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Comparison of Nursing Home-acquired Pneumonia and Community-acquired Pneumonia and Evaluation of Factors Predicting Mortality

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ABSTRACT

Objective: The number of admissions to the emergency department (ED) of elderly patients who reside in nursing homes with a diagnosis of pneumonia continues to grow. This study was designed to assess factors that predicted mortality in the patient group defined as those with nursing home-acquired pneumonia (NHAP).

Materials and Methods: This was a prospective, observational study conducted in a hospital ED. The data of nursing home patients admitted to the ED with a pneumonia presentation (NHAP) were compared with those of patients with community-acquired pneumonia (CAP). Factors that predicted mortality in the NHAP group were analyzed. SPSS for Windows, Version 16.0 software (SPSS Inc., Chicago, IL, USA) was used to perform the statistical analysis.

Results: A total of 98 patients >18 years of age, 36 of whom were NHAP patients, were included in the research. The risk level and rates of intensive care admission and mortality were significantly higher in the NHAP group ($p<0.05$), and the thiol level, an antioxidant parameter, was lower in the NHAP group than that of the CAP group ($p<0.001$). Evaluation of the NHAP group alone revealed a higher mortality rate in patients with congestive heart failure, those hospitalized in intensive care, and those with high risk scores ($p<0.05$). The shock index (SI) value was found to be an independent predictor of mortality in the NHAP group. The study results indicated that each 0.1 unit increase in the SI increased mortality 3.637 times (95% confidence interval: 1.024-12.921) ($p=0.046$).

Conclusion: The findings suggest that the SI could serve as a valuable marker for predicting mortality in NHAP patients.

Keywords: Mortality, nursing home-acquired pneumonia, oxidative stress, shock index, thiol/disulfide homeostasis

INTRODUCTION

Nursing home-acquired pneumonia (NHAP) is a subgroup within the definition of health care-associated pneumonia (HCAP) to more specifically categorize patients who often require hospitalization when admitted to the emergency department (ED). The NHAP group comprises a large population of elderly patients who live in long-term care facilities and often have many comorbid diseases (1, 2). It has been noted in the literature that there is a 1.96 to 10-fold increase in the hospitalization rate and a 2.29-fold increase in the 30-day mortality rate in this population when compared with elderly individuals living in the community (3). While NAHP often resembles community-acquired pneumonia (CAP) clinically, it may be associated with multidrug-resistant bacteria (3).

Difficulty finding a precise definition for NHAP has made it challenging to develop a standard approach, especially for follow-up and treatment in the ED. There is currently no specific risk assessment tool or scoring system for NHAP patients as there is for CAP. Hospitalization of NHAP patients has been reported to have only a minimal effect on mortality in comparison with treatment in the residential care facility (4). Russo et al. (5) observed that NHAP patients had a greater risk of inadequate antibiotic treatment at the long-term care facility and should therefore be treated in a hospital where acute care could be provided.

The importance of oxidative stress in CAP as reflected in thiol/disulfide homeostasis has been noted in previous studies (6). To our knowledge, a similar analysis has not yet been conducted for HCAP or NHAP. It may be that the pathological process and oxidative stress is more severe in NHAP patients than in CAP. Considering the frequent delay in diagnosis and the high mortality rate, it is clear that a marker or risk assessment tool to predict mortality in NHAP is needed (7). The objective of this study was to examine and compare the oxidative stress in NHAP and CAP patients and to determine factors affecting mortality in order to offer guidance for the management of NHAP.

MATERIALS and METHODS

The principles of the World Medical Association (WMA) Declaration of Helsinki were observed at all stages of this study. Ethics approval was granted by the Local Ethics Committee of our institute for the study on October 25, 2017 (no: 194). All of the study participants provided informed consent.

This prospective, observational, open study was conducted in the ED of a training and research hospital between November 2017 and February 2018 (winter season). The initial patient evaluation was made in the ED using laboratory and radiological examinations, and patients were hospitalized in the relevant service or the intensive care unit (ICU) for follow-up and treatment. Due to the observational study design, no intervention was performed related to the research other than routine ED studies.

