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Original Article

The Effectiveness of Geriatric Pneumonia Severity Index in Predicting Mortality

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SUMMARY

Background: Pneumonia severity index (PSI) estimates the risk of 30-day mortality in patients with pneumonia. In this study, we aim to develop a simplified version of the PSI (G-PSI) to estimate the risk of mortality in geriatric patients with community-acquired pneumonia (CAP).
Methods: This retrospective study included 186 patients aged 65 and older with a diagnosis of CAP. PSI score and 30-day mortality rate of each patient were calculated. PSI parameters were analyzed using univariate regression analysis and the G-PSI scoring system was established to predict 30-day mortality and compared with PSI.
Results: Significant effectiveness of the values of cancer (odds ratio (OR) = 3.67; 95% confidence interval (CI): 1.42–9.48), altered mental status (OR = 0.79; 95% CI: 0.68–0.92), systolic blood pressure (OR = 0.98; 95% CI: 0.97–1.00), haematocrit (Hct) (OR = 0.87; 95% CI: 0.81–0.93) and blood urea nitrogen (BUN) (OR = 1.04; 95% CI: 1.02–1.06) were observed for predicting mortality in univariate regression analysis. G-PSI scoring system, like PSI score (if cancer + 30 points, if altered mental status +20 points, if systolic blood pressure < 90 mmHg + 20 points, if Hct < 30% + 10 points and if BUN ≥ 30 mg/dl + 30 points) was created. The area under the receiver operating characteristic curve (AUC) was 0.762 (95% CI 0.673–0.851), revealing the excellent discriminatory ability of the G-PSI model. The AUC for the PSI score was 0.719 (95% CI 0.631–0.806). When G-PSI and PSI were compared, G-PSI had a high level of significance in predicting 30-day mortality.
Conclusion: Calculated with only five parameters from standard PSI information, G-PSI accurately displays the 30-day mortality risk of geriatric patients with CAP. The applicability of the G-PSI is easier in a busy emergency service environment with similar prognostic accuracy and clinical prediction.

1. Introduction

Community-acquired pneumonia (CAP) is still one of the most common causes of mortality and morbidity in the geriatric patient group. While the prevalence rate is 6/1000 in the 18–39 age group, it is 34/1000 in people aged 75 and over.[1] In-hospital mortality rate is more than 10% and 1-year mortality is more than 40% in patients over 65 years old diagnosed with CAP.[2] These high mortality rates indicate that the prognosis of patients hospitalized with CAP diagnosis is at least as severe as heart failure or stroke.[3]

Scoring systems, such as pneumonia severity index (PSI), modified American Thoracic Society (mATS) rule or CURB 65 (confusion; urea; respiratory rate; blood pressure; age over 65), have been developed to minimize the risk of pneumonia mortality.[4–6] This prognostic information obtained using scoring systems in the evaluation and management of pneumonia patients is significant in the regulation of patient care and in the hospitalization decision or guiding the admission process to the intensive care unit.[7–9] It also helps the clinician determine the suitability of early hospital discharge or outpatient care through accurate and objective prognosis prediction.

Although these scoring systems are widely used in clinical practice, all of them have different practical limitations.[3,10] In PSI, which is one of the most used scoring systems, five risk groups are created using 20 clinical and investigational variables of the patient, and the 30-day mortality rate is calculated.[4] The high number of variables in the PSI scoring system makes this scoring system difficult to use in busy emergency service departments.

The present study aims to calculate the PSI score by examining the geriatric patients who applied to our emergency department and diagnosed with CAP and to provide a simplified version of PSI in patients over 65 years of age by determining the effects on mortality of the clinical and investigational variables used in the PSI scoring system.

2. Materials and Methods

In this study, we analyzed the cases of CAP diagnosed in patients aged 65 and over in the Emergency Department of the University of Health Sciences Haydarpasa Numune Training and Research Center during 12 months from November 2018, retrospectively. This study was conducted in accordance with the Declaration of Helsinki and

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was approved by the Ethics Committee of the University of Health Sciences, Haydarpasa Numune Training and Research Hospital (Grant No.2020/36-2128). Since this study was a retrospective study, written informed consent was waived by the ethics committee of the designated hospital. The annual number of patient applications to our emergency department is approximately 200000–250000 individuals, and 9.6% of these patients are over 65 years of age. The diagnosis of pneumonia was determined by physical examination findings and radiological findings in patients presenting with symptoms, such as dry or productive cough, chest pain, fever or shortness of breath. Patients with a history of hospitalization for any reason in the last 30 days, patients who received intravenous drug therapy at home or in the care center, patients undergoing hemodialysis and patients with decubitus ulcers were excluded from this study and patients diagnosed with community-acquired pneumonia were included in this study.

