Turkish Journal of Geriatrics
2017;20 (4):254-263

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RESEARCH

PREDICTING THE 28-DAY MORTALITY RATE IN ELDERLY PATIENTS WITH COMMUNITY-ACQUIRED PNEUMONIA: EVALUATION OF 11 RISK PREDICTION SCORES

Abstract

Introduction: Community-acquired pneumonia frequently causes infectious disease-related morbidity and mortality among patients. Elderly patients are at a higher risk of developing severe Community-acquired pneumonia due to underlying diseases and changes in health status. We evaluated the performance of existing risk scores for predicting the 28-day mortality rate in elderly patients presenting with Community-acquired pneumonia to Emergency Department.

Materials and Method: We evaluated 151 elderly patients [mean age, 76.6±7.8 years (range, 65–94 years); 65.6% men] with Community-acquired pneumonia. There were 30 deaths by day 28, with an all-cause mortality rate of 19.9%. All scores, except the CAP-PIRO, achieved an area under the receiver operating characteristic curve >0.700. Z-test was used to determine significant differences between the scores.

Results: We evaluated 151 elderly patients [mean age, 76.6±7.8 years (range, 65–94 years); 65.6% men] with Community-acquired pneumonia. There were 30 deaths by day 28, with an all-cause mortality rate of 19.9%. All scores, except the CAP-PIRO, achieved an area under the receiver operating characteristic curve >0.700. Z-test was used to determine significant differences between the scores.

Conclusion: Of the existing scores, 4 had good discriminatory power to predict the 28-day mortality rate. The best discrimination was demonstrated by CURB-age, a score designed for elderly patients with Community-acquired pneumonia. Additional research is necessary to determine the best risk score for predicting early mortality rates in elderly patients with Community-acquired pneumonia.

Key Words: Aged; Pneumonia; Mortality

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Received: 11/09/2017
Accepted: 24/11/2017

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This article was presented as a poster at the EUGMS Congress 2017, Nice (France).

ARAŞTIRMA

TOPLUM KÖKENLİ PNÖMONİLİ YAŞLI HASTALARDA 28 GÜNLÜK MORTALİTE ORANININ ÖNGÖRÜLMESİ: 11 RİSK TAHMİN SKORUNUN DEĞERLENDİRMESİ

Öz

Giriş: Toplum Kökenli Pnömoni sıklıkla bulaşıcı hastalığa bağlı morbidite ve mortaliteye neden olur. Yaşlı hastalarda, altta yatan hastalıklar ve sağlık durumundaki değişiklikler nedeniyle ciddi Toplum Kökenli Pnömoni gelişme riski yüksektir. Topluluk kökenli pnömoni ile acil servise başvuran yaşlı hastalarda 28 günlük mortaliteyi öngörmede mevcut risk skorlarının performansını değerlendirdik.

Gereç ve Yöntem: Manisa Celal Bayar Üniversitesi Hastanesi Acil Servis Ünitesine başvuran, Toplum Kökenli Pnömoni tanılı 65 yaş ve üzeri hastaların kayıtlarını retrospektif olarak incelendik. Tüm hastaların başvurularından 28 gün sonraki sonuçları değerlendirildi. Toplum Kökenli Pnömonili hastalar için 11 risk prediksiyon skorunun ayırt edici performansı alıcı işletim karakteristiği eğrisi altındaki alan kullanarak değerlendirildi.

Bulgular: Toplum kökenli pnömoni tanısı olan 151 [ortalama yaş, 76.6±7.8 yıl (aralık 65-94 yıl); % 65.6 erkek] yaşlı hastayı değerlendirdik. 28 günlük izlemler boyunca 30 ölüm vardı, tüm nedenlere bağlı ölüm yüzdesi 19.9 idi. CAP-PIRO hariç tüm puanlar makul bir ayırt edici performansı eğrisi altı alana ulaştı. Skorlar arasındaki anlamlı farkları belirlemek için Z-testi kullanıldı.

Sonuç: Mevcut skorların 4'ü 28 günlük mortaliteyi tahmin etmek için iyi bir ayırt edici performansı eğrisi altı alana sahipti. En iyi ayırt etme gücü yaşlı Toplum Kökenli Pnömonili hastalar için tasarlanmış bir puan olan CURB-age tarafından gösterildi. Toplum kökenli pnömonili yaşlı hastalarda erken mortaliteyi tahmin etmede en iyi risk skorunu belirlemek için ek araştırmalar gereklidir.