Patients who lived in long-term care facilities with a new pneumonic infiltration observed on a chest X-ray or thorax computed tomography and who presented with symptoms such as a body temperature >38°C, cough, purulent sputum, elevated leukocyte count, or hypoxia were accepted into the study as cases of NHAP. Pneumonia patients who lived in the community presenting with similar clinical findings and who did not meet the HCAP diagnostic criteria were included in the study with the diagnosis of CAP (2, 4). Patients <18 years of age, those who had a hospital discharge in the 15 days prior to the current presentation, those whose symptoms and signs of pneumonia started at least 48 hours after the previous hospitalization, and patients who had been on mechanical ventilation were excluded from both groups to eliminate other forms of pneumonia (2).

In addition to standard laboratory and radiological examinations, studies were performed to examine thiol/disulfide homeostasis parameters (native thiol [NT], total thiol [TT], disulphide [D]) using the method developed by Erel and Neşelioğlu (8). Details of demographic data and vital signs were prospectively recorded on the patient registration form at bedside. The shock index (SI) value was calculated by dividing the heart rate (HR) by the systolic blood pressure (SBP). Laboratory and radiological examination results were also obtained prospectively using the hospital information management system. CURB-65 (9) and pneumonia severity index (PSI) (10) scores were calculated and also included in the analysis. ICU admission and 30-day mortality rates were analyzed as the primary outcome in the comparison of the NHAP and CAP groups. Additional analyses were performed to determine factors affecting 30-day mortality in the NHAP patient group. Demographic characteristics, vital signs, laboratory parameters, radiological findings, and risk scores of the NHAP and CAP groups were compared as well as mortality and survival groups.

Statistical Analysis

The statistical analysis was performed using SPSS for Windows, Version 16.0 software (SPSS Inc., Chicago, IL, USA). The distribution of the continuous data was assessed using the Shapiro- Wilk Test, a histogram, and a Q-Q plot graph. Normally distributed data were presented as the mean±SD, non-normally distributed data as the median and interquartile range (IQR). In the comparison of 2 independent groups, the Mann-Whitney U test was used for parameters that did not show normal distribution, and an independent samples-t test was used for parameters demonstrating normal distribution. Comparisons of the frequency of categorical data were made using chi-squared analysis and the data were expressed as a percentage. Multiple logistic regression analysis was performed for mortality prediction in the NHAP group. Parameters with a p<0.05 result in the univariate model were included in the multiple logistic regression analysis. Collinearity analysis revealed a strong correlation between the SI and the HR and lactate parameters, therefore, these 2 parameters were excluded from the analysis. Finally, analysis was performed using the chronic heart failure (CHF), SI, and D values. Receiver operating characteristic (ROC) analysis was used to examine the usefulness of parameters in predicting mortality and the results were presented with area under the curve (AUC) and diagnostic statistics. A p level of <0.05 was used to determine statistical significance. The sample size was calculated via preliminary analysis using vital signs, oxidative stress parameters, and the PSI score. At least 36 cases for each of the CAP and NHAP groups would provide 80% power, 5% Type-1 error, and a large effect size (d=1.62) for the D parameter. The number of samples required for other parameters is even less calculated.