The epicrisis of the patients were examined and age, gender, co-morbid diseases, care place, altered mental status, respiratory rate, systolic blood pressure, fever, heart rate, pH, sodium, BUN, glucose, hemotocrit, partial oxygen pressure, presence of pleural effusion in X-ray, discharge or hospitalization, mortality and length of hospital stay were recorded and PSI scores were calculated. The presence of altered mental status was accepted as acute impairment of consciousness or confusion when compared to basal cerebral functions of the patients.[7]

In this study, mean, standard deviation, median, lowest, highest and frequency and ratio values were used in the descriptive statistics of the data. The distribution of variables was measured using the Kolmogorov Smirnov test. Unpaired t-test and Mann-Whitney U test were used in the analysis of quantitative independent data. In the analysis of qualitative independent data, the chi-square test was used and the Fischer test was used when chi-square test conditions were not met. Its effect level was investigated by multivariate logistic regression. SPSS 26.0 program was used in the analyses. A p-value of less than 0.05 was considered statistically significant.

3. Results

One hundred eighty-six geriatric patients diagnosed with CAP were included in this study. The mean age of the patients was 79.4 ± 8.7; 55.9% (n = 104) of them were female. The 30 days mortality rate was 18.8% (n = 35). Only three of the patients lived in a nursing home. Demographic data, comorbid diseases, laboratory parameters and 1-month mortality rate of 186 patients are given in Table 1.

When we classified the patients into two groups as a survivor and a 30-day mortality group, no significant difference was detected between the ages, gender and location distribution of the patients (p > 0.05). While the rate of neoplastic disease was 25.7% (n = 9) in the mortality group, it was 8.6% (n = 13) in the survivor group (p = 0.005). When we examined the CHF, CVA, kidney disease, CAD, and liver disease comorbidities in the PSI scoring system, no significant difference was observed between the two groups (p = 0.686, p = 0.644, p = 0.067, p = 0.678, p = 1.000, respectively). It was observed that the respiratory rate of ≥ 30 breaths/min, and the presence of pleural effusion in lung imaging had no effect on mortality (p = 0.626 vs. p = 1.000, respectively). In the group with mortality, 37.1% (n = 13) of the patients altered mental status, while this rate was 15.2% (n = 23) in the survivor group (p = 0.003). Systolic blood pressure was 118.7 ± 26.6 mmHg in the mortality group, while it was 129.2 ± 25.5 mmHg in the survivor group (p = 0.031). Glucose (152.0 ± 80.4 vs. 157.8 ± 77.7), fever (37.0 ± 0.7 vs. 36.9 ± 0.7), pulse (94.3 ± 17.2 vs. 91.9 ± 16.2), arterial pH (7.4 ± 0.1 vs. 7.4 ± 0.2), PaO_2 (49.9 ± 17.1 vs. 48.8 ± 15.4), sodium (138.1 ± 4.5 vs. 136.6 ± 5.6) parameters did not differ significantly between the survivor and mortality groups (p = 0.373, p = 0.215, p = 0.707, p = 0.658, p = 0.997, p = 0.418, respectively). Htc level was lower in the mortality group as compared to the survivor group (32.1 ± 7.5% vs. 37.7 ± 5.9%, p < 0.001, respectively). BUN level was higher in the mortality group as compared to the survivor group (43.0 ± 22.8 mg/dl vs. 27.8 ± 16.3 mg/dl, p < 0.001, respectively) (Table 2).

For predicting mortality in univariate regression analysis, cancer (OR = 3.67; 95% CI: 1.42–9.48, p = 0.007), altered mental status (OR = 0.79; 95% CI: 0.68–0.92, p = 0.003), systolic blood pressure (OR = 0.98; 95% CI: 0.97–1.00, p = 0.033), Hct (OR = 0.87; 95% CI: 0.81–0.93, p < 0.001) and BUN (OR = 1.04; 95% CI: 1.02–1.06, p 0.001) values' significant efficacy was observed (Table 3).

