001

NOTE. P_{AO_2}/FIO_2, ratio of arterial oxygen tension to inspired oxygen fraction; SBP, systolic blood pressure.

of the patients with septic shock, whose cases were initially managed and stabilized in the emergency department, were not subsequently admitted to an ICU (table 3). Of 132 patients with septic shock, 91 (69%) did not receive invasive mechanical ventilation. Patients with septic shock who did not receive mechanical ventilation who were hospitalized in the ICU and such patients who were not hospitalized in the ICU had similar severity scores, such as PSI (mean score ± SD, 124 ± 37 vs. 117 ± 46) and CURB 65 (mean score ± SD, 2.5 ± 1.0 vs. 2.2 ± 1.3). However, the 30-day in-hospital mortality was lower among patients who were hospitalized in the ICU than it was among patients who were not hospitalized in the ICU (2 [6%] vs. 17 [30%]; $P = .014$), suggesting a possible benefit of ICU care for patients with septic shock.

Minor severity criteria were associated with ICU admission less often than were major severity criteria. Among the 219 patients with severe CAP defined by the presence of minor severity criteria only, 47 (21%) were admitted to an ICU (table 6). The number of minor severity criteria, as well as the PSI risk classes and hospital mortality, were similar between patients hospitalized in the ICU and patients who were not hospitalized in the ICU. Patients with hypoxemia were more likely to be admitted to the ICU, and those with mental confusion were less likely to be admitted to the ICU. The remaining minor severity criteria were as common among those admitted to the ICU as they were among those who were not admitted to the ICU.

Among the patients with nonsevere CAP, 1012 (59%) met 1 or 2 of the minor severity criteria. Again, the number of minor severity criteria, as well as the PSI risk classes and mortality, were similar between patients hospitalized in the ICU and those who were not hospitalized in the ICU (table 6). Only leukopenia was more common among patients with nonsevere CAP who were admitted to the ICU than it was among patients with nonsevere CAP who were not admitted to the ICU.

In our population, 1924 patients had no major severity criteria. Of these, 115 were admitted to the ICU, and 1809 were not admitted to the ICU. Among this population, the number of minor severity criteria with the best discriminative capacity to predict ICU admission was 2, with a sensitivity of 64% and a specificity of 72%. The number of minor severity criteria was related to hospital mortality (relative risk, 1.97 for each of the criteria; 95% CI, 1.63–2.37; $P < .001$). However, there were no differences in hospital mortality between patients admitted to the ICU and patients not admitted to the ICU according to the different number of minor severity criteria present (table 7).

DISCUSSION

The definition of severe CAP in the current IDSA/ATS guidelines for the management of adults with CAP is accurate for predicting ICU admission. Of the 235 patients who were admitted to the ICU, 167 (71%) met severe CAP criteria. Compared with the modified score of the 2001 ATS guidelines [10], the current IDSA/ATS guidelines [11] are similar in predicting ICU admission and better in predicting hospital mortality. However, the predictive rule identified 230 patients with severe CAP criteria who were not admitted to the ICU. These patients had a higher mortality rate than did patients who did not meet

Table 4. Characteristics of patients with severe and nonsevere community-acquired pneumonia (CAP) in relation to hospital site of care.

Variable	Patients with severe CAP			Patients with nonsevere CAP		
	Not hospitalized in the ICU (n = 230)	Hospitalized in the ICU (n = 167)	P	Not hospitalized in the ICU (n = 1637)	Hospitalized in the ICU (n = 68)	P
Hospital mortality						
At 30 days	36 (16)	27 (16)	>.99	43 (3)	3 (4)	.43
At 7 days	19 (8)	6 (4)	.093	25 (2)	0 (0)	.62
Age, mean years ± SD	75 ± 16	65 ± 16	<.001	66 ± 18	59 ± 17	.003
Length of hospital stay, mean days ± SD	10 ± 8	20 ± 17	<.001	7 ± 6	14 ± 9	<.001
Pneumonia Severity Index risk class, mean value ± SD	3.9 ±1.3	4.2 ± 1.0	.003	3.2 ± 1.4	3.7 ± 1.1	<.001
CURB 65 score, mean value ± SD	2.4 ± 1.0	2.0 ± 0.9	<.001	1.0 ± 0.8	1.1 ± 0.8	.64
Major severity criteria for severe CAP						
Septic shock	57 (25)	75 (45)	<.001	…	…	
Receipt of mechanical ventilation	1 (0.4)	86 (52)	<.001	…	…	
Minor severity criteria for severe CAP						
Systolic blood pressure <90 mm Hg	37 (16)	28 (17)	.96	20 (1)	0 (0)	>.99
Respiratory rate >30 breaths/min	140 (61)	106 (64)	.67	345 (21)	22 (32)	.039
P_{AO_2}/F_{IO_2} <250	135 (59)	126 (75)	.001	263 (16)	18 (27)	.036
Temperature <36°C	30 (13)	15 (9)	.27	44 (3)	0 (0)	.42
WBC count <4000 cells/mm^3	13 (6)	15 (9)	.28	12 (1)	3 (4)	.020
Platelet count <100,000 platelets/mm^3	17 (7)	13 (8)	>.99	27 (2)	1 (1)	>.99
Creatinine level >2 mg/dL	78 (34)	42 (25)	.077	93 (6)	7 (10)	.11
Multilobar involvement	113 (49)	92 (55)	.28	288 (18)	24 (35)	<.001
Mental confusion	131 (57)	69 (41)	.003	214 (13)	10 (15)	.84