Anahtar Sözcükler: İleri yaş; Pnömoni; Mortalite

INTRODUCTION

Community-acquired pneumonia (CAP) is the most frequent cause of infectious disease-related hospitalization, morbidity, and mortality among patients of all ages (1). Elderly patients are at a higher risk of developing severe CAP due to underlying heart and respiratory disease, changes in mental status, and immunosuppression (2).

The first stage in the management of patients with CAP is to assess the severity of the disease and estimate the potential clinical course. This information helps in making critical decisions regarding therapeutic interventions, required laboratory tests, and site of care (3). Delayed transfer to the intensive care unit (ICU) or unnecessary admission to a hospital increases the risk of secondary complications, such as thromboembolic events and nosocomial superinfection, which further increase the risk of poor outcome (4).

The decision regarding the site of care is the first important point to consider in CAP management. Therefore, several clinical and prognostic scoring tools have been developed to safely and reliably predict the feasibility of treatment in an outpatient setting as well as the need for hospitalization or ICU admission and risk of death (4). The study aimed to evaluate 11 pneumonia severity scores to determine their effectiveness in predicting the 28-day mortality in elderly patients with CAP.

MATERIALS AND METHOD

Setting and design

This retrospective cross-sectional study was conducted at the emergency department (ED) of Celal Bayar University Hospital in Manisa, Turkey. Consecutive elderly patients with the diagnosis of CAP admitted to the ED between July 2013 and April 2015 were included. Data required for risk prediction scores were extracted from the hospital's electronic medical record and related electronic databases by 1 emergency medicine resident using a standardized data extraction form. The local ethic committee approval was obtained (reference no. 20.478.486-408).

Clinical scores

Due to the increasing costs associated with CAP, the Pneumonia Severity Index (PSI) was introduced to help predict which patients do not need hospitalization and those with lower risk of mortality (5). The PSI is based on evaluation of >20 clinical and laboratory parameters. Due to its complexity, the British Thoracic Society developed CURB-65 to simplify the evaluation of patients with pneumonia. Although both PSI and CURB-65 are good predictors of mortality and identifiers of lower-risk patients, a new scoring method was needed to identify patients requiring intensive care. Hence, the Infectious Disease Society of America and the American Thoracic Society developed the IDSA-ATS criteria for this purpose (6). CAP severity was graded baed on data extracted from the records according to the pneumonia severity scores: PSI (5), CURB-65 (7), IDSA-ATS (6), SMART-COP (8), CAP-PIRO (9), SCAP, CURXO-80 (10), ADROP (11), CRB-65, CORB-75 (12), and CURB-age (7).

Selection of participants

Patients who were aged ≥65 years of age and diagnosed with CAP were included. Exclusion criteria were readmission; diagnosis of hospital-acquired pneumonia (HAP), health care-associated pneumonia (HCAP), or aspiration pneumonia; the presence of active pulmonary tuberculosis; known human immunodeficiency virus positivity; or the presence of chronic immunosuppression.

Data collection

At the time of ED presentation, information regarding age, sex, whether living at home or in a nursing home, comorbid diseases, and medications were obtained from the patients. Additional parameters such as initial blood pressure, pulse rate, respiratory rate, peripheral oxygen saturation on room air, body temperature, and presence of mental confusion were recorded. Additionally, ED laboratory data, chest X-ray or chest computed tomography findings; ICU admission; requirement for mechanical ventilation; hospital length of stay (LOS); and death within 28 days were recorded.

The primary outcome was all-cause mortality within 28 days of presentation. Secondary outcomes were hospitalization, ICU admission, mechanical ventilation requirements, and hospital LOS. Local civil records were also reviewed for deaths occurring outside the hospital.

Statistical analysis

At the end of 28 days, Fisher's exact test was used to determine differences between survivors and non-survivors, and the Wilcoxon/Kruskal-Wallis rank sum tests were used for non-normally distributed data. Logistic regression was used for multivariate analyzes. The area under the curve (AUC) was calculated to compare the accuracy of each score for predicting 28-day mortality. AUC, Z-value, and 95% confidence interval of the receiver operating characteristic (ROC) curves were calculated for all severity scores. Statistical analyses were performed using the SPSS, version 15.0 and MedCalc, version 12.

