ORIGINAL ARTICLE

Repeated Pneumonia Severity Index Measurement After Admission Increases its Predictive Value for Mortality in Severe Community-acquired Pneumonia

*Chiung-Zuei Chen,[1†] Po-Sheng Fan,[2†] Chien-Chung Lin,[1] Cheng-Hung Lee,[1] Tzuen-Ren Hsiue[1]**

Background/Purpose: Severe community-acquired pneumonia (CAP) is associated with high hospital mortality, and accurate assessment of patients is important for supporting clinical decision making. The Pneumonia Severity Index (PSI) is a good tool for predicting disease severity, especially in the low-risk group of patients with CAP. We investigated whether the change in PSI measurement after admission could identify patients at high risk of mortality from CAP.

Methods: We prospectively studied 250 inpatients with CAP. PSI was measured at admission and 72 hours later at a tertiary referral medical center from May 2005 to February 2006. The initial and repeated PSI results were compared. Hospital mortality was used as the outcome measure.

Results: Initial PSI in high-risk patients (PSI class > IV) had a low specificity (37%), and a low positive predictive value (PPV) (17%). Increased repeated PSI score, as compared with initial score, was associated with an increased mortality rate (from 7.8% to 33.3% in class IV, and 25.3% to 53.3% in class V; $p < 0.0001$), and improved the predictive value, with 94% specificity and a PPV of 46% for mortality in high-risk patients.

Conclusion: Increased PSI score, 72 hours after admission, for patients with CAP improved the predictive value of PSI score and more accurately identified patients with a high risk of mortality. [*J Formos Med Assoc* 2009;108(3):219–223]

Key Words: community-acquired pneumonia, pneumonia severity index, severity assessment

Community-acquired pneumonia (CAP) remains a serious disease with significant mortality. The mortality rate for all hospitalized CAP patients is 10–15%,[1,2] and 20–50% of the mortality of those who require admission to an intensive care unit (ICU) is caused by CAP.[3,4] Disease severity assessment is important for guiding therapeutic options.[5] An accurate assessment can help the physician to determine the initial site of care and to select empirical therapy. Early identification of patients with severe CAP and high risk of mortality will help to ensure that empirical therapy is prompt and directed at the most likely pathogens. It also supports the physician's decision making regarding the need for ICU admission. The Pneumonia Severity Index (PSI) is a good tool for predicting pneumonia mortality. It is best validated for assessing patients with a low mortality risk who may be suitable for outpatient management.[6–9] However, our previous study found a low specificity

[1]Department of Internal Medicine, College of Medicine, National Cheng Kung University, Tainan, and [2]Department of Internal Medicine, Chiayi Christian Hospital, Chiayi, Taiwan.

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***Correspondence to:** Dr Tzuen-Ren Hsiue, Department of Internal Medicine, College of Medicine, National Cheng Kung University, 138 Sheng-Li Road, Tainan 704, Taiwan.
E-mail: hsiue@mail.ncku.edu.tw
†Chiung-Zuei Chen and Po-Sheng Fan contributed equally to this work.

and positive predictive value (PPV) (58% and 18%, respectively) of PSI for mortality in patients with severe CAP (PSI class IV and V patients).[10]

Our aim was to evaluate whether repeated measurement of PSI at 72 hours after admission can improve the value of this index in identifying CAP patients at high risk of hospital mortality.

Methods

All patients with CAP treated from May 2005 to February 2006 at National Cheng Kung University Hospital, a tertiary referral medical center in southern Taiwan, were included in this study. The study was approved by the Institutional Review Board, and all patients provided signed informed consent. The prediction rule using the PSI scoring system was evaluated using data obtained by a prospective observational study method.

