Severity of illness scoring systems in patients with bacteraemic pneumococcal pneumonia: implications for the intensive care unit care

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Abstract

Severity of illness scoring systems are useful for decisions on the management of patients with community-acquired pneumonia (CAP), including assessing the need for intensified therapy and monitoring, or for intensive care unit (ICU) admission. We compared the accuracy of the Pneumonia Severity Index (PSI), the CURB-65 and CRB-65 score, the modified-American Thoracic Society score (ATS), the IDSA/ATS guidelines and the Pitt Bacteraemia score (PBS) in evaluating severity of illness in 766 patients with bacteraemic pneumococcal pneumonia. We evaluated the sensitivity and specificity, the positive predictive value (PPV) and the negative predictive value (NPV) and the accuracy of the classification in predicting 14-day mortality. The PSI and the IDSA/ATS guidelines were the most sensitive whereas the PBS and modified-ATS scoring systems were the most specific in predicting mortality. The NPV was comparable for all four scoring systems (all above 90%), but the PPV was highest for PBS (54.2%) and lowest for PSI (23.2%). The predictive accuracy and discriminating power as measured by the receiver-operating characteristic (ROC) curve was highest for the PBS. Both the modified-ATS and the PBS scoring systems identified those patients who might benefit most from intensified care and monitoring. The PBS and modified-ATS proved superior to the IDSA/ATS guidelines, CURB-65 and CRB-65 with respect to their specificity and PPV. The low PPV of the PSI rendered it not usable as a parameter for decision-making in severely-ill patients with pneumococcal bacteraemia.

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Introduction

Severity of illness (SOI) plays a major role in determining the site of care, the diagnostic workup and the empirical choice of antibiotics for patients with community-acquired pneumonia (CAP) [1]. A number of scoring systems have been developed for evaluation of the severity of infection. We compared the accuracy of the Pneumonia Severity Index (PSI) [2], the CURB-65 scoring system [3], the CRB-65 scoring system without the uraemia factor [4], the modified-American Thoracic Society (ATS) scoring system [5], the IDSA/ATS guidelines [6] and the Pitt Bacteremia Score (PBS) [7] in evaluating severity of illness in patients with bacteraemic pneumococcal pneumonia. Our objective was to assess which scoring system would be most accurate in selecting patients at high risk for mortality and who might benefit from treatment in the intensive care unit (ICU).

Methods

Study sites and patients

Study design. We analysed data collected from a prospective observational study of 844 patients with bacteraemic

pneumococcal disease from 21 hospitals in ten countries [8]. Institutional review board approval was obtained from all sites in accordance with their local requirements. We excluded patients who also had meningitis (59 patients) and endocarditis (seven patients), those whose ICU status was uncertain (nine patients) and those whose mental status was not evaluated (three patients). Thus, 766 cases of radiologically-confirmed pneumonia associated with pneumococcal bacteraemia were evaluated.

Patients were defined as 'severely-ill' for a PBS of >4, a PSI of IV or V and a CURB-65 score ≥3 (Table 1). The modified-ATS score of 2 minor criteria or 1 major criterion was considered to indicate 'severely-ill' (Table 1). The IDSA/ATS guidelines of 3 minor criteria or 1 major criterion was considered to indicate 'severely-ill' (Table 1). Missing laboratory parameter values were considered as normal values where feasible. Twenty-seven patients did not have their age recorded. To minimize biases from missing data, we also assessed a subgroup of patients in whom there were no missing values (*n* = 519) for any of the scoring systems. The endpoints were 14-day and 30-day mortality.

Statistical analysis

We evaluated the sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) as well as the accuracy of classification of 14-day and 30-day mortality for each SOI scoring system. We calculated the area under the receiver-operating characteristic (ROC) curve for each SOI scoring system; 95% confidence intervals were calculated and a two-sided p-value of <0.05 was considered statistically significant.

Results

Study sample

The number of patients varied for each score depending on the number of parameters evaluable: PBS (766 patients), modified-ATS criteria (766 patients), IDSA/ATS guidelines (766 patients), CURB-65 and CRB-65 (744 patients) and PSI (742 patients). Overall 739 patients were evaluable for all scoring systems if normal values were substituted for missing laboratory parameters. When patients with any missing parameter were excluded, 519 patients were available for evaluation.

Predictive accuracy

The PSI had the highest sensitivity (80.2%) whereas the PBS had the highest specificity (91.3%) and positive predictive value (PPV) (54.2%) (Table 2). All scoring systems had

TABLE 1. Calculation parameters of the PBS, modified-ATS, CURB-65, CRB-65 and PSI[a]

Scoring system	Parameters used		Severe illness criteria	Reference
PBS	Fever (oral temperature)		>4	[7]
	≤35°C or ≥40°C	2		
	35.1–36.0°C or 39.0–39.9°C	1		
	36.1–38.9°C	0		
	Hypotension	2		
	Acute hypotensive event with drop in systolic blood pressure >30 mmHg and diastolic blood pressure >20 mmHg or Requirement for intravenous vasopressor agents or Systolic blood pressure <90 mmHg			
	Mechanical ventilation	2		
	Cardiac arrest	4		
	Mental status			
	Alert	0		
	Disoriented	1		
	Stuporous	2		
	Comatose	4		
Modified-ATS	Minor criteria		2 minor or 1 major	[9]
	Systolic BP <90 mmHg[a]			
	Multilobar involvement (>2 lobes)[a]			
	Pa02/Fi02 ratio (<250)[a]			
	Major criteria			
	Requirement for mechanical ventilation[a]			
	Septic shock[a]			
IDSA/ATS	Minor criteria		Any major or 3 minor	[6]
	Resp rate ≥30/min[a]			
	Pa0$_2$/Fi0$_2$ ratio ≤250[a]			
	Multilobar infiltrate[a]			
	Confusion and/or disorientation[a]			
	Uraemia (BUN≥20 mg/dL)[a]			
	Leucopenia (WBC <4000 cells/mm^3)[a]			
	Thrombocytopenia(platelet<100 000cells/mm^3)[a]			
	Hypothermia (≤36°C)[a]			
	Hypotension[a]			
	Major criteria			
	Requirement for mechanical ventilation[a]			
	Septic shock[a]			
CURB-65	Confusion[a]		≥3	[3]
	Urea (>7 mmol/L)[a],			
	Respiratory rate (≥30/min)[a],			
	Blood pressure (systolic <90 or diastolic[a] ≤60 mmHg, and age ≥65 years[a]			
CRB-65	As above without urea variable		≥3	[4]
PSI	Uses 20 variables including age, gender, co-morbidity, vital sign abnormalities and several laboratory and radiographic parameters		IV or V	[2]

[a]All criteria are graded within 48 h before or on the day of first positive blood culture. The highest point score during that time is recorded.

respectable NPVs (over 90%) (Tables 2 and 3). Analyses of only the 519 patients in whom all SOI parameters were available gave similar results to those for the larger groups in the case of each individual SOI score (Table 3).

Discriminatory power

The PBS had a significantly higher discriminatory power as measured by ROC curve than any of the other scores (four-way comparison, p <0.05, data not shown). There was no significant difference in discriminatory power