Articolo originale

Original article

Correspondence between hospital admission and the pneumonia severity index (PSI), CURB-65 criteria and comparison of their predictive value in mortality and hospital stay

Correlazione tra ricovero in ospedale per polmonite, criteri PSI e CURB-65 e confronto tra il loro valore predittivo della mortalità e durata della degenza

Mojtaba Varshochi[1,2], Parisa Kianmehr[1,2], Mohammad Naghavi-Behzad[3], Zhinous Bayat-Makoo[1,2]

[1]Infectious & Tropical Diseases Research Centre, Tabriz University of Medical Sciences, Tabriz, Iran;
[2]Department of Infectious Diseases, Faculty of Medicine, Tabriz University of Medical Sciences, Tabriz, Iran;
[3]Medical Philosophy and History Research Centre, Tabriz University of Medical Sciences, Tabriz, Iran

INTRODUCTION

Community-acquired pneumonia (CAP) is one of the most common, and sometimes life-threatening, infections. Approximately 10% of CAP cases are so severe that require mechanical ventilation and intensive care. The physician will face three basic questions about making a decision about the correct management while visiting patient with pneumonia.

First he/she should pay careful attention to a prospective comparison of patient's symptoms and signs with pneumonia diagnosis and ruling out differential. Second, he/she should make a decision for hospitalization or outpatient management and third, should rightly guess the most probable etiologic organisms involved [1-3].

Making the correct decision about hospitalization of the patients with pneumonia diagnosis is very important. Avoiding admission of needful patients can be harmful and will lead to increased patients mortality rate, on the other hand, unnecessary hospitalization can be coupled with economic burden to the patient and society, which may lead to increased patient's and his/her family anxiety.

Most of the physicians refer their suspected patients to emergency room or clinic if they have one or some of the following findings: increased respiratory rate; old age; shock status on arrival; altered mental status; findings of adult respiratory distress syndrome; oliguria; leukopenia; bilateral pulmonary involvement and large areas of pulmonary infiltrates on chest X-ray; decreased arterial PO2 on blood gas analysis; evidence of renal dysfunction; severe underlying diseases or malignancy.

Patients having only one of the above findings cannot fulfill the condition of hospital admission [4, 5].

Presently, pneumonia severity index (PSI) and CURB-65 are usually used to register a patient with pneumonia for hospital admission [6, 7]. Each of them includes 20 and 5 criteria respectively.

*Corresponding author
Zhinous Bayat-Makoo
E-mail: Zhinous_b@yahoo.com

In this study, we investigated:

1) the number of patients with CAP who had appropriate criteria for hospitalization and were primarily visited in emergency rooms of our two educational hospitals considering PSI and CURB-65 criteria;
2) the difference between abilities of each system for predicting patient's mortality and length of hospital stay.

MATERIAL AND METHODS

This is a descriptive-analytic study in which concordance between admission criteria for our pneumonia patients and those of PSI and CURB-65 were investigated, and the degree of prognostic precision values in two models (PSI and CURB-65) were determined. During a period of 21 months (21 April 2010 - 19 march 2012), 134 patients with CAP who were hospitalized in our two educational hospital centers (Imam Reza and Sina in Tabriz) were enrolled in our study.

All participants have signed a written consent, and the study protocol was approved by the Ethics Committee of Tabriz University of Medical Sciences (TUMS), which was in compliance with Helsinki Declaration.

Data check list were completed once at the time of patient admission in emergency room or in infectious disease and pulmonary or ICU wards, and then again at the end of their hospital stay. Inclusion criteria were as following: acute respiratory symptoms (cough, sputum, fever, and dyspnea), physical exam findings (percussion dullness, crackle, evidence of consolidation), and radiologic findings in favor of pneumonia.

Our check list included age, gender, residence place, nursing home residence, altered mental status, underlying disease, pleural effusion, mechanical ventilation assist, serum pH, PaO_2, hematocrit (HCT), serum sodium and blood urea nitrogen (BUN), systolic and diastolic blood pressure, pulse rate, respiratory rate, body temperature, blood sugar, PSI classes, CURB-65 score, duration of hospitalization and patient's outcome.

PSI and CURB-65 criteria were matched with patients' data available in their charts; then classification and scoring for each system were determined.

