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# Factors afffecting the treatment success of patients followed in the intensive care unit with community-acquired pneumonia

**Nihan Çetin, Gülten Arslan[1], Banu Çevik Eler[1]**

**ORCID:**
*Nihan Çetin: https://orcid.org/0000-0002-7872-1794*
*Gülten Arslan: https://orcid.org/0000-0002-8322-5357*
*Banu Çevik Eler: https://orcid.org/0000-0003-2476-4307*

**Abstract:**

**BACKGROUND:** Pneumonia developing in the community is defined as community-acquired-pneumonia (CAP) and causes serious mortality. We aimed to investigate the characteristics and factors affecting the treatment success of severe CAP patients in the intensive care unit (ICU).

**MATERIALS AND METHODS:** Demographic characteristics (age and gender), presence of comorbidity, duration of ICU and intubation, laboratory data, chest X-ray findings, mechanical ventilation (MV) supports, presence of sepsis, septic shock, requirement of inotropic, reintubation, tracheostomy, microbiological etiology in cultures, nutritional characteristics, and mortality of 121 CAP cases who were admitted to our ICU within 4 years were recorded retrospectively. Pneumonia severity index, predisposition, infection, response, organ dysfunction (PIRO), confusion, urea, respiratory rate, blood pressure-Age (CURB-65), and Acute Physiology and Chronic Health Evaluation II (APACHE II) scores were examined.

**RESULTS:** Mortality in male gender was found to be higher ($P$ = 0.009). It was determined that the nonsurvivor patients stayed longer in the ICU ($P$ = 0.006). Mortality rate was higher in patients with bilateral and multilobar infiltration ($P$ < 0.001), pleural effusion ($P$ = 0.001) on chest X-ray, who were admitted to the ICU as intubated ($P$ = 0.01), and who required MV ($P$ < 0.001) and tracheostomy ($P$ = 0.002). Statistically significant relationship was found between duration of intubation ($P$ = 0.01), presence of sepsis ($P$ < 0.001), and septic shock ($P$ = 0.003) on admission to ICU and mortality. Only, a positive correlation between procalcitonin (PCT) and negative correlation between $SaO_2$ ($P$ = 0.03) and pH ($P$ = 0.009), $pO_2$ ($P$ = 0.006) in arterial blood gas from the laboratory values on admission to ICU and mortality was determined.

**CONCLUSIONS:** It was concluded that male gender, intubation, tracheostomy, supports of MV and inotropic, presence of sepsis, septic shock and multilobar, bilateral infiltration and pleural effusion on chest X-ray, low levels of pH, $pO_2$, $SaO_2$, and $SpO_2$ may be factors affecting mortality in CAP patients in the ICU, PCT values, APACHE II, CURB-65, and PIRO scores can be used as a marker to predict mortality.

**Keywords:**

Acute physiology and chronic health evaluation II, confusion, urea, respiratory rate, blood pressure-65, mortality, pneumonia severity index, predisposition, infection, response, organ dysfunction, severity community-acquired pneumonia

*Department of Anaesthesiology and Reanimation, Taksim Training and Research Hospital, University of Health Science, [1]Department of Anaesthesiology and Reanimation, Kartal, Dr. Lütfi Kirdar Training and Research Hospital, University of Health Science, Istanbul, Turkey*

**Address for correspondence:**
Dr. Gülten Arslan, Cevizli Mh., Semsi Denizer Cad, E-5 Karayolu Cevizli Mevkii, 34890 Kartal, Istanbul, Turkey. E-mail: gulten.arslan@yahoo.com.tr

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## Highlights

Serious or severe CAP is the case of pneumonia require admission to the intensive care unit due to shock with a need for vasopressor and/or respiratory failure requiring mechanical ventilation.

Severe community-acquired pneumonia is associated with a very high morbidity and mortality worldwide.

Male gender, intubation, tracheostomy, invasive mechanical ventilation, presence of sepsis, septic shock and multilobar involvement, bilateral infiltration, pleural effusion on chest X-ray, inotropic support, low levels of pH, $pO_2$, $SaO_2$ in arterial blood gas and $SpO_2$ on admission to ICU, and increased procalcitonin values are thought to be the factors affecting the mortality.