Geriatric PSI (G-PSI) scoring system was created using cancer, altered mental status, systolic blood pressure, Hct and BUN parameters that were significant from the PSI parameters as a result of univariate regression analysis. In the scoring of the parameters that we used in the G-PSI scoring system, the scoring was performed using the scoring system in PSI (if cancer + 30 points, if altered mental status + 20 points, if systolic blood pressure < 90 mmHg + 20 points, if Hct < 30% + 10 points and if BUN ≥ 30 mg/dl + 30 points). Thus, the effectiveness of G-PSI in predicting 30-day mortality was calculated.

It was observed that the G-PSI score calculated with cancer, altered mental status, systolic blood pressure, Hct and BUN parameters had a significant effect in predicting mortality in geriatric

Table 1
Investigation of PSI parameters and 30-day mortality rate of patients diagnosed with geriatric CAP.

Variables	n (%)
Age	
Min-max	65.0–104.0
Median	79.0
Mean ± SD	79.4 ± 8.7
Female	104 (55.9)
Accommodation, n (%)	
Nursing home	3 (1.6)
Private	183 (98.4)
Co-morbidities, n (%)	
Neoplastic disease	22 (11.8)
Liver disease history	6 (3.2)
Congestive heart failure	53 (28.5)
Cerebrovascular disease	20 (10.8)
Renal disease history	29 (15.6)
Coronary artery disease	48 (25.8)
Respiratory rate < 30 breaths/min, n (%)	149 (80.1)
Respiratory rate > 30 breaths/min, n (%)	37 (19.9)
Altered mental status	36 (19.4)
30 day mortality, n (%)	
No	151 (81.2)
Yes	35 (18.8)
CAP characteristics (med, min-max)	
Glucose, mg/dl	131.0 (59.0–706.0)
SBP, mmHg	127.5 (60.0–206.0)
Temperature, °C	36.8 (36.0–39.4)
Pulse, bpm	92.0 (56.0–141.0)
Arterial, pH	7.4 (7.0–8.2)
PaO_2, mmHg	49.0 (47.0–107.0)
Htc, %	37.1 (12.7–54.3)
Sodium, mEq/l	138.0 (116.0–165.0)
BUN, mg/dl	25.5 (10.0–98.0)

Abbreviations: CAP, community-acquired pneumonia; SBP, systolic blood pressure; PaO_2, partial pressure of arterial oxygen; Htc, haematocrit; BUN, blood urea nitrogen.

Table 2
The significance level of gender, accommodation, comorbidities, respiratory rate, altered mental status and laboratory parameters according to 30-day mortality.

	30 day mortality (no)	30 day mortality (yes)	p
	n (%)	n (%)	
Gender			0.871
Female	84 (55.6)	20 (57.1)	
Male	67 (44.4)	15 (42.9)	
Accommodation			0.467
Nursing home	2 (1.3)	1 (2.9)	
Private	149 (98.7)	34 (97.1)	
Co-morbidities			
Neoplastic disease			
Yes	13 (8.6)	9 (25.7)	**0.005**
Liver disease history			
Yes	5 (3.3)	1 (2.9)	1.000
Congestive heart failure			
Yes	44 (29.1)	9 (25.7)	0.686
Cerebrovascular disease			
Yes	17 (11.3)	3 (8.6)	0.644
Renal disease history			
Yes	20 (13.2)	9 (25.7)	0.067
Coronary artery disease			
Yes	38 (25.2)	10 (28.6)	0.678
RR < 30 breaths/min	122 (80.8)	27 (77.1)	0.626
RR > 30 breaths/min	29 (19.2)	8 (22.9)	
Altered mental status	23 (15.2)	13 (37.1)	0.003
Age	78.8 ± 8.4 (78.0)	81.6 ± 9.5 (80.0)	0.164
Glucose, mg/dl	152.0 ± 80.4 (128.0)	157.8 ± 77.7 (147.0)	0.373
SBP, mmHg	129.2 ± 25.5 (130.0)	118.7 ± 26.6 (120.0)	0.031
Temperature, °C	37.0 ± 0.7 (36.9)	36.9 ± 0.7 (36.7)	0.215
Pulse, bpm	94.3 ± 17.2 (92.0)	91.9 ± 16.2 (92.0)	0.707
Arterial, pH	7.4 ± 0.1 (7.4)	7.4 ± 0.2 (7.4)	0.658
PaO_2, mmHg	49.9 ± 17.1 (49.0)	48.8 ± 15.4 (52.0)	0.997
Htc, %	37.7 ± 5.9 (37.6)	32.1 ± 7.5 (33.6)	**0.001**
Sodium, mmol/l	138.1 ± 4.5 (138.0)	136.6 ± 5.6 (138.0)	0.418
BUN, mg/dl	27.8 ± 16.3 (24.0)	43.0 ± 22.8 (33.0)	**0.001**
PSI	110.0 ± 29.8 (103.0)	136.5 ± 36.3 (132.0)	**0.001**
G-PSI	12.08 ± 15.1 (0.00)	31.47 ± 19.8 (30.0)	**0.001**
CURB 65	2.14 ± 0.93 (2.00)	2.86 ± 1.09 (3.00)	**0.001**