According to collected data we classified the patients, on the basis of PSI criteria, from classes I to V, while at the same time scoring them from 0 to ≥3 based on CURB-65 criteria. Then the two systems were matched as:

- Class I (PSI): equivalent to score 0 (CURB-65)
- Class II (PSI): equivalent to score I (CURB-65)
- Class III (PSI): without equivalent
- Class IV (PSI): equivalent to score 2 (CURB-65)
- Class V (PSI): equivalent to score ≥3 (CURB-65).

Exclusion criteria of the study were considered as: pulmonary embolism, pulmonary cancer, decompounded congestive heart failure, pulmonary edema, and etc, if they were diagnosed before or during hospital stay.

Prognostic measures of the study were considered as: length of hospitalization and in-hospital death.

STATISTICAL ANALYSIS

The obtained information have been expressed as average ± standard deviation (SD), frequency and percentage.

SPSS™, 16th edition, was used as statistical software. Comparison of qualitative variables was done by chi-square test or Fisher's exact test. The quantitative variables were analyzed by T-test for independent groups and/or univariate analysis. The receiver operating characteristics (ROC) were drawn for defining ideal cutting points of the curve.

All results with P value ≤0.05 were considered as statistically significant.

RESULTS

A group of 134 hospitalized patients with CAP was investigated. The patients' information has been summarized in Table 1. One-hundred and twelve cases (83.6%) met the appropriate criteria of PSI (class ≥III) or CURB-65 (score ≥2). Concordance between PSI and CURB- 65 criteria was found in 61 patients (45.5%). Twenty-five (18.7%) patients, out of remaining, had high registration for classification in PSI system as was so for 48 (35.8%) patients for scoring in CURB-65 system.

Mean duration of hospital stay and mortality rate for different classes of patients in PSI system is shown in Table 2.

Based on the results of univariate analysis test, the mean duration of hospital stay for the pa-

Table 1 - Information of hospitalized patients with CAP*.

Age	>50 ≥65 Average	103 (76.9%) 58 (43.3%) 64.23±19.82 (15-103)
Gender	Male Female	87 (64.9%) 47 (35.1%)
Place of residence	Urban Rural	90 (67.2%) 44 (32.8%)
Residing at nursing home		2 (1.5%)
Altered mental status		35 (26.1%)
Congestive heart failure		48 (35.8%)
Previous liver disease		1 (0.7%)
Previous renal disease		43 (32.1%)
Previous cerebrovascular disease		25 (18.7%)
Previous malignancy		16 (11.9%)
Pleural effusion		24 (17.9%)
Using mechanical ventilation		39 (29.1%)
Systolic blood pressure (mm/Hg)	<90 Average	10 (7.5%) 118.98±24.69 (60-190)
Diastolic blood pressure (mm/Hg)	<60 Average	34 (25.4%) 73.22±13.44 (40-100)
Pulse rate (/min)	≥125 Average	11 (8.2%) 99.89±17.68 (73-130)
Respiratory rate (/min)	>30 Average	73 (54.5%) 30.51±8.08 (21-46)
Body temperature (°C)	≥40 or <35 Average	27 (20.1%) 38.00±1.93 (36-41)
Serum pH	<7.35 Average	45 (33.6%) 7.37±0.08 (7.1 - 7.5)
PaO2	<60	78 (58.2%)
HCT	<30 Average	14 (10.4%) 39.14±8.33 (17.2-61.2)
Serum Na+ (mEq/L)	<130 Average	7 (5.2%) 138.39±5.43 (122-153)
BUN (mg/dl)	≥30 Average	57 (42.5%) 33.30±23.15 (4-140)
Urea (mg/dl)	>19 Average	123 (91.8%) 64.25±45.51 (9-240)
Blood sugar (mg/dl)	≥250 Average	3 (2.2%) 121.58±43.00 (69-287)
PSI (number)		12.58±48.55 (29-254)
PSI (class)	I II II IV V	4 (3%) 18 (13.4%) 21 (15.7%) 40 (29.9%) 51 (38.1%)
CURB-65 (score)	0 1 2 3 4 5	4 (3%) 18 (13.4%) 52 (38.8%) 43 (32.1%) 9 (6.7%) 8 (6%)
Hospitalization Duration (day)		9.33±5.24 (1-30)
Outcome	Death Discharge	35 (26.1%) 99 (73.9%)

*Data shown as average ± SD and frequency/percentage.