PIRO is the most helpful and valuable prediction rule in assessing illness severity.

## Introduction

Pneumonia is responsible for a significant part of hospital admissions, treatment expenses, and school-workday losses worldwide and causes serious morbidity and mortality.[1] Pneumonia that develops in the community and during daily life is defined as community-acquired pneumonia (CAP). Today, deaths from infectious diseases are gradually decreasing as a result of widespread use of antibiotics, whereas CAP is still the cause of high mortality. While the mortality rate in outpatients is 1%–5%, this rate can reach up to 12% in patients treated in hospital and 40%–50% in patients requiring intensive care unit (ICU) support.[2]

Serious or severe CAP (SCAP) is defined as cases that should be treated in ICU due to shock requiring vasopressor and/or acute respiratory failure requiring mechanical ventilation (MV).[3] Risk factors that facilitate and increase the occurrence and mortality and criteria that required for admission to ICU for this disease with high incidence and mortality were defined. These include the updated American Thoracic Society (ATS) Criteria (2007), Confusion, Urea, Respiratory Rate, Blood Pressure-Age (CURB-65), and Pneumonia Severity Index (PSI), which is the severity assessment score recommended by the British Thoracic Society (BTS).[2,4] ATS published major and minor criteria for admission to ICU in 2007.[2] Major criteria for the diagnosis of CAP include the need for invasive MV (IMV), septic shock that requires vasopressor. Minor criteria are defined as hypotension requiring intensive fluid therapy, respiratory rate $\geq$30/min, $PaO_2/FiO_2 \leq$250, multilobar infiltration, confusion-orientation disorder, uremia (BUN $\geq$20 mg/dl), leukopenia (leukocyte <4000/$mm^3$), thrombocytopenia (platelet <100,000/$mm^3$), hypothermia (body temperature < 36°C). BTS determined three main criteria, including uremia, respiratory rate, and blood pressure, which significantly increased mortality in 1987. CURB-65 scoring was created by adding mental status and age to these criteria in the following years.[4] Rello *et al*. reported that there was a strong correlation between increased "Predisposition," "Infection," "Response," "Organ Dysfunction" (PIRO) score and MV requirement, ICU duration and mortality of SCAP patients in their studies, and they reported that they predicted 28-day mortality better than Acute Physiology and Chronic Health Evaluation II (APACHE II), and ATS/Infectious Diseases Society of America criteria.[5]

In this retrospective, observational, cohort study, we aimed to investigate the characteristics, factors affecting the treatment success, and mortality in patients with SCAP patients who were admitted to our ICU, whose data can be accessed completely with the electronic system.

### Outcome measures

The primary outcome is to determine the factors affecting their mortality to guide the studies carried out to reduce mortality in SCAP cases admitted to the ICUs. The secondary outcome is to evaluate the performance of scoring systems that can be used to predict the mortality in cases of SCAP.

## Methods and Participants

### Ethics statement

This study was approved by the Ethical Committee of our university hospital (ethics committee decision no: 2017/514/115/1) and was in accordance with the revised declaration of Helsinki. Due to the retrospective nature of the study, written informed consent was not obtained from the participants.

### Study population

In this retrospective study, 121 cases who were admitted to our hospital within 4 years, diagnosed SCAP with clinical findings of lower respiratory tract infection (cough, sputum, fever, abnormal leukocyte count, chest pain, and consolidation findings on physical examination), presence of infiltration on the chest X-ray and transferred from emergency or services to ICU within the first 24 h and followed up in the ICU, and whose records can be accessed from archive files, computer system, and death records were evaluated.

### Definitions

SCAP defined as including a major (IMV require, septic shock requiring vasopressor) or two or more minor criteria (respiratory rate $\geq$30/min, $PaO_2/$

$FiO_2 \leq 250$, multilobar infiltration, confusion-orientation disorder, uremia, leukopenia, thrombocytopenia, and hypothermia) with the diagnosis of CAP.