NOTE. Data are no. (%) of patients, unless otherwise indicated. ICU, intensive care unit; CURB 65, confusion, urea, respiratory rate, blood pressure plus age ⩾65 years; P_{AO_2}/F_{IO_2}, ratio of arterial oxygen tension to inspired oxygen fraction.

severe CAP criteria who were admitted to the ICU (table 4). Thus, although this predictive rule overestimated ICU admission in clinical practice, many of these patients may have benefited from ICU care, and our findings may reflect a lack of availability of ICU beds for the management of these patients.

Approximately 10% of hospitalized patients with CAP (for whom a higher rate of complications, higher mortality rate, and prolonged hospital stay are expected) require admission to an ICU [17–19]. However, the optimal management of CAP requires that seriously ill patients be recognized as such in the emergency department, which allows appropriate site-of-care decisions to be made. The site-of-care (home, hospital ward, or ICU) often determines the extensiveness of the diagnostic evaluation, the choice and route of antimicrobial therapy, the intensity of clinical observation, and the economic cost [8].

Prognostic scoring systems are used to define the predicted mortality rate associated with CAP and, by inference, the site-of-care, suggesting hospitalization for those patients who are expected to have higher mortality rates. The PSI [5] and the CURB 65 scores [7] are designed for recognizing those patients whose cases can safely be managed outside the hospital if serious vital sign abnormalities or comorbidities are absent. However, the likelihood of receiving ICU care is poorly predicted by these severity scores [14, 15, 20]. A wrong decision regarding ICU admission could result in underuse or overuse of the ICU, with consequences including delayed or inadequate treatment for some patients and excessive resource use for other patients (keeping in mind that the cost of inpatient care for pneumonia is as much as 25 times greater than the cost of outpatient care) [21].

Creating accurate and objective prediction models for ICU admission has several advantages. First, the appropriate placement of patients optimizes the use of limited ICU resources, selecting those patients who would actually benefit from ICU care or high-level monitoring. Second, an accurate prediction model avoids the delayed ICU transfer of patients who are initially placed in other hospital units, which is associated with increased mortality [22]. Third, correct site-of-care can optimize initial antibiotic treatment, because the microbial etiologies of severe CAP differ from those associated with CAP in general [23, 24]. Avoidance of initial inappropriate antibiotic treatment is associated with lower mortality [25, 26].

The first guideline-based definition of severe CAP involved 10 criteria [9]. The presence of only 1 criterion was enough to

Table 5. Association of the predictive rule of severe community-acquired pneumonia (CAP) and other indices with 30-day in-hospital mortality.

Variable	Patients alive at 30 days: Yes (n = 1993)	Patients alive at 30 days: No (n = 109)	Risk ratio (95% CI)	P
Age, mean years ± SD	66 ± 18	77 ± 13	1.043 (1.027–1.058)	<.001
Severe CAP criteria	343 (17)	63 (58)	6.8 (4.6–10.1)	<.001
Major severity criteria for severe CAP				
Septic shock	102 (5)	30 (28)	7.0 (4.1–11.9)	<.001
Receipt of mechanical ventilation	66 (3)	21 (19)	6.9 (4.2–11.5)	<.001
Minor severity criteria for severe CAP				
Systolic blood pressure <90 mm Hg	78 (4)	7 (6)	1.7 (0.8–3.7)	.21
Respiratory rate >30 breaths/min	552 (28)	61 (56)	3.3 (2.2–4.9)	<.001
P_{AO_2}/F_{IO_2} <250	487 (24)	55 (51)	3.2 (2.1–4.6)	<.001
Temperature <36°C	80 (4)	9 (8)	2.2 (1.1–4.4)	.046
WBC count <4000 cells/mm^3	36 (2)	7 (6)	3.7 (1.6–8.6)	.006
Platelet count <100,000 platelets/mm^3	54 (3)	4 (4)	1.4 (0.5–3.8)	.54
Creatinine level >2 mg/dL	191 (10)	29 (27)	3.4 (2.2–5.4)	<.001
Multilobar involvement	483 (24)	34 (31)	1.4 (0.9–2.2)	.13
Mental confusion	370 (19)	54 (50)	4.3 (2.9–6.4)	<.001
Pneumonia Severity Index risk class, mean value ± SD	3.3 ± 1.4	4.0 ± 1.1	1.62 (1.35–1.95)	<.001
CURB 65 score, mean value ± SD	1.2 ± 1.0	2.2 ± 1.0	2.48 (2.06–2.98)	<.001