Data are presented as mean ± standard deviation and median.
Abbreviations: RR, respiratory rate; SBP, systolic blood pressure; PaO2, partial pressure of arterial oxygen; Htc, haematocrit; BUN, blood urea nitrogen; PSI, Pneumonia Severity Index; G-PSI, Geriatric Pneumonia Severity Index.

Table 3
Evaluation of factors affecting mortality with univariate logistic regression analysis.

	Univariate regression analysis	
	OR (95% CI)	p
Neoplastic disease	3.67 (1.42–9.48)	0.007
Altered mental status	0.79 (0.68–0.92)	0.003
SBP	0.98 (0.97–1.00)	0.033
Hct	0.87 (0.81–0.93)	< 0.001
BUN	1.04 (1.02–1.06)	< 0.001
PSI	1.02 (1.01–1.03)	< 0.001
G-PSI	1.06 (1.03–1.08)	< 0.001
CURB 65	2.06 (1.39–3.04)	< 0.001

Abbreviations: SBP, systolic blood pressure; Htc, haematocrit; BUN, blood urea nitrogen; PSI, Pneumonia Severity Index; G-PSI, Geriatric Pneumonia Severity Index; CI, confidence intervals.

patients with CAP. G-PSI score was 31.47 ± 19.8 (mean ± standard deviation) in the mortality group, while it was 12.08 ± 15.1 (mean ± standard deviation) in the survivor group (p = 0.001) (Table 2). The area under the receiver operating characteristic curve (AUC) was 0.762 (95% CI 0.673–0.851), revealing the excellent discriminatory ability of the G-PSI model. The AUC for PSI and CURB 65 scores was 0.719 (95% CI 0.631–0.806) and 0.687 (95% CI 0.584–0.790), respectively (Figure 1). In predicting mortality, the sensitivity of the G-PSI > 0 cut-off value of the highest under the curve area was 85.7%, speci-

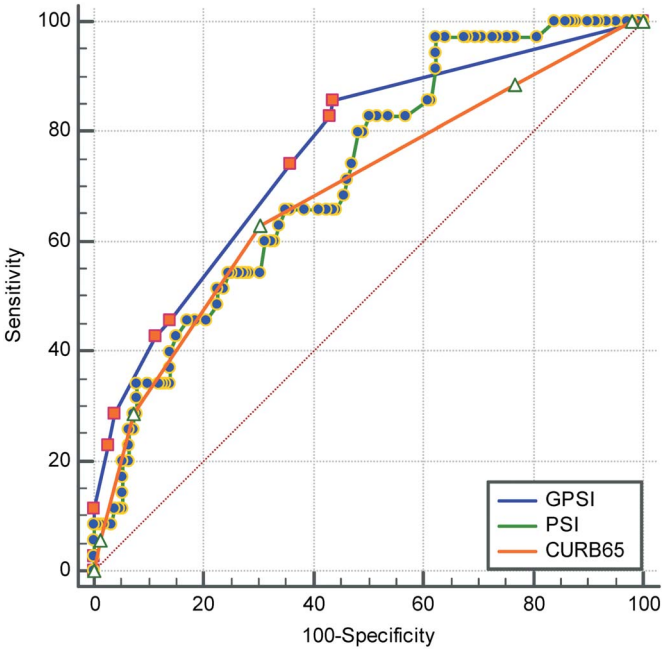

Figure 1. Receiver operating characteristic curves for G-PSI, PSI and CURB 65. The area under the curve (AUC) is 0.762 (95% confidence interval (CI) 0.673–0.851) for G-PSI. The AUC for PSI and CURB 65 scores was 0.719 (95% CI 0.631–0.806) and 0.687 (95% CI 0.584–0.790), respectively.