### Exclusion criteria

Patients who developed pneumonia during hospitalization, admitted to the ICU after more than 24 h, those under the age of 18, pregnant women, immunosuppressed patients such as malignant, chemotherapy, radiotherapy or high-dose corticosteroid intake, and HIV positivity were excluded from the study.

### Data collection and evaluation

Demographic characteristics (age and gender), presence of comorbidity (hypertension, diabetes mellitus, chronic obstructive pulmonary disease [COPD], etc.), duration of intubation and ICU, laboratory data (hematocrit, white blood cell [WBC], C-reactive protein [CRP], procalcitonin [PCT], and arterial blood gas [ABG] data [pH, $pCO_2$, $pO_2$, and $SaO_2$]), fingertip peripheral oxygen saturations ($SpO_2$), chest X-ray findings (number of lung lobe involvement and pleural effusion) on the admission to the ICU, MV supports (non-IMV), presence of sepsis, septic shock, requirement of inotropic, re-intubation and tracheostomy, and mortality rates were recorded. The results of tracheal aspirate culture from the sputum sample or endotracheal aspirate and blood culture on admission to ICU to identify the microbiological etiology, and nutritional characteristics (enterally and parenterally) were added to the data. In addition, PSI, PIRO, CURB-65, and APACHE II scores of the cases were calculated and recorded.

### Statistical analysis

The demographic characteristics and collected data of the patients were introduced to IBM® SPSS® (the Statistical Package for the Social Sciences, IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp) Statistics software version 25. Variables were characterized using mean, maximum and minimum values, and percentage values were used for the qualitative variables. Normal distributions were reported as mean ± standard deviation and Student's *t*-test was used for comparisons between groups. Pearson Chi-square test was used for the analysis of qualitative variables, and if the group was small, the Fisher's exact test was used. Nonparametric continuous variables were recorded as median and intermittent distribution and compared using the Mann–Whitney *U*-tests. $P < 0.05$ was considered statistically significant. Independent risk factors were determined by evaluating the results that were significant in the multiple and single variable analysis. The reliability of the scoring systems in predicting the prognosis was examined with receiver-operating characteristic (ROC) curves and the area under the curve (area under curve = AUC) was evaluated.

The data for Kaplan–Meir analysis were entered in MedCalc ® version 12.2.1.0. Cutoff values were determined for those who were found to be significantly effective in determining mortality from scoring systems with ROC analysis. Sensitivity and specificity were calculated for these values. Then, using these values, patients with high and low scores were determined, and 60-day survival was compared with Kaplan–Meir analysis. Hazard ratios have been determined.

## Results

The results showed that the mean age of 121 patients admitted to the ICU with SCAP was 71.1 ± 17.1 years (22–98 years). It was determined that a total of 31 (25.6%) had discharged, whereas others were died ($n = 90$; 74.4%). The mean age of the nonsurvivor was 72.1 ± 16.6 years, and survivors were 68.2 ± 18.5 years, and the difference was not statistically significant ($P = 0.283$). The relationship between gender, comorbidity and previous hospitalization history, and mortality is shown in Table 1.

A statistically significant correlation was found between the duration of ICU and intubation and mortality ($P = 0.006$, $P = 0.01$). It was determined that the longer the periods, the higher the mortality [Table 2].

The relationship between the type of admission to ICU and MV necessity and mortality of 121 patients whom are diagnosed with SCAP are shown in Table 1. It was determined that five (4.5%) patients with IMV had reintubation needs. There was no significant relationship between reintubation and mortality ($P = 0.976$).

The relationships between presence of sepsis, septic shock, requirement of tracheostomy and inotropic, radiological findings on the admission to ICU, and mortality are shown in Table 1.

It was found that 54.5% ($n = 66$) of 121 patients were fed enterally, 27.3% ($n = 33$) parenterally, and 18.2% ($n = 22$) both enterally and parenterally in the ICU follow-ups and their mortality was determined as 81.8%, 63.6%, and 68.2%, respectively. As a result, it was observed that the type of nutrition was not effective on mortality ($P = 0.113$).