NOTE. CURB 65, confusion, urea, respiratory rate, blood pressure plus age ⩾65 years; P_{AO_2}/F_{IO_2}, ratio of arterial oxygen tension to inspired oxygen fraction.

recommend ICU admission; therefore, this rule was highly sensitive (98%) but insufficiently specific (32%) [20]. A new score was proposed that relied on 1 of 2 major severity criteria (receipt of mechanical ventilation and septic shock) or 2 of 3 minor severity criteria [20], and this score was adopted in the 2001 ATS guidelines [10]. This modified ATS score achieved a sensitivity of 69% and a specificity of 97% in predicting ICU admission, whereas the prediction of mortality yielded a sensitivity of 94% and a specificity of 93% [14].

The modified ATS score showed better discriminatory capacity for ICU admission than did the PSI, CURB, and CURB 65 scores [8, 14]. However, one study found that none of the prediction rules were particularly good, largely because of their poor positive predictive value; in this study, most patients who met the criteria were never admitted to an ICU [8]. This study concluded that the discrimination of the scores appeared to be too low to guide individual decision making for ICU admission.

To achieve better prediction for ICU admission, the IDSA/ATS adopted a new prediction rule for defining severe CAP, with the inclusion of a new set of minor severity criteria [11]. We have evaluated, for the first time, to our knowledge, how this predictive rule fits with the clinical practice in a large population of patients with CAP who were hospitalized before the IDSA/ATS guidelines were published (and therefore, a population in which the decisions regarding ICU admission were not affected by the guidelines). This predictive rule has a good sensitivity and specificity in identifying ICU admission, but it does not improve substantially the discriminative capacity of the modified ATS rule [10].

The presence of 1 of the 2 major criterion (in particular, receipt of invasive mechanical ventilation) was a major determinant in the decision for ICU admission. This is obvious, because patients who need invasive mechanical ventilation cannot be treated outside the ICU in most hospitals. The worse outcomes among patients with septic shock who were not treated in an ICU after the initial stabilization in the emergency department confirm the need for close monitoring and ICU care of these patients.

A significant number of patients in our population who met the criteria for severe CAP were not admitted to the ICU. We identified the absence of major severity criteria or hypoxemia, together with older age and lower score on the severity indices, as the main reasons that they were treated outside the ICU. The higher proportion of mental confusion in patients who were not treated in the ICU is explained by the fact that this subset of patients was older, with the highest proportions of limitation in the activities of the daily life, witnessed aspiration, and neurological comorbidity. Likewise, several patients with nonsevere CAP were actually admitted to the ICU. ICU admission was related to the presence of minor severity criteria,

Table 6. Characteristics of patients with severe and patients with nonsevere community-acquired pneumonia (CAP) who met minor severity criteria but not major severity criteria.