RESULTS

Of 190 consecutive elderly patients presenting to the ED with pneumonia, 15 were diagnosed with HAP, and 11 with HCAP, 7 were immunocompromised, and 6 had recurrent pneumonia, leaving 151 participants. Their mean age (standard deviation) was 76.6 (7.8) years, and 99 (65.6%) were male. During the initial 28 days, a total of 30 patients died. The mean length of survival among patients who died during the follow-up period was 12 days (range: 1–28 days). Overall, 105 patients were hospitalized while 46 were discharged from the ED and followed as outpatients. For secondary outcomes, 23.2% were admitted to the ICU, 16.6% required mechanical ventilation, and mean hospital LOS was 6.1±7.2 days. Table 1 shows the comparison of baseline characteristics and patient status at the end of the 28-day follow-up period. The most frequent comorbid diseases were chronic heart disease (56.3%), chronic lung disease (49.7%), and neoplasm (18.5%). Additionally, a history of chronic lung disease, chronic renal failure, and dementia were associated with a high risk of death ($P = 0.005$, $P = 0.016$, and $P = 0.031$, respectively). In the analysis aimed at correcting age-related diseases affecting mortality; it was found that deaths were higher 3.04 times for those with dementia, 5.85 times for those with CBI, and 3.41 times for those without COPD. Significant differences were found between survivors and those who died in terms of blood urea nitrogen, creatinine levels, and mean platelet volume ($P < 0.001$, $P = 0.009$, and $p < 0.001$, respectively). Table 2 shows a comparison of the results of the 11 clinical scores for survivors and those who died.

The sensitivity and specificity of the scores were demonstrated using ROC curves (Fig. 1). With the exception of CAP-PIRO, all scores had an AUC ≥0.700, a threshold that designates fair discriminating ability. The CURB-age had the best performance with an AUC of 0.836 (Table 3). Three other scores that performed well were SCAP, IDSA-ATS, and CURXO-80 (AUC was 0.833, 0.822, 0.805, respectively). The Z-test did not show significant differences among the AUC values except for CURB-age versus CAP-PIRO. Z-test statistics and P values are shown in Table 4.

Table 1. Baseline characteristics of the 151 study subjects, categorized with respect to the center of origin.

Variables	Survivors (n = 121)	Nonsurvivors (n = 30)	p
Demographic data			
Age (y)	76.5±7.7	77.1±8.5	0.709
Women/Men (n)	42/79	10/20	0.887
Previous medical history			
Diabetes mellitus	21 (17.4)	5 (16.7)	0.929
Chronic heart disease	69 (57.0)	16 (53.3)	0.715
Chronic pulmonary disease	67 (55.4)	8 (26.7)	0.005
Chronic renal failure	4 (3.3)	5 (16.7)	0.016
Chronic liver failure	1 (0.8)	0 (0)	0.801
Cerebrovascular disease	11 (9.1)	7 (23.3)	0.548
Dementia	8 (7.3)	10 (24.4)	0.031
Neoplasm	21 (17.4)	7 (23.3)	0.451
Dyslipidemia	7 (5.8)	4 (13.3)	0.150
Hemodynamic parameters at presentation			
Systolic blood pressure (mm Hg)	139.9±26.8	122.4±37.2	0.020
Diastolic blood pressure (mm Hg)	77.0±16.8	68.9±18.9	0.023
Heart rate (beats/min)	101.1±19.9	106.9±23.5	0.175
Respiratory rate (breaths/min)	22.2±6.7	25.7±7.9	0.015
Oxygen saturation (SaO_2%)	89.0±11.7	87.6±5.5	0.526
Forehead temperature (^{0}C)	37.3±1.0	37.1±1.0	0.404
Labaratory results			
White blood cell count (x 10^3 /μL)	14.5±7.6	15.5±7.0	0.372
Platelet count (K/uL)	251.8±103.0	246.2±110.8	0.793
Haemoglobin (g/dL)	12.4±2.1	12.5±2.8	0.814
Hct (%)	37.9±6.1	38.1±8.0	0.903
MPV (fL)	9.2±1.3	8.0±0.8	<0.001
Glucose (g/dL)	142.5±50.5	170.4 ±100.9	0.180
Blood urea nitrogene (mg/dL)	27.9±19.9	57.4±55.6	<0.001
Urea (mg/dL)	59.3±40.1	117.1±119.5	0.002
Creatinine (mg/dL)	1.14±0.69	2.25±2.4	0.009

Table 1 (continued)... Baseline characteristics of the 151 study subjects, categorized with respect to the center of origin.