Disease definitions and complete inclusion and exclusion criteria were as previously described.[7] To be included, patients had to have: (1) symptoms and signs of respiratory tract infection, such as cough, fever and sputum; (2) acute pulmonary infiltrates present on chest radiography that were compatible with pneumonia; and (3) acquisition of infection outside the confines of a hospital, chronic care facility, or nursing home. Patients were excluded if they had known human immunodeficiency virus infection or had evidence of active tuberculosis Data on demographic characteristics, comorbidity, baseline clinical and laboratory features, and hospital mortality were obtained during admission. We evaluated the PSI score immediately after admission and repeated PSI measurements were studied about 72 hours after admission. For repeated PSI score, the PSI parameters were evaluated about 72 hours after admission in every patient except those patients who died within 72 hours of admission.

Our aim was to evaluate whether repeated measurement of the PSI score at 72 hours after admission improved its value in predicting which patients had a high risk of mortality. The mortality in stratified risk class of initial PSI was calculated. The performances including sensitivity, specificity, PPV, negative predictive value (NPV) and accuracy of initial PSI and increased repeated PSI score for predicting mortality in severe CAP (class IV and V) were also calculated.

Results are expressed as mean ± standard deviation. Categorical variables were compared using the χ^2 or Fisher's exact test as appropriate. All tests were interpreted using a two-tailed significance level of $p < 0.05$.

Results

Two hundred and fifty patients were enrolled in this prospective study. The demographic characteristics, comorbidity, physical examination findings and laboratory data for these patients are shown in Table 1.

The correlation of inhospital mortality with PSI risk classification at admission is shown in Table 2. For the initial PSI score, the total class-specific mortality ranged from 2.9% for class III, to 7.8% for class IV, and 25.3% for class V ($p < 0.001$). No mortality occurred among patients in class I and II.

To test whether repeated measurement of the PSI score could more accurately predict mortality, PSI was reassessed 72 hours after admission in all patients, except the seven patients who died within the first 72 hours of admission (one with PSI class III and six with class V). The repeated PSI score was compared with the initial PSI score for each patient (Table 3). Patients whose repeated PSI score decreased compared with the initial value had a lower mortality rate (from 7.8% to 3.7% in class IV patients, and 25.3% to 13% in class V), while those with an increased repeated PSI score had an increased mortality rate (from 7.8% to 33.3% in class IV patients, and 25.3% to 53.3% in class V). The specificity and PPV of an increased repeated PSI score for predicting hospital mortality in high-risk patients increased from 37% to 94% and from 17% to 46%, respectively, and the accuracy

also increased from 44% to 90%, as compared with initial PSI scores (Table 4). Increased PSI score 72 hours after admission predicted the outcome of severe CAP better than the initial PSI score did.

Table 1. Demographic characteristics of the patients ($n = 250$)

	n (%)
Demographic characteristics	
Age < 50 yr	44 (18)
Female	89 (36)
Comorbidities	
Diabetes mellitus	58 (23)
Chronic lung disease	55 (22)
Cerebrovascular	53 (21)
Chronic renal disease	38 (15)
Chronic liver disease	30 (12)
Chronic heart failure	28 (11)
Neoplasm	24 (10)
Alcohol abuse	12 (5)
Smoking	53 (21)
Physical examination	
Altered mental status	61 (24)
Pulse ≥ 125 beats/min	67 (27)
Respiratory rate ≥ 30 beats/min	78 (31)
Systolic blood pressure < 90 mmHg	39 (16)
Temperature < 35°C or ≥ 40°C	23 (9)
Laboratory	
Urea ≥ 30 mg/dL	65 (26)
Glucose ≥ 250 mg/dL	26 (10)
Hematocrit < 30%	40 (16)
Sodium < 130 mmol/L	34 (14)
PaO_2 < 60 mmHg	131 (52)
Arterial pH < 7.35	36 (14)

Discussion

The PSI is designed to identify patients with CAP who are at a low risk of mortality and other adverse outcomes. This information can help physicians to make more rational decisions about the site of care for patients with CAP. A previous study has found that the admission rate decreased after implementation of admission decisions in combination with specific recommendations for outpatient antibiotic therapy.[11] Disease severity assessment is also important for the early identification of high-risk patients who not only require admission, but who also require ICU management. An accurate assessment also helps the physician to make decisions about the extent of diagnostic testing, and the type and intensity of antibiotic treatment.[12]