ficity 56.3%, positive prediction 31.3%, negative prediction 94.4%. The specificity of the cut-off value of G-PSI > 30 in predicting mortality was 86%, while its sensitivity was 45.7%. In the PSI scoring system with the highest area under the curve in predicting patients with mortality, the sensitivity of the cut-off value of 94 score was 94.3%, specificity was 37.7%, the positive predictive value was 26.0%, and the negative predictive value was 96.6%. In the CURB 65 scoring system with the highest area under the curve in predicting patients with mortality, the sensitivity of the cut-off value of 2 scores was 62.9%, specificity was 69.5%, the positive predictive value was 32.4%, and the negative predictive value was 89.0%.

4. Discussion

This study suggests that simplified PSI (G-PSI) in geriatric patients successfully predicts 30-day mortality after CAP. Compared with PSI, we showed that G-PSI has similar prognostic accuracy. The main purpose of pneumonia risk scores is to assist the clinician in identifying patients at high risk of mortality to reduce hospitalization and healthcare spending. Previous studies have emphasized that when evaluating pneumonia patients, PSI is more prominent and it is more sensitive to predict mortality than mATS and CURB 65.[3,11] In our study, when we compared the groups with and without 30-day mortality, it was seen that PSI predicted mortality at high rates in accordance with the literature in predicting mortality. However, scoring 20 clinical and laboratory variables with different score weights in PSI is difficult and time-consuming at the bedside.

Today, the elderly population is growing faster than the young population and it is expected to reach 20% of the world population by 2050.[12] Therefore, the management of patients diagnosed with CAP and the prediction of mortality will undoubtedly be even more important for both geriatric patients and clinicians in the coming years. Aging alone is an important risk factor for most chronic diseases. Therefore, the mortality rate due to diseases, such as liver disease, coronary artery disease, ischemic heart disease, cerebrovascular disease, cancer and diabetes, in elderly people is expected to increase.[13] In the course of acute or subacute disease, such as pneumonia, the mortality of elderly patients will change with the effect of functional status, person's immunity, biological condition or environmental factors.[3,14,15] When we look at the literature, advanced age, male gender and comorbidities are emphasized as significant prognostic parameters in geriatric patients diagnosed with CAP.[2,3] In different studies, advanced age has not been reported as a prognostic marker for 30-day mortality in elderly patients.[15,16] As the age score is already high in the PSI scoring system, very old patients fall into the Class III or IV risk category only because of their age.[15] When we compared the groups with and without 30-day mortality in our study, there was no age and gender difference between the two groups, and the place where the patient lived did not have an effect on mortality in our study. That the number of elderly living in nursing homes is low for traditional reasons in our country may cause this parameter to be meaningless in our study group.

In our study, the 30-day mortality rate was 18.8%, which is compatible with studies on the geriatric population diagnosed with CAP in different countries; 16% and 19%, Japan and the USA, respectively.[7,17] When we look at the comorbidities of the patients included in our study, comorbid liver disease, previous stroke, kidney disease, CHF or CAD diagnosis did not significantly affect mortality ($p > 0.05$). We think that this situation can be explained by the increase in the incidence of chronic diseases in the elderly population.

The incidence of cancer increases with aging, and 70% of the cancer-related deaths occur at the age of 65 and over.[18] Functional status, comorbidities, nutritional difficulties, cognitive problems or cancer-specific treatments may lead to infection susceptibility by causing immune impairment and lung damage in cancer patients.[19] In accordance with this information, according to the univariate regression analysis of our study, the additional diagnosis of malignancy in the patient diagnosed with pneumonia increases the mortality rate 3.6 times. While hematocrit decrease in the elderly may be secondary to nutritional deficiency, chronic inflammation or comorbid diseases, the cause of anemia cannot be explained in one-third of the patient.[20] The incidence of anemia over 65 years of age is 11% in males and 10% in females.[21] When we look at the literature, anemia of any level has been reported as an independent factor on mortality and morbidity in elderly patients.[20,22,23] In our study, Hct < 30% was effective in mortality.