The microbiological etiology was identified in tracheal culture in 28 (23.1%) and in blood culture in 12 (9.87%) of 121 patients. The number of patients who were found to be microbiological etiology in both tracheal and blood culture was 4 (3.3%). While the mortality rate was 88.9% in patients with microbiological etiology detected in tracheal culture, it was 70.2% in those who could not be identified. These rates were observed as 80% and 73.9% in blood culture, respectively,

**Table 1: The relationship between gender, comorbidity, previous hospitalization history, radiological findings, type of admission to intensive care unit, mechanical ventilation necessity, presence of sepsis, septic shock, requirement of inotropic and tracheostomy and mortality**

| | *n* (%) | Mortality (%) | *P* |
|---|---|---|---|
| Sex | | | |
| Male | 71 (58.7) | 83.1 | 0.009 |
| Female | 50 (41.3) | 62.0 | |
| Comorbidity | | | |
| No | 9 (7.4) | 88.9 | 0.445 |
| Yes | 112 (92.6) | 73.2 | |
| Previous hospitalization history | | | |
| No | 13 (10.7) | 84.6 | 0.371 |
| Yes | 108 (89.3) | 73.1 | |
| Radiological findings | | | |
| Multilobar involvement | 17 (14.06) | 94.1 | <0.001 |
| Bilateral involvement | 61 (50.41) | 85.2 | |
| Unilateral involvement | 43 (35.5) | 51.2 | |
| Pleural effusion | 37 (30.5) | 94.6 | 0.001 |
| Type of admission to ICU | | | |
| Intubated | 105 (86.5) | 78.2 | 0.01 |
| Nonintubated | 16 (13.5) | 50.0 | |
| Mechanical ventilation necessity | | | |
| IMV | 101 (83.5) | 82.2 | <0.001 |
| NIMV | 9 (7.4) | 11.1 | |
| Combined (IMV+NIMV) | 11 (9.1) | 54.5 | |
| Sepsis | | | |
| Yes | 50 (41.3) | 98.0 | <0.001 |
| No | 71 (58.7) | 57.7 | |
| Septic shock | | | |
| Yes | 27 (22.3) | 96.3 | 0.003 |
| No | 94 (77.7) | 68.1 | |
| Requirement of inotropic | | | |
| Yes | 27 (22.3) | 96.3 | 0.003 |
| No | 94 (77.7) | 68.1 | |
| Requirement of tracheostomy | | | |
| Yes | 21 (17.4) | 100 | 0.002 |
| No | 100 (82.6) | 69 | |

ICU: Intensive care unit, IMV: Invasive mechanical ventilation, NIMV: Noninvasive mechanical ventilation

and no statistically significant relationship between determining the microbiological etiology in cultures and mortality ($P = 0.102$, $P = 0.671$). The most common microbiological etiology in tracheal culture was Acinetobacter (6.61%), Pseudomonas (6.61%), followed by *Escherichia coli* (2.47%), *Staphylococcus (S) aureus* (2.47%), Klebsiella (2.47%), Candida (0.82%), *Hemophilus influenza* (0.82%), Moraxella (M) Catarrhalis (0.82%), respectively. In blood culture, the most common microbiological etiology was *Enterococcus faecalis* (2.47%), followed by *S. aureus* (1.65%), *Staphylococcus epidermidis* (1.65%), *Acinetobacter baumanii* (0.82%), Candida (0.82%), *Stenotrophomonas maltophilia* (0.82%), *Staphylococcus haemolyticus* (0.82%), and *Staphylococcus warneii* (0.82%), respectively.

The biomarkers checked on the admission to the ICU are shown in Table 2. It was determined that only PCT was significant (AUC = 0.657 [$P < 0.009$, 95% confidence interval (CI): 0.544–0.770]) when the reliability of laboratory findings in predicting mortality was evaluated with ROC curves.

The fingertip $SpO_2$, ABG findings and APACHE II, CURB-65, PIRO, and PSI scores measured on the admission of patients to the ICU and their relationship with mortality are shown in Table 2.