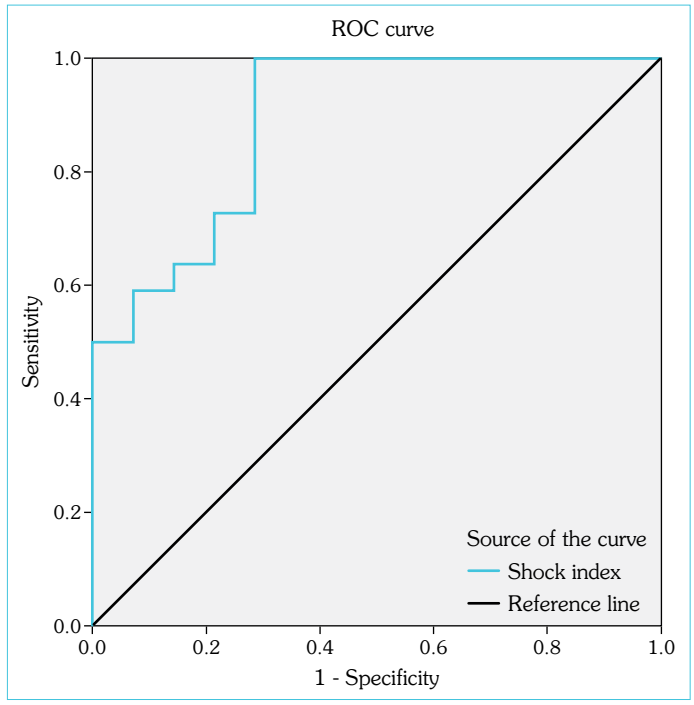

Figure 1. Receiver operating characteristic (ROC) curve for the shock index score in nursing home-acquired pneumonia patients and the prediction of mortality

RESULTS

A total of 98 patients, 62 (63.3%) CAP and 36 (36.7%) NHAP, were included in the study. The ratio of female patients was statistically higher in the NHAP group than in the CAP group (61.1% vs 33.9%; p=0.009). The patient age was also significantly higher in the NHAP group (median: 88.5 vs 76.5; p<0.001). There was no significant difference between the groups in terms of comorbid diseases (Table 1). The radiolog-

Table 1. Analysis of the study patients according to pneumonia type, demographic data, risk scores, and main outcomes

	Pneumonia type				p
	CAP		NHAP		
	n	%	n	%	
All patients	62	63.3	36	36.7	–
Gender					0.009*
Female	21	33.9	22	61.1	
Male	41	66.1	14	38.9	
Age (years)					<0.001†
Median (IQR)	76.5 (65–83)		88.5 (81–91)		
Min.–Max.	22–100		67–95		
DM	16	25.8	4	11.1	0.082*
COPD	19	30.6	5	13.9	0.063*
CKF	16	25.8	4	11.1	0.082*
CHF	20	32.3	18	50.0	0.082*
Malignancy	8	12.9	3	8.3	0.741‡
CVD	7	11.3	4	11.1	1.000‡
Hepatic	0	0.0	1	2.8	0.367‡
Radiological involvement					0.493*
Unilateral	29	63.0	20	55.6	
Bilateral	17	37.0	16	44.4	
Pleural effusion	22	35.5	12	33.3	0.829*
CURB-65					–
5	0	0.0	2	5.6	
4	3	4.8	16	44.4	
3	17	27.4	13	36.1	
2	27	43.5	4	11.1	
1	7	11.3	1	2.8	
0	8	12.9	0	0.0	
CURB-65 risk					<0.001*
High risk	20	32.3	31	86.1	
Moderate risk	27	43.5	4	11.1	
Low risk	15	24.2	1	2.8	
PSI score, Mean±SD	117±38		162±34		<0.001§
PSI stage					–
5	21	33.9	30	83.3	
4	27	43.5	6	16.7	
3	5	8.1	0	0.0	
2	4	6.5	0	0.0	
1	5	8.1	0	0.0	
PSI risk					<0.001*
High risk	21	33.9	30	83.3	
Moderate risk	27	43.5	6	16.7	
Low risk	14	22.6	0	0.0	
ICU admission	18	29.0	32	88.9	<0.001*
28-day mortality	8	12.9	22	61.1	<0.001*

*: Pearson chi-squared test; †: Mann-Whitney U test; ‡: Fisher's Exact test; §: Independent samples-t test; CAP: Community-acquired pneumonia; CHF: Chronic heart failure; CKF: Chronic kidney failure; COPD: Chronic obstructive pulmonary disease; CVD: Cerebrovascular disease; DM: Diabetes mellitus; ICU: intensive care unit; IQR: interquartile range; NHAP: Nursing home-acquired pneumonia; PSI: Pneumonia severity index; Min: Minimum; Max: Maximum