Table 2 - Hospitalization duration and mortality rate in different classes based on PSI classification.

PSI class	*Number of patients*	*Hospitalization duration (day)*	*P value*	*Death*	*P value*
I & II	22*	8.73±6.72*	0.43	0 (0)*	<0.001
III	21	8.14±4.16		2 (9.5)	
IV	40	9.18±4.83		8 (20)	
V	51	10.20±5.22		25 (49)	
*Date shown as average ± SD and frequency (Percentage).					

Table 3 - Hospitalization duration and mortality rate in different groups based on CURB-65 Score.

CURB-65 score	*Number of patients*	*Hospitalization duration (day)*	*P value*	*Death*	*P value*
0 & 1	22*	9.09±5.81*	0.91	3 (13.6)*	<0.001
2	52	9.02±5.17		3 (5.8)	
3	43	9.60±5.18		21 (48.8)	
4 & 5	17	9.88±5.21		8 (47.1)	
*Date shown as average ± SD and Frequency (Percentage).					

tients in different classes of PSI system did not have significant statistical difference (P=0.43). But the chi-square test results showed significant statistical difference for mortality rate in the same groups of patients (<0.001). This means that patients classified in higher classes of PSI systems had higher mortality rate.

Based on the results of univariate analysis test, the mean duration of hospital stay for the patients in different score groups of CURB-65 system did not have significant statistical difference (P=0.91) but the chi-square test result showed significant statistical difference for mortality rate in the same groups of patients (P<0.001), as is shown in Table 3.

This means that the patients in higher score (≥3) in CURB-65 system had higher mortality rate.

In the patients meeting PSI criteria for admission, the mean duration of hospital stay was 9.45±4.92 days whereas for patients who did not meet PSI criteria, that was 8.73±6.72 days. Based on the results of T-test there was no significant statistical difference between them (p=0.56).

In the first group of patients 35 cases died (31.3%) whereas there was no death event in the second group.

Fisher tests analysis showed significant statistical difference between two groups of patients (P= 0.002).

In the patients meeting CURB-65 criteria for admission, the mean duration of hospital stay was 9.38±5.14 days whereas for patients who did not meet CURB-65 criteria, that was 9.09±5.81 days. Based on the results of T-test there was no significant statistical difference between them (P=0.82). In the first group of patients 32 cases died (28.6%) whereas 3 cases died (13.6%) in the second group.

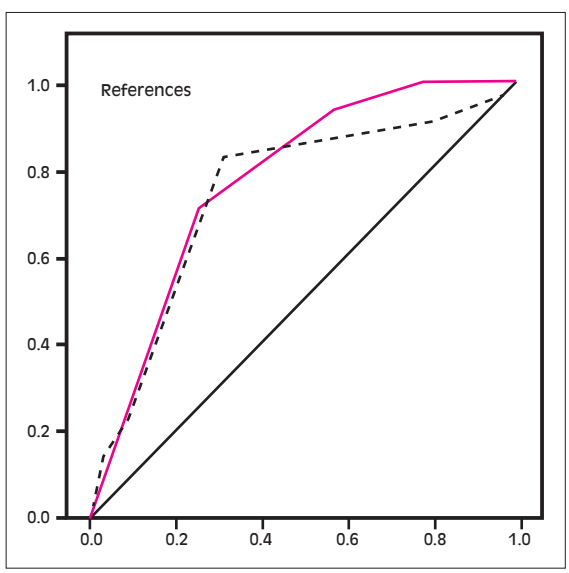

Figure 1 - ROC curve of ideal cutting point for PSI and CURB-65 in predicting in-patient mortality in hospitalized patients with CAP.

Fisher tests analysis showed significant statistical difference between two groups of patients (P=0.13).
The ROC curve of patient's outcome (in-patients mortality) has been shown in Figure 1 according to both PSI and CURB-65 systems. Based on this, the area under the curve (ideal for calculating appropriate cutting point) was 0.77 (0.69-0.85) according to PSI (confidence interval 95%, P<0.001). It was 0.74 (0.65-0.84) for CURB-65 system (confidence interval 95%, P<0.001).
According to this analysis the best mortality prediction was obtained in cases with PSI class ≥IV, with sensitivity and specificity of 80, 66.7 percent respectively. The same results was obtained in cases with CURB-65 score ≥2, with sensitivity and specificity of 82.9, 68.7 percent respectively.