Sodium (mmol/L)	137.1±5.7	137.6±6.4	0.683
Potassium (mmol/L)	4.3±0.7	4.4±1.0	0.414
Chlorine (mmol/L)	101.0±7.6	101.5±7.4	0.724
Calcium (mmol/L)	8.8±0.6	8.8±1.1	0.977
Blood gas analysis (arterial)			
Ph (Ph units)	7.42±0.09	7.39±0.10	0.087
PaO_2 (mm Hg)	65.7±18.7	60.1±16.2	0.136
$PaCO_2$ (mm Hg)	39.2±11.6	39.2±17.6	0.130
HCO_3^- (mmol/L)	25.6±3.8	23.1±5.9	0.032
BE^{ecf} (mmol/L)	1.91±4.66	-1.24±7.35	0.031
Radiographic findings			
Bilateral lung involvement	39 (32.2)	16 (53.3)	0.032
>2 zones involvement	56 (46.3)	20 (66.7)	0.046
Pleural effusion	27 (22.3)	11 (36.7)	0.105
Secondary outcomes			
ICU admission	18 (14.9)	17 (56.7)	<0.001
Mechanical ventilation	10 (8.3)	15 (50.0)	<0.001
Hospital LOS (days)	5.1±8.0	8.0±8.7	0.081

Data are expressed as mean±SD or count (percentage of the 151 subjects) for categorical variables unless otherwise indicated. **Abbreviations:** Hct, Hematocrit; MPV, Mean platelet volumeRed cell distribution width; BE^{ecf}, Base Excess of extracellular fluid; ICU, Intensive Care Unite; LOS, length of stay.

Table 2. Comparisons of mortality prognostic scores, categorized with respect to the center of origin.

Variables	Survivors (n=121)	Nonsurvivors (n=30)	p
Clinical scores			
CURB-age	2 (1-5)	4 (1-6)	<0.001
SCAP	2 (0-6)	4 (1-6)	<0.001
IDSA-ATS	2 (0-6)	4 (0-7)	<0.001
CURXO-80	1 (0-5)	3 (0-5)	<0.001
ADROP	2 (0-4)	3 (0-4)	<0.001
PSI	106 (56-174)	141 (72-192)	<0.001
CRB-65	1 (1-4)	2.5 (1-4)	<0.001
CURB-65	2 (1-4)	3 (1-5)	<0.001
CORB-75	1 (0-5)	2 (0-5)	<0.001
SMART-COP	3 (0-8)	4 (0-9)	<0.001
CAP-PIRO	3 (1-6)	4 (1-6)	0.001

Data are expressed as median (min - max).

Table 3. Areas under the ROC curve in prediction of 28-day mortality.

Variables	p	sd	Areas	Lower bound 95 % CI	Upper bound
CURB-age	<0.001	0.045	0.836	0.747	0.925
SCAP	<0.001	0.039	0.833	0.756	0.909
IDSA-ATS	<0.001	0.046	0.822	0.731	0.912
CURXO-80	<0.001	0.045	0.805	0.717	0.893
ADROP	<0.001	0.050	0.786	0.687	0.885
PSI	<0.001	0.051	0.784	0.685	0.883
CRB-65	<0.001	0.050	0.775	0.677	0.873
CURB-65	<0.001	0.051	0.765	0.665	0.866
CORB-75	<0.001	0.054	0.734	0.628	0.840
SMART-COP	<0.001	0.055	0.712	0.604	0.820
CAP-PIRO	0.001	0.058	0.690	0.576	0.804

Abbreviations: sd, standard deviation; CI, confidence interval.