Table 2. Analysis of the study patients according to pneumonia type, vital signs and laboratory findings

	Pneumonia type				p
	CAP		NHAP		
	Median	IQR	Median	IQR	
SBP (mmHg)	126.5	114–140	115.5	97–129.5	0.017*
DBP (mmHg)†	70.7±15.2		66.5±17.1		0.208†
HR (/min)	92.5	85–100	103	84–120	0.058*
Shock index‡	0.76	0.64–0.88	0.90	0.71–1.09	0.004*
RR (/min)	18	14–22	25.5	20–32	<0.001*
BT (°C)	36.8	36.5–37.1	36.4	36–37.1	0.061*
sO_2 (%)	90	84–94	90.5	82.5–95	0.991*
GCS	15	15–15	11	9–13	<0.001*
WBC (x10^9/L)	10.1	7.5–15	11.1	7.3–16.2	0.732*
Platelet (x10^9/L)	197	145–312	254	172–300	0.325*
Htc (%)	39	33–45	39	32.9–41.2	0.297*
Hb (g/dL)†	12.2±2.5		11.4±2.3		0.154†
pH	7.39	7.33–7.44	7.42	7.36–7.49	0.170*
Lactate (mmol/L)	1.9	1.3–2.8	2.1	1.3–4.75	0.279*
Glucose (mg/dL)	129.5	110–172	140	106.5–181	0.997*
BUN (mg/dL)	28.7	18.2–50	39.9	25.7–63.4	0.047*
Creatinine (mg/dL)	1.28	0.84–1.9	1.23	0.8–1.87	0.693*
K (mEq/L)	4.4	4–4.8	4.1	3.5–4.8	0.103*
Na (mEq/L)	136	133–138	141	136.5–149	<0.001*
CRP (g/L)	115	39–235	149	83.8–182.5	0.369*
Pct (µg/L)	0.57	0.16–1.52	0.51	0.19–2.01	0.679*
NT (µmol/L)†	274.3±85.2		196.8±80.6		<0.001†
TT (µmol/L)	299.5	241.2–371.6	218.7	164.7–280.4	<0.001*
D (µmol/L)	17.83	14.25–23.15	12.15	5.25–17.13	<0.001*

*: Mann-Whitney U test, median (IQR); †: Independent samples t- test, mean±SD (DBP, Hb, and NT); ‡: Formula: Shock index=HR/SBP; BT: Body temperature; BUN: Blood urea nitrogen; CAP: Community-acquired pneumonia; D: Disulphide; DBP: Diastolic blood pressure; DM: Diabetes mellitus; GCS: Glasgow Coma Scale; Hb: Hemoglobin; HR: Heart rate; Htc: Hematocrit; IQR: interquartile range; K: Potassium; Na: Sodium; NHAP: Nursing home-acquired pneumonia; NT: Native thiol; Pct: Procalcitonin; PSI: Pneumonia severity index; RR: Respiratory rate; SBP: Systolic blood pressure; sO_2: Oxygen saturation; TT: Total thiol; WBC: White blood cell

ical evaluations were similar between the 2 groups. The PSI score was significantly higher in the NHAP group (162±34 vs 117±38; p<0.001). The PSI and CURB-65 risk assessment results indicated that the risk of mortality was significantly higher in the NHAP group (Table 1). The mortality and ICU admission rates were significantly higher in the NHAP group (Table 1; both p<0.001). When only patients aged ≥65 were evaluated in this respect, the mortality and ICU hospitalization rates were very similar to those of the total group, and the analysis also displayed the same direction (For NHAP and CAP, respectively; mortality: 61.1% vs 12.8%; ICU hospitalization: 88.9% vs 29.8%; both p<0.001).