DISCUSSION

In this study, concordance between admission criteria for our patients with CAP, who were admitted to our two educational hospitals (Imam Reza and Sina) in Tabriz, and those of PSI and CURB-65 were investigated and the predictive abilities of these two systems for hospital stay duration and in-patient mortality rate were evaluated.
83.6% of studied patients were hospitalized meeting either PSI or CURB-65 criteria. In a similar study by Aydogdu et al. from Turkey, 92% of their patients met the criteria of PSI for hospitalization.
It seems that complete agreement is not practically expected [8]. There may be multiple reasons for this discrepancy, among the most important ones is the diversity of systems used by physicians based on their interest which have their own pros and cons, in terms of each system's ability to predict prognosis in admitted patients.
We evaluated the concordance between criteria of PSI and CURB-65 for our admitted patients and found agreement between the two systems in 45.5% of cases.
This shows that there is not a major agreement between two systems for admitted patients. Considering in-patient mortality rate and hospital stay duration as prognostic measures, we found significant agreement between PSI and CURB-65 for mortality rate but statistically, not so for hospital stay duration.
This was in contrast to Yandiola et al. study but in favor of Shah et al. findings [9, 10].
To predict death event we compared two systems; we used ROC depiction and its components as comparison measures and found no significant difference between two systems. It was found that PSI≥IV class had 80% and 66.7% specificity and sensitivity rates, respectively for predicting death while CURB-65 had 82.9% and 68.7% sensitivity and specificity rates, respectively for score ≥2.
Buising et al. found sensitivity and specificity of 97.3% and 47.9%; for death event when their patients were at class ≥IV of PSI system [11]. Similar rates were 81% and 67.9% when scoring of their patients were ≥3 in CURB-65 system.
In the study of Valencia et al., sensitivity and specificity were 71% and 65% respectively in PSI system and 73% and 48% in CURB-65 system [12].
Anada-Rajab et al. concluded in a study that just PSI system can predict 30 day in-patient mortality rate with high precision, while the same is not true about CURB-65 system [13].
In a similar study, Fang et al. have shown that the ability of PSI system to predict death events was more than that of CURB-65 [14]. In this study the area under the curve was 0.70 and 0.66 for PSI and CURB-65 respectively. Apart from these studies, others have shown that the predictive abilities of both systems for mortality rate among pneumonia patients were same [10, 15-17].
It was shown in a study carried by Loke et al. that sensitivity rate of PSI for predicting mortality was more than that of CURB-65, but much lower rates was found for specificity, at the same time [18].
In this regard, it seems that the results of various studies are not homogeneous and the demographic differences and the factor of sensitivity, specificity, confound the results. As an example, age ≥65 as a variable in CURB-65 system is one of short coming of this system as in increases the sensitivity rate of the system decreases considerably [19].
Adding other variables such as diastolic blood pressure or serum urea level into study makes the matter even more complex because such variables are abnormal in old aged patients even in their non-pathologic states.
Sometimes, PO_2 measurement is another limitation. It has been shown that beside preadmission criteria, other factors such as microbial cause of pneumonia and treatment protocols al-

so play a role in determination of prognosis for these patients; while these factors are not considered as criteria in presently used systems [9]. In another study, Niederman emphasized that PSI system is more precious for predicting mortality rate among low risk patients while CURB-65 is so for high risk patients [20].

In our study, when we have compared in-patient mortality between two hospitalized groups with and without indication, the mortality rate was significantly higher in hospitalized cases according to PSI system indications but not according to CURB-65 model.

Although these findings are different from those of Niederman's report, but positively influences the use of each system in its right place.

In other words, using one particular system as a basis for decision making and treatment planning is not logical and no system can replace clinical Judgment [11].

One interesting pint of our study, as mentioned before, is that CURB-65 score ≥2 is the cutoff point for predicting mortality rate while generally CURB-65 score ≥3 is considered high-risk score for patients with community acquired pneumonia [11, 13]. This issue is also concluded in other studies [14, 21] but further studies seem to be required for its approval.