Although the factors affecting prognosis have been investigated in studies related to CAP and especially respiratory rate (RR), heart rate (HR), systolic blood pressure (SBP), BUN, pH and PaO_2 have been shown to be predictors for mortality, studies in the geriatric patient population are insufficient.[7,24,25] When we look at the studies conducted to predict mortality in pneumonia patients, Acute Physiology and Chronic Health Evaluation II (APACHE II) and Simplified Acute Physiology Score (SAPS) showed mortality higher than it actually existed.[15,26] Torres et al., in their study with 99 pneumonia patients over 65 years of age, showed the activity of daily living (ADL) as an independent predictor of mortality.[15] In another study with 134 elderly patients, the prognostic value of the multidimensional prognostic index (MPI) was more significant than PSI.[3] In a study conducted on 337 patients over the age of 80, the parameters of anorexia, systolic BP less than 90 mmHg, performance status (PS) Grade 3 or higher, HR 100 beats/min or higher, RR 30/min or higher, pH less than 7.35, BUN 30 mg/dL or greater, $PaCO_2$ 50 mmHg or greater, and PaO_2 less than 60 mmHg in pneumonia patients were found effective in demonstrating mortality in univariate analysis.[7] In this study, we aimed to predict pneumonia mortality with fewer parameters in patients over 65 years of age. In our study, when we looked at the univariate regression analysis of PSI parameters among the mortality groups, it was seen that the values of cancer, altered mental status, systolic blood pressure below 90 mmHg, Hct < 30% and BUN 30 mg/dL or greater had a significant effect on 30-day mortality and G-PSI consisted of these parameters was also found to be at a high level of significance in predicting mortality. We showed that in geriatric patients with a diagnosis of CAP, a G-PSI score above 0 or, in other words, a positive G-PSI parameter predicts mortality with 85.7% sensitivity, 56.3% specificity and 94.4% negative predictive value. A specificity of 86% could be achieved in the event of the G-PSI cut-off value is > 30, if the clinician wants to obtain a higher specificity when assessing the geriatric patients with pneumonia. PSI score predicts mortality with a sensitivity of 94.3% and a specificity of 37.7% at a cut-off score of 94. When we compare G-PSI and PSI score, both scores have similar prognostic accuracy. Therefore, using G-PSI instead of PSI in geriatric patients will enable us to predict the prognosis with fewer parameters in a shorter time in the chaotic environment of emergency services.

The small sample size and being single-centred are the major limitations of our study. Today, the geriatric population is gradually increasing. Multicentre studies on this subject will facilitate the management of geriatric patients and contribute to shaping the treatment plan and reducing health expenditures by shedding light on the clinician on predicting the prognosis.

5. Conclusion

In our study, the mortality estimation of G-PSI in the manage-

ment of the patients diagnosed with CAP over the age of 65 has a similar significance level to that of PSI. Thus, calculating the G-PSI score instead of PSI in patients with geriatric pneumonia in the emergency clinic will highly likely to save us time in predicting the risk of mortality and will guide the preparation of the treatment plan.

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Competing interests

The authors declare no conflict of interest.