Variable	Patients with severe CAP			Patients with nonsevere CAP		
	Not hospitalized in the ICU (n = 172)	Hospitalized in the ICU (n = 47)	P	Not hospitalized in the ICU (n = 954)	Hospitalized in the ICU (n = 58)	P
Hospital mortality						
At 30 days	19 (11)	4 (9)	.79	38 (4)	3 (5)	.51
At 7 days	9 (5)	0 (0)	.21	22 (2)	0 (0)	.63
Age, mean years ± SD	77 ± 15	66 ± 18	<.001	69 ± 17	59 ± 17	<.001
Length of hospital stay, mean days ± SD	10 ± 6	15 ± 8	<.001	8 ± 7	14 ± 9	<.001
Pneumonia Severity Index risk class, mean value ± SD	3.9 ± 1.2	4.2 ± 1.0	.095	3.4 ± 1.2	3.7 ± 1.1	.12
CURB 65 score, mean value ± SD	2.6 ± 0.8	2.3 ± 0.9	.019	1.4 ± 0.9	1.1 ± 0.8	.027
Mean no. of minor severity criteria ± SD	3.3 ± 0.5	3.4 ± 0.6	.33	1.4 ± 0.5	1.5 ± 0.5	.16
Systolic blood pressure <90 mm Hg	15 (9)	3 (6)	.77	20 (2)	0 (0)	.62
Respiratory rate >30 breaths/min	118 (69)	38 (81)	.14	345 (36)	22 (28)	.90
P_{AO_2}/F_{IO_2} <250	112 (65)	41 (87)	.006	263 (28)	18 (31)	.17
Temperature <36°C	28 (16)	4 (9)	.27	44 (5)	0 (0)	.42
WBC count <4000 cells/mm^3	11 (6)	4 (9)	.53	12 (1)	3 (5)	.050
Platelet count <100,000 platelets/mm^3	16 (9)	5 (11)	.78	27 (3)	1 (2)	.93
Creatinine level >2 mg/dL	61 (36)	13 (28)	.41	93 (10)	7 (12)	.73
Multilobar involvement	99 (58)	32 (68)	.26	288 (30)	24 (41)	.10
Mental confusion	108 (63)	20 (43)	.020	214 (22)	10 (17)	.45

NOTE. Data are no. (%) of patients, unless otherwise indicated. CURB 65, confusion, urea, respiratory rate, blood pressure plus age ≥65 years; ICU, intensive care unit; P_{AO_2}/F_{IO_2}, ratio of arterial oxygen tension to inspired oxygen fraction.

particularly tachypnea, hypoxemia, leukopenia, and multilobar involvement, together with younger age and higher PSI risk classes. Other clinical prediction rules for severe CAP that include factors similar to the minor severity criteria of the IDSA/ATS guidelines have been proposed [27]. These investigators weighted each variable and created a quantitative score. However, we think that their results cannot be compared with those of the present study, because they used hospital mortality, receipt of mechanical ventilation, and septic shock to define severe CAP, which does not correspond to published guidelines.

In the absence of major severity criteria, we could not demonstrate that ICU admission resulted in reduced mortality for patients with minor severity criteria. In addition, the number of minor severity criteria could not discriminate which patients could benefit from ICU admission.

Several limitations of this study deserve comment. First, blood urea nitrogen level was not systematically determined in our hospital; therefore, we used serum creatinine level as a surrogate, as we have done in previous studies [14, 15]. Therefore, we cannot exclude the possibility that some cases did not entirely meet the definitions given in the guidelines. Second, information regarding "do not intubate" (DNI) decisions was available for only 856 (41%) of the episodes. Previous DNI orders may influence the decision for ICU admission. However, among patients for whom such information was available, the rate of previous DNI orders did not substantially differ between patients who were hospitalized in the ICU and patients who were not (6% and 10%, respectively). The proportion of ICU admissions did not differ substantially between patients with and patients without a previous DNI decision (9% and 14%, respectively). After excluding patients with a previous DNI decision, the sensitivity (72%) and specificity (88%) of the IDSA/ATS guidelines were similar to the sensitivity and specificity among the overall population. Third, we used the decision for

Table 7. Thirty-day in-hospital mortality among patients without major severity criteria, according to the number of minor criteria present.

No. of minor severity criteria	No. of patients	30-day mortality, no. (%) of patients		P
		Not hospitalized in the ICU (n = 1809)	Hospitalized in the ICU (n = 115)	
0	693	5/683 (1)	0/10 (0)	>.99
1	633	17/602 (3)	0/31 (0)	>.99
2	379	21/352 (6)	3/27 (11)	.24
3	158	12/126 (10)	2/32 (6)	.74
4	52	7/41 (17)	1/11 (9)	>.99
5	8	0/1 (0)	1/4 (25)	>.99
6	1	0 (0)	…	
Total	1924	62/1809 (3)	7/115 (6)	.19

NOTE. ICU, intensive care unit.

ICU admission as the gold standard, because this reflected the actual clinical practice. However, the variability of clinicians' judgment and the frequent constraints on the availability of ICU beds may have influenced the site-of-care decisions.

In conclusion, the predictive rule of the IDSA/ATS guidelines for identification of severe CAP is accurate, but it slightly overestimates ICU admission in clinical practice. Compared with the previous ATS guidelines, the current IDSA/ATS guidelines are similar at defining the need for ICU admission and are better at predicting hospital mortality. Although ICU admission is clearly indicated for patients who require invasive mechanical ventilation or experience septic shock, the need for ICU admission derived from minor severity criteria alone is uncertain in our population and deserves further prospective evaluation.

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