When the reliability of the scoring systems in predicting mortality was evaluated by ROC curves, PIRO has the best performance (AUC = 0.815 [$P < 0.001$, 95% GA: 0.733–0.896]), followed by APACHE II (AUC = 0.787 [$P < 0.001$, 95% GA: 0.696–0.877]) and CURB-65 (AUC = 0.706 [$P = 0.001$, 95% CI: 0.601–0.810]), respectively. PSI's performance in predicting mortality was close to the statistical level, but it was found to be poor compared to other scoring systems (AUC = 0.606 [$P = 0.08$, 95% CI: 0.483–0.728]). The evaluation of the reliability of scoring systems in predicting mortality with ROC curves is shown in Figure 1.

The threshold values determined for CURB65, PIRO and APACHE-II, and the corresponding sensitivity and specificity values are shown in Figure 1. The 60-day survivals of the groups are shown in Figure 2.

When multivariate analysis was performed, MV application ($P < 0.001$), presence of sepsis ($P < 0.001$), septic shock state ($P = 0.001$), unilateral pneumonia ($P = 0.001$), presence of pleural effusion ($P = 0.009$), pO2 low ($P = 0.01$), and inotropic use were found to be independent risk factors for the prognosis.

## Discussion

SCAP is a lower respiratory tract infection that still constitutes a significant part of adult ICU admissions and causes serious mortality. In our study, we investigated the characteristics, mortality rates, and factors affecting the treatment success of the patients followed up in ICU with the diagnosis of SCAP. The mortality rate of 121 patients who were followed up in the ICU with the diagnosis of SCAP was 74.4% ($n = 90$). In a retrospective study conducted by Erdem *et al*.,[6] the mortality of 445 patients diagnosed with CAP was determined as 31.2%, while other researchers reported this rate as 43%, 55%, and 57.6%, respectively.[7-9] As we observed from the results of the researchers, mortality rates were stated quite differently. 10% of the cases with CAP diagnosis require admission to the ICU. However, ICU indications may also vary depending

**Table 2: The relationship between duration of intensive care unit and duration of intubation, laboratory findings, fingertip $SpO_2$, scoring systems and mortality**

| | Mean±SD | | *P* |
|---|---|---|---|
| | Nonsurvivor (*n*=90) | Survivor (*n*=31) | |
| Duration of ICU (days) | 24.1±26.5 | 11.6±12.0 | 0.006 |
| Duration of intubation (days) | 23.5±26.2 | 10.6±11.1 | 0.01 |
| Htc (%) | 33.3±7.4 | 33.5±6.0 | 0.867 |
| WBC ($10^3$/ml) | 13758±8186.9 | 11961.9±4979.9 | 0.253 |
| CRP (mg/dl) | 170.3±99.1 | 142.8±86.9 | 0.173 |
| PCT (mcg/l) | 5.7±9.5 | 3.7±9.7 | 0.335 |
| pH | 7.33±0.1 | 7.41±0.1 | 0.009 |
| $pCO_2$ (mmHg) | 44.0±11.9 | 39.7±10.4 | 0.07 |
| $pO_2$ (mmHg) | 82.3±41.7 | 113.7±78.5 | 0.006 |
| $SaO_2$ (%) | 91.2±7.8 | 94.5±5.6 | 0.03 |
| Fingertip $SpO_2$ (%) | 91.5±8.5 | 95.2±5.0 | 0.02 |
| APACHE II | 27.3±5.6 | 21.6±4.9 | <0.001 |
| CURB-65 | 3.4±1.0 | 2.5±1.1 | <0.001 |
| PIRO | 2.7±1.1 | 1.4±0.7 | <0.001 |
| PSI | 4.7±0.7 | 4.4±0.8 | 0.075 |

ICU: Intensive care unit, APACHE II: Acute physiology and chronic health evaluation II, CURB-65: Confusion, urea, respiratory rate, blood pressure, PIRO: Predisposition, infection, response, organ disfunction, PSI: Pneumonia severity index, WBC: White blood cell, CRP: C-reactive protein, PCT: Procalcitonin, SD: Standard deviation