Table 4. Data for the different ROC curves followed by the result of pairwise comparison of all ROC curves.

Mortality prognostic scores	Z Statistics	p
CURB-age versus SCAP	0.0504	0.9598
CURB-age versus IDSA-ATS	0.2180	0.8278
CURB-age versus CURXO-80	0.4870	0.6262
CURB-age versus ADROP	0.7430	0.4573
CURB-age versus PSI	0.7650	0.4445
CURB-age versus CRB-65	0.9070	0.3645
CURB-age versus CURB-65	1.0440	0.2965
CURB-age versus CORB-75	1.4510	0.1468
CURB-age versus SMART-COP	1.7450	0.0810
CURB-age versus CAP-PIRO	1.9890	0.0467

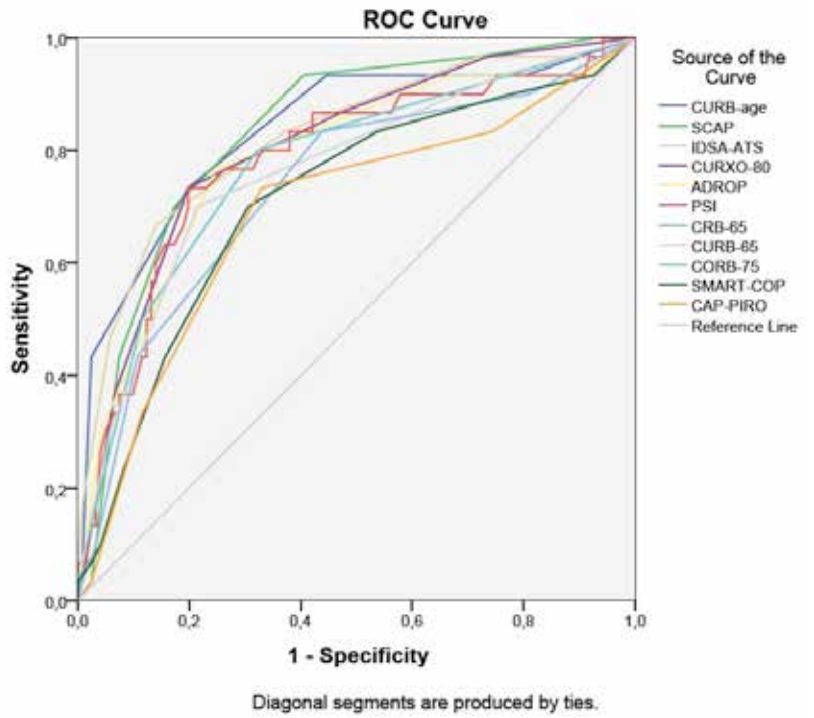

Figure 1. Areas under the ROC curves in prediction of 28-day mortality.

DISCUSSION

Despite important advances in treatment regimens, CAP is still associated with a high mortality rate (13). Because pneumonia can manifest with extrapulmonary signs (delirium, chronic confusion or falling) in elderly patients, it may be difficult to diagnose CAP in this age group (14). Few studies have evaluated the effectiveness of pneumonia severity assessment scores in predicting mortality rates exclusively in the elderly. This study compared the ability of the 11 most common pneumonia severity assessment scores to predict early mortality rates in 151 elderly patients diagnosed with CAP. Of these 11 scores, 10 had at least fair discriminative power (AUC>0.700). Of those 10 scores, 4 had good discriminative power (AUC>0.800). The CURB-age had the highest sensitivity and specificity (AUC, 0.836) followed by SCAP, IDSA-ATS, and CURXO-80 (Tables 2 and 3). Conversely, CAP-PIRO had the lowest AUC at 0.690, which demonstrated poor discriminative power. The performance of the CURB-age was not notably different from the other scores.

PSI and CURB-65 were the first 2 pneumonia severity assessment scores developed to predict mortality rates in the general population (15). Due to the complexity of PSI (consisting of 20 variables), CURB-65 was developed to evaluate of CAP in the general population (5). However, it was later claimed that both scores were insufficient for identifying patients with severe pneumonia who required admission to the ICU; thus, IDSA-ATS, SMART-COP, SCAP, and CAP-PIRO were developed with this purpose in mind (15–18).