The SBP and Glasgow Coma Score findings were significantly lower in the NHAP group, and the respiratory rate was high (Table 2). Blood urea nitrogen and sodium levels were also significantly higher in the NHAP group (Table 2). All of the thiol/disulphide homeostasis parameters (NT, TT, and D) were statistically significantly lower in the NHAP group (Table 2).

The NHAP cases were also evaluated separately in 2 groups according to mortality. Among the parameters used in univariate analysis, only CHF was related to mortality; no significant relationship was found between other demographic features and mortality (Table 3). Furthermore, the radiological findings were not associated with mortality. The PSI score was found to be significantly higher in the mortality group (174±34 vs 142±23; p=0.003) (Table 3). The mortality rate was also significantly higher among ICU patients (68.8% vs 0.0%; p=0.017; Table 3).

In the NHAP cases, the SBP was low in the mortality group, while the HR and SI (SI=HR/SBP) were high. Lactate and procalcitonin values were significantly higher in the mortality group (Table 4). No other significant difference was seen among the vital findings and laboratory parameters (Table 4).

Multiple logistic regression analysis was performed to predict mortality among the NHAP cases. Based on the results of the univariate model, CHF, SI, and D variables were included in

Table 3. Analysis of NHAP patients according to mortality, demographics, risk scores, and main outcomes

	28-day mortality				p
	No		Yes		
	n	%	n	%	
All patients	14	38.9	22	61.1	–
Gender					0.275*
Female	7	31.8	15	68.2	
Male	7	50.0	7	50.0	
Age (years)- Median (IQR)	87.5 (83–91)		89 (81–91)		0.625†
DM	1	25.0	3	75.0	1.000‡
COPD	2	40.0	3	60.0	1.000‡
CKF	0	0.0	4	100.0	0.141‡
CHF	3	16.7	15	83.3	0.006*
Malignancy	0	0.0	3	100.0	0.267‡
CVD	2	50.0	2	50.0	0.634‡
Hepatic	0	0.0	1	100.0	1.000‡
ICU admission	10	31.2	22	68.8	0.017‡
Radiology					0.221*
Unilateral	6	30.0	14	70.0	
Bilateral	8	50.0	8	50.0	
Pleural effusion	3	25.0	9	75.0	0.292‡
CURB-65					–
1	1	100.0	0	0.0	
2	3	75.0	1	25.0	
3	5	38.5	8	61.5	
4	4	25.0	12	75.0	
5	1	50.0	1	50.0	
CURB-65 high risk	10	32.3	21	67.7	0.064‡
PSI score- Mean±SD	142±23		174±34		0.003§
PSI stage					
4	5	83.3	1	16.7	0.024‡
5	9	30.0	21	70.0	
PSI risk					0.024‡
Moderate risk	5	83.3	1	16.7	
High risk	9	30.0	21	70.0	

*: Pearson chi-squared test; †: Mann-Whitney U test; ‡: Fisher's Exact test; §: Independent samples t-test; CHF: Chronic heart failure; CKF: Chronic kidney failure; COPD: Chronic obstructive pulmonary disease; CVD: Cerebrovascular disease; DM: Diabetes mellitus; ICU: Intensive care unit; IQR: interquartile range; NHAP: Nursing home–acquired pneumonia; PSI: Pneumonia severity index

the multiple regression analysis. The results indicated that the SI score was an independent predictor of mortality. Mortality increased 3.637 times (95% confidence interval [CI]: 1.024–12.921) for every 0.1 unit increase in the SI (p=0.046; Table 5).

ROC analysis to examine the value of the SI to predict mortality revealed, it was evaluated that the AUC was statistically significant (AUC: 0.890; 95% CI: 0.779–1.000; p<0.001) (Figure 1; Table 6). The SI cutoff levels obtained as a result of this analysis and the diagnostic statistics for these levels are presented in Table 6. The highest Youden index value for the SI was 0.79.

DISCUSSION

In part due to longer lifespans and the increasing size of the elderly population throughout the world, nursing homes and other forms of residential facilities designed for the elderly are becoming more common. There is an established increased risk of infection in communal living areas. Pneumonia, in particular, is one of the most common infections in nursing homes. In cases of NHAP, there are also often factors related to multidrug-resistant bacteria. This, in addition to advanced age and the burden of severe comorbid diseases, contributes to high mortality rates in NHAP (3).