The PSI is best validated for assessing patients with a low mortality risk who may be suitable for treatment as outpatients, rather than in predicting inhospital mortality for those with severe CAP.[6–9] We also demonstrated a significant correlation between PSI class and inhospital mortality. Although this finding confirms that PSI is a powerful tool for identifying low-risk patients, the specificity and PPV for predicting mortality in high-risk patients (class IV and class V) were low (37% and 17%, respectively). These results are similar to those of our previous study[10] and another study[13] that used PSI to predict mortality of high-risk patients with CAP, and also found a low specificity of 58–70% and low PPV of 11–18%.

Halm et al found that the median time to overall clinical stability in hospitalized patients with

Table 2. Initial PSI score and risk class specific mortality for patients with CAP

PSI class at admission	Total number (%)	Mortality number (%)*
I	21 (8.4)	0
II	26 (10.4)	0
III	35 (14.0)	1 (2.9)
IV	77 (30.8)	6 (7.8)
V	91 (36.4)	23 (25.3)
Total	250 (100)	30 (12.0)

**Mortality was significantly associated with risk class ($p < 0.001$).*

Table 3. Compared repeated PSI score with initial PSI score for predicting mortality of patients with CAP

Initial PSI class and predicted mortality	Change of score by comparing repeated PSI with initial PSI	Case number	Median (range) for change of score	Mortality number (%)
Class I (0%)	Decreased	0		0
	Stationary	21		0
	Increased	0		0
Class II (0%)	Decreased	8	−12.5 (10–30)	0
	Stationary	17		0
	Increased	1	10	0
Class III (2.9%)	Decreased	12	−17.5 (10–45)	0
	Stationary	20		0
	Increased	2	40 (10–70)	0
Class IV (7.8%)	Decreased	54	−25 (10–50)	2 (3.7)
	Stationary	14		1 (7.1)
	Increased	9	30 (10–90)	3 (33.3)*
Class V (25.3%)	Decreased	69	−40 (10–100)	9 (13.0)
	Stationary	1		0
	Increased	15	30 (10–70)	8 (53.3)†

**p < 0.02 and †p < 0.01 as compared with the pool data of stationary and decreased patients in the same class. We defined three categories: "decreased", "stationary" and "increased" for change of repeated PSI score. "Stationary" means exactly the same score, "decreased" means any decreased scores and "increased" means any increased score as compared with the initial PSI score.*

Table 4. Comparison of the performance characteristics of initial PSI ≥ Class IV and increased repeated PSI score in Class IV and V patients for predicting the mortality of CAP

	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Initial PSI	97	37	17	99	44
Increased repeated PSI score	48	94	46	95	90

CAP was 3 days.[14] Most patients with CAP have an adequate clinical response within 3 days. However, up to 10% of all CAP patients do not respond to initial therapy.[5] Therefore, it is reasonable to hypothesize that repeated measurement of PSI score 72 hours after admission might improve the utility of this instrument. The change in serial PSI score from initial measurement to repeated evaluation at 72 hours after admission revealed that the mortality rate decreased if the repeated PSI score decreased, and increased if the repeated PSI score increased in high-risk patients (class IV and class V). Thus, this comparison of initial and repeated PSI scores allowed more accurate prediction of hospital mortality because of improved specificity and PPV (94% and 46%, respectively). This repeated assessment may thus help physicians detect the most severe CAP patients, who have significantly higher mortality rates (33.3% in class IV and 53.3% in class V). Focusing on the identification of high-risk patients through repeated PSI assessment may assist in their rapid triage and aggressive management, and reduce subsequent mortality from severe CAP. However, the relatively low sensitivity of the performance of the increased repeated PSI score, also reminded us that, even though the mortality was decreased, there were still some patients with stationary or decreased repeated PSI score who will die.

In conclusion, we demonstrated that the PSI scoring system had low specificity and low PPV for mortality in high-risk patients with CAP.

Repeated assessment with increased PSI score 72 hours after admission improved the performance of the PSI scoring system for identifying patients at high risk of mortality.

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