Higher CURB-65 and IDSA/ATS scores were found to be correlated with a higher mortality. However, the AUC for CURB-65 was greater than for

IDSA/ATS (13). IDSA/ATS 2007 has been shown to perform better than CURB-65 (19), and one study found that IDSA-ATS was better than PSI and CURB-65 at predicting in-hospital mortality rates and ICU admission requirements (20).

SMART-COP was developed to prevent unnecessary ICU admissions and particularly to identify patients requiring intensive respiratory or vasopressor support. The latter requirement is better predicted by SMART-COP than PSI or CURB-65 (8). However, CAP-PIRO is better than IDSA-ATS for predicting the 28-day mortality rate in ICU patients (18).

The SCAP score was developed to better predict severe CAP (i.e., higher hospital mortality rate, need for mechanical ventilation, and risk for septic shock) in the ED (10). This score contains 8 variables and was found to have better discriminatory power for predicting severe CAP compared to IDSA-ATS, CURB-65, or PSI (21). CURXO-80 was developed prior to the introduction of SCAP score to evaluate patients with CAP in the ED (10).

ADROP was developed by The Japanese Respiratory Society (JRS) as a modification of CURB-65. The JRS assumed that CURB-65 was only good at predicting low mortality risk; therefore, they aimed to develop a score that could easily be applied by general practitioners and specialists. The ADROP score aims to facilitate the patient evaluation, recommending management of those with mild-to-moderate CAP as outpatients and admission of those with moderate-to-severe CAP to the ICU (11). One study involving ADROP found that it had similar sensitivity and specificity to CURB-65 for predicting the 28-day mortality rate in patients with CAP (22).

CURB-age was developed based on the assumption that CURB-65 was insufficient at predicting mortality rates in patients aged > 65 years of age (7). The design was based on CURB-65; but 2 evaluative criteria were added: age >85 years, and urea > 11 mmol/L. A study by Myint and colleagues showed that CURB-65 was useful for predicting mortality rates in patients with CAP among the general population, while CURB-age was less sensitive in this broad patient population, although both were better at predicting mortality rates for all ages than for patients aged ≥65 years of age (23). A recent study performed in the general population found that CURB-age had better AUC and higher sensitivity than either CURB-65 or CRB-65 for predicting the 28-day mortality rate (24).

In our study, the 28-day mortality rate was 19.9%, which was similar to the 11%-35% rate reported in previous studies in the ≥65 age group. Although 4 scores had good discriminative power (AUC > 0.800), in our study, 3 (SCAP, IDSA-ATS, and CURXO-80) were designed to identify patients requiring intensive respiratory or vasopressor support. It is notable and interesting that CURB-age had the highest AUC. Additionally, 2 scores developed to prevent unnecessary ICU admission (SMART-COP and CAP-PIRO) had the lowest discriminative power (AUC=0.712 and 0.690, respectively) for mortality, and scores particularly designed to be used in the general population had less discriminative power (AUC =0.7000–0.800) in our study compared with the results of previous studies (13,22,25).

Our results indicate that clinical scores are good for evaluating elderly patients diagnosed with CAP after ED admission. Nevertheless, our study has some limitations. First, because of its retrospective design, we could not gather all of the data in every patient diagnosed with CAP. Second, as patients were evaluated by their first radiological findings, new pulmonary infiltrates may not be present in the early stages of disease. As a result, possible patients with CAP, with normal or indeterminate findings on chest imaging have been excluded from this study. Finally, confounding variables that were not measured in this study, such as nutritional status, smoking, and vaccinations for pneumococcus and influenza may have influenced the results.

In conclusion, more studies are necessary to

determine the best score to accurately predict the short-term mortality rate in elderly patients with CAP. A reliable score for prediction of CAP-mortality rates in the ever-growing elderly population is necessary. In our evaluation of 11 existing prediction scores, the best discriminative power was demonstrated by CURB-age, which was specifically designed for elderly patients. However, we evaluated the independent risk of these 11 models over mortality and found that IDSA-ATS was 3.72 times more accurate than other risk prediction scores in estimating mortality. Therefore, more detailed prospective studies should be planned to assess the most appropriate risk score or to create a new risk score that can be used in ER.

Conflict of Interest

The authors have no conflicts of interest to declare.

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