Table 4. Analysis of NHAP patients according to mortality, vital signs, and laboratory findings

	28-day mortality				p
	No		Yes		
	Median	IQR	Median	IQR	
SBP (mmHg)	129.5	122–135	108	90–122	0.004*
DBP (mmHg)†	72.7±17.1		62.5±16.2		0.091†
HR (/min)	84	78–95	117	103–127	0.001*
Shock index‡	0.65	0.59–0.89	1.00	0.89–1.34	<0.001*
RR (/min)	25.5	20–34	25.5	20–31	0.537*
BT (°C)	36.3	36–36.7	36.6	36–37.3	0.280*
sO_2 (%)	90	86–94	90.5	82–96	0.808*
GCS	12	10–15	11	8–13	0.218*
WBC (x10^9/L)	9.6	7.1–13.3	12.9	7.6–17.1	0.355*
Platelet (x10^9/L)	250	172–283	266	169–312	0.770*
Htc (%)	40.2	36.6–41.6	38.3	28.6–40.8	0.135*
Hb (g/dL)†	12±1.9		11.1±2.4		0.242†
pH	7.45	7.42–7.49	7.39	7.34–7.48	0.167*
Lactate (mmol/L)	1.25	1.1–1.5	3.15	2.2–6.2	<0.001*
Glucose (mg/dL)	132	97–158	142	116–187	0.399*
BUN (mg/dL)	37.6	20.3–54.9	39.9	33.2–86.4	0.299*
Creatinine (mg/dL)	1.18	0.8–1.52	1.35	0.8–2.1	0.417*
K (mEq/L)	4	3.3–4.4	4.2	3.6–5	0.372*
Na (mEq/L)	141.5	139–149	140.5	136–151	0.733*
CRP (g/L)	135	55.6–169	151	84.9–231	0.548*
Pct (µg/L)	0.22	0.11–0.98	1.09	0.33–2.53	0.026*
NT (µmol/L)†	195.7±78.7		197.5±83.6		0.974†
TT (µmol/L)†	213.4±78.7		230.8±80.6		0.485†
D (µmol/L)	7.63	3.6–13.45	12.75	7.85–22.2	0.077*

*: Mann-Whitney U test; median (IQR); †: Independent samples t-test, mean±SD; ‡: Formula: Shock index=HR/SBP; BT: Body temperature; BUN: Blood urea nitrogen; CRP: C-reactive protein; D: Disulphide; DBP: Diastolic blood pressure; GCS: Glasgow Coma Scale; Hb: Hemoglobin; HR: Heart rate; Htc: Hematocrit; IQR: Interquartile range; K: Potassium; Na: Sodium; NHAP: Nursing home-acquired pneumonia; NT: Native thiol; Pct: Procalcitonin; RR: Respiratory rate; SBP: Systolic blood pressure; sO_2: Oxygen saturation; TT: Total thiol; WBC: White blood cell

A specific definition of NHAP is a relatively new concept, and studies on this subject are limited in the literature. Our results indicated that high-risk scores and the mortality and ICU rates were higher in the NHAP group than in the CAP group, and that an oxidative stress pathogenesis was more prominent in NHAP patients. When the NHAP group was evaluated separately, the increase in the SI, as an independent risk factor, was found to be associated with increased 28-day mortality.

The effect of oxidative stress on the pathogenesis in CAP cases has been discussed in previous studies and low thiol levels have been associated with high-risk groups. Şener et al. (6) observed that the thiol/disulfide homeostasis parameters (NT, TT, and D) increased in cases of pneumonia, but found no definitive relationship with mortality. In our study, the low levels of thiol compounds, which have antioxidant properties, suggest that oxidative damage may be more prominent in NHAP patients. However, we found no relationship between mortality and NT, TT, and D levels.