CONCLUSION

According to the present study there has been a considerable agreement among hospitalized cases with CAP in our educational centers in Tabriz with hospitalizing indication according to two systems of PSI and CURB-65. These two evaluating models have nearly equal sensitivity and specificity for predicting mortality when PSI class ≥IV and CURB-65 score ≥2. Conducting further studies are recommended based on other prognostic models.

Keywords: community-acquired pneumonia (CAP), pneumonia severity index (PSI), CURB-65.

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Conflict of interest

The authors have no proprietary interest in any aspect of this study.

No one has been paid during preparing this manuscript.

SUMMARY

Pneumonia severity assessment systems, such as the pneumonia severity index (PSI) and CURB-65, were designed to guide physicians to admit the patients involved to appropriate wards of hospitals. This study evaluated concordance rate of decisions leading to patients' hospitalization in accordance with PSI and CURB-65 criteria and comparison of the two systems' P-values in evaluating mortality and the hospitalization period of the patients in question.

A total of 134 hospitalized patients with community-acquired pneumonia (CAP) were evaluated. Patients were classified on the basis of risk factors implicated in the PSI and CURB-65 systems. Prognostic P-values and indication measures of hospitalization for the two systems were then compared. Eighty-seven males (64.9%) and 47 females (35.1%) with a mean age of 64.23±19.82 (**15-103**) years were enrolled in the study. Based on the results of both systems, hospitalization was indicated in 112 cases (83.6%) and there was total agreement between the two systems in 61 cases (45.5%). There was no significant association between hospitalization duration in the two systems. However, both systems significantly predicted mortality within the hospitalization period with rather equal accuracies. Patients expired more frequently in the group with indication of hospitalization based on the PSI classes. However, there was no significant difference in the mortality between the two groups with and without admission indication according to the CURB-65 system.

A considerable portion of our hospitalizations met the related criteria of the PSI/CURB-65. The two evaluation systems have near equal sensitivity and specificity for predicting mortality among hospitalized patients with CAP when the PSI class ≥IV and CURB-65 score ≥2.

RIASSUNTO

I sistemi di classificazione della gravità della polmonite, quali l'indice di gravità della polmonite (PSI, Pneumonia Severity Index*) e il CURB-65, sono stati messi a punto per guidare il clinico nel processo di ricovero dei pazienti con polmonite nei reparti ospedalieri più appropriati. In questo studio abbiamo valutato il grado di correlazione tra la decisione di ospedalizzare i pazienti in accordo al PSI e ai criteri CURB-65 e il confronto dei valori di P dei due sistemi nel valutare la mortalità e la durata della degenza dei pazienti considerati.*
Complessivamente, sono stati valutati 134 pazienti ospedalizzati affetti da polmonite acquisita in comunità (CAP, Community-Acquired Pneumonia*). I pazienti sono stati classificati sulla base dei fattori di rischio considerati dai sistemi PSI e CURB-65. I valori prognostici di P e le indicazioni delle misure di ospedalizzazione per i due sistemi sono stati quindi confrontati. Nello studio sono stati arruolati 87 uomini (64,9%) e 47 donne (35,1%) di età media pari a 64,23±19,82 (15-103) anni. Sulla base dei risultati di entrambi i sistemi, l'ospedalizzazione risultava indicata per 112 casi (83,6%), e la concordanza totale tra i due sistemi è stata osservata in 61 casi (45,5%). L'associazione alla durata dell'ospedalizzazione non è risultata significativa in nessuno dei due sistemi; l'accuratezza predittiva della mortalità nel corso della degenza è stata pressoché uguale per entrambi i sistemi. Il maggior numero di decessi è stato riscontrato nel gruppo di pazienti per i quali l'indicazione all'ospedalizzazione si era basata sulle classi del PSI. Tuttavia, non è stata rilevata una differenza significativa nella mortalità tra i gruppi di pazienti, con e senza indicazione al ricovero, sulla base del sistema CURB-65. Una quota considerevole delle ospedalizzazioni ha soddisfatto i criteri PSI/CURB-65 correlati. I due sistemi di valutazione possiedono sensibilità e specificità pressoché uguali nel predire la mortalità nell'ambito di pazienti con CAP quando la classe PSI è ≥IV e il punteggio CURB-65 è ≥2.*

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