References

1. Viegi G, Pistelli R, Cazzola M, et al. Epidemiological survey on incidence and treatment of community acquired pneumonia in Italy. *Respir Med.* 2006;100:46–55.
2. Kaplan V, Clermont G, Griffin MF, et al. Pneumonia: still the old man's friend? *Arch Intern Med.* 2003;163:317–323.
3. Pilotto A, Addante F, Ferrucci L, et al. The multidimensional prognostic index predicts short- and long-term mortality in hospitalized geriatric patients with pneumonia. *J Gerontol A Biol Sci Med Sci.* 2009;64:880–887.
4. Fine MJ, Auble TE, Yealy DM, et al. A prediction rule to identify low-risk patients with community-acquired pneumonia. *N Engl J Med.* 1997;336:243–250.
5. Lim WS, van der Eerden MM, Laing R, et al. Defining community acquired pneumonia severity on presentation to hospital: an international derivation and validation study. *Thorax.* 2003;58:377–382.
6. Ito A, Ishida T, Tokumasu H, et al. Prognostic factors in hospitalized community-acquired pneumonia: a retrospective study of a prospective observational cohort. *BMC Pulm Med.* 2017;17:78.
7. Naito T, Suda T, Yasuda K, et al. A validation and potential modification of the pneumonia severity index in elderly patients with community-acquired pneumonia. *J Am Geriatr Soc.* 2006;54:1212–1219.
8. Lim WS, Baudouin SV, George RC, et al. BTS guidelines for the management of community acquired pneumonia in adults: update 2009. *Thorax*. 2009;64:iii1–iii55.
9. Bartlett JG, Dowell SF, Mandell LA, et al. Practice guidelines for the management of community-acquired pneumonia in adults. Infectious Diseases Society of America. *Clin Infect Dis.* 2000;31:347–382.
10. Buising KL, Thursky KA, Black JF, et al. A prospective comparison of severity scores for identifying patients with severe community acquired pneumonia: reconsidering what is meant by severe pneumonia. *Thorax.* 2006;61:419–424.
11. Spindler C, Ortqvist A. Prognostic score systems and community-acquired bacteraemic pneumococcal pneumonia. *Eur Respir J.* 2006;28:816–823.
12. Stupka JE, Mortensen EM, Anzueto A, et al. Community-acquired pneumonia in elderly patients. *Aging Health.* 2009;5:763–774.
13. Kim IH, Kisseleva T, Brenner DA. Aging and liver disease. *Curr Opin Gastroenterol.* 2015;31:184–191.
14. Rubenstein LZ. Joseph T. Freeman award lecture: comprehensive geriatric assessment: from miracle to reality. *J Gerontol A Biol Sci Med Sci.* 2004;59:473–477.
15. Torres OH, Muñoz J, Ruiz D, et al. Outcome predictors of pneumonia in elderly patients: importance of functional assessment. *J Am Geriatr Soc.* 2004;52:1603–1609.
16. El-Solh AA, Sikka P, Ramadan F. Outcome of older patients with severe pneumonia predicted by recursive partitioning. *J Am Geriatr Soc.* 2001;49:1614–1621.
17. Mody L, Sun R, Bradley SF. Assessment of pneumonia in older adults: effect of functional status. *J Am Geriatr Soc.* 2006;54:1062–1067.
18. Hurria A, Gupta S, Zauderer M, et al. Developing a cancer-specific geriatric assessment: a feasibility study. *Cancer.* 2005;104:1998–2005.
19. Jung J, Moon SM, Jang HC, et al. Incidence and risk factors of postoperative pneumonia following cancer surgery in adult patients with selected solid cancer: results of "Cancer POP" study. *Cancer Med.* 2018;7:261–269.
20. Vanasse GJ, Berliner N. Anemia in elderly patients: an emerging problem for the 21st century. *Hematology Am Soc Hematol Educ Program.* 2010;2010:271–275.
21. Guralnik JM, Eisenstaedt RS, Ferrucci L, et al. Prevalence of anemia in persons 65 years and older in the United States: evidence for a high rate of unexplained anemia. *Blood.* 2004;104:2263–2268.
22. Lanier JB, Park JJ, Callahan RC. Anemia in older adults. *Am Fam Physician.* 2018;98:437–442.
23. Kikuchi M, Inagaki T, Shinagawa N. Five-year survival of older people with anemia: variation with hemoglobin concentration. *J Am Geriatr Soc.* 2001;49:1226–1228.
24. Lim WS, Macfarlane JT. Defining prognostic factors in the elderly with community acquired pneumonia: A case controlled study of patients aged > or = 75 yrs. *Eur Respir J.* 2001;17:200–205.
25. Yoshikawa TT, Marrie TJ. Community-acquired pneumonia in the elderly. *Clin Infect Dis.* 2000;31:1066–1078.
26. Sikka P, Jaafar WM, Bozkanat E, et al. A comparison of severity of illness scoring systems for elderly patients with severe pneumonia. *Intensive Care Med.* 2000;26:1803–1810.