A mortality rate of 24% to 40% has been reported in NHAP cases (11–13). There was a serious mortality rate of 61.1% in this study. Ma et al. (12) found that the microbiological etiology of NHAP cases was similar to that of CAP cases and that multidrug-resistant bacteria were not common in NHAP cases. They concluded that NHAP cases should be treated like CAP rather than hospital-acquired pneumonia (HAP). However, considering the difference in NHAP and CAP mortality rates recorded in our study, this assumption would seem to merit more research. Particularly considering that the comorbid disease characteristics of the patients were not statistically significantly different, the difference in mortality rate becomes even more meaningful. In fact, the rate of diabetes mellitus and chronic obstructive pulmonary disease were higher in the CAP group, though without statistical significance. Although the age of the NHAP group was greater, the prognostic results did not change in analysis of patients aged ≥65. In this study, similar to the results reported by Ma et al. (12), there was a significant predominance of female patients in the NHAP group. This may be related to sociocultural characteristics.

Table 5. Multiple logistic regression analysis for mortality prediction

	Univariate analysis				Multivariate analysis			
	B	Wald	Sig.	Exp (B)	B	Wald	Sig.	Exp (B)
Age	0.005	1.824	0.177	1.005 (0.998–1.013)				
Gender (1)	-0.904	1.748	0.186	0.405 (0.106–1.547)				
CHF (1)	1.911	6.594	0.010	6.760 (1.572–29.068)	2.173	2.587	0.108	8.785 (0.622–124.130)
Radiology	0.192	0.754	0.385	1.212 (0.785–1.871)				
Pleural effusion	1.099	2.716	0.099	3.000 (0.812–11.081)				
SBP	0.002	0.451	0.502	1.002 (0.996–1.008)				
DBP	0.004	0.750	0.387	1.004 (0.995–1.014)				
HR	0.007	3.857	0.050	1.007 (1.000–1.013)				
Shock index	0.870	5.618	0.018	2.388 (1.163–4.904)	1.291	3.987	0.046	3.637 (1.024–12.921)
RR	0.014	1.148	0.284	1.014 (0.989–1.039)				
BT	0.013	1.828	0.176	1.013 (0.994–1.031)				
sO_2	0.005	1.652	0.199	1.005 (0.997–1.013)				
GKS	0.027	0.848	0.357	1.028 (0.969–1.090)				
WBC	0.005	0.117	0.732	1.005 (0.977–1.034)				
Plt	0.002	1.753	0.185	1.002 (0.999–1.004)				
Htc	-0.086	1.783	0.182	0.917 (0.808–1.041)				
Hb	-0.180	1.206	0.272	0.835 (0.606–1.152)				
pH	-4.784	1.512	0.219	0.008 (0.000–17.124)				
Lactate	0.429	3.845	0.050	1.535 (1.000–2.356)				
Blood glucose	0.004	2.391	0.122	1.004 (0.999–1.008)				
BUN	0.012	3.288	0.070	1.012 (0.999–1.025)				
Creatinine	0.352	2.581	0.108	1.421 (0.926–2.182)				
K	0.111	1.913	0.167	1.118 (0.955–1.308)				
Na	0.003	1.654	0.198	1.003 (0.998–1.008)				
CRP	0.004	2.58	0.108	1.004 (0.999–1.008)				
Pct	0.104	0.942	0.332	1.109 (0.900–1.367)				
NT	0.002	1.551	0.213	1.002 (0.999–1.005)				
TT	0.002	2.093	0.148	1.002 (0.999–1.005)				
D	0.053	4.288	0.038	1.054 (1.003–1.108)	0.164	2.825	0.093	1.178 (0.973–1.426)
PSI score	0.004	3.364	0.067	1.004 (1.000–1.008)				

a: Variable(s) selected according to p level (<0.05): CHF, shock index (x 10) and D; b: Despite a level p<0.05, HR and lactate were excluded due to collinearity analysis; both strongly correlated with shock index; c: Equation: logit (p) =-12,532 + (1.291 x 10 x shock index). BT: Body temperature; BUN: Blood urea nitrogen; CHF: Chronic heart failure; CRP: C-reactive protein; D: Disulphide; DBP: Diastolic blood pressure; GCS: Glasgow Coma Scale; Hb: Hemoglobin; HR: Heart rate; Htc: Hematocrit; K: Potassium; Na: Sodium; NT: Native thiol; Pct: Procalcitonin; PSI: Pneumonia severity index; RR: Respiratory rate; SBP: Systolic blood pressure; sO_2: Oxygen saturation; TT: Total thiol; WBC: White blood cell

Evaluation of the CURB-65 and PSI scores indicated a larger proportion of high-risk patients in the NHAP group. Given that the NHAP patients in this study were ≥65 years of age and the factor of residing in a nursing home, the CURB-65 assessment starts with 1 point and the PSI assessment starts with 65 points. Therefore, when a patient over the age of 65 who resides in a nursing home arrives at the ED with a pneumonia presentation, it would not be wrong to regard this patient as an ICU candidate in the initial evaluation.

Sankaran et al. (14) noted that the SI can be an important prognostic criterion in CAP even in cases where the HR and blood pressure are within normal limits. They also observed that the SI is associated with left ventricular function and cardiac output, and provides important information in hemorrhagic shock and sepsis and is a valuable parameter in predicting 6-week mortality. To the best of our knowledge, there is no published study that has analyzed the utility of the SI in NHAP. Our findings indicated that the SI value in the NHAP group was significantly different from that of the CAP group. In addition, a high median SI value of 1.0 (IQR: 0.89–1.34) was seen in the mortality group of NHAP patients. In addition, it is noteworthy that all of the patients with an SI score of >1.0116 died. New scoring systems have been described in some recent studies that substitute the SI for SBP and HR alone in the evaluation of hemodynamics

Table 6. Diagnostic statistics for shock index in terms of mortality prediction

Cut-off point	Sen (%)	Spe (%)	PPV (%)	NPV (%)	YI	Acc
0.7385	100.00	64.29	81.48	100.00	0.643	0.861
0.7923	100.00	71.43	84.62	100.00	0.714	0.889
0.8361	95.45	71.43	84.00	90.91	0.669	0.861
0.8946	72.73	78.57	84.21	64.71	0.513	0.750
0.9477	59.09	92.86	92.86	59.09	0.519	0.722
1.0116	50.00	100.00	100.00	56.00	0.500	0.694

Area under the curve=0.890 (0.779–1.000); p<0.001; Acc: Accuracy; NPV: Negative predictive value; PPV: Positive predictive value; Sen: Sensitivity; Spe: Specificity; YI: Youden index

(15, 16). According to our logistic regression analysis and ROC analysis findings, the PSI score, which includes 20 parameters, was not as successful in terms of mortality prediction as the SI, which can be obtained at the time of admission with a simple calculation.

The main limitations of this research are that the study was single-centered and not blinded. The lack of patients <65 years of age or with a low PSI risk class (1-2-3) in the NHAP group may have affected the results; however, this is not unexpected due to the general characteristics of the nursing home resident population. In addition, the microbiological data of the patients were not available and could not be included in the analysis. Finally, another limitation is the small sample count used in chi-squared analyses.

CONCLUSION

When elderly NHAP patients present at the ED, it is necessary to quickly evaluate their candidacy for ICU admission and the mortality risk. The data of this study suggest that the SI may be a reasonable mortality predictor in NHAP patients. Our findings indicated that although oxidative stress was more prominent in NHAP group, these parameters had no significant value as predictors of mortality. Given the ED burden, use of the SI rather than the PSI may be both more effective and more economical in early patient assessment.

Ethics Committee Approval: The Ankara Yıldırım Beyazıt University Clinical Research Ethics Committee granted approval for this study (date: 25.10.2017, number: 194).

Informed Consent: Written informed consent was obtained from patients who participated in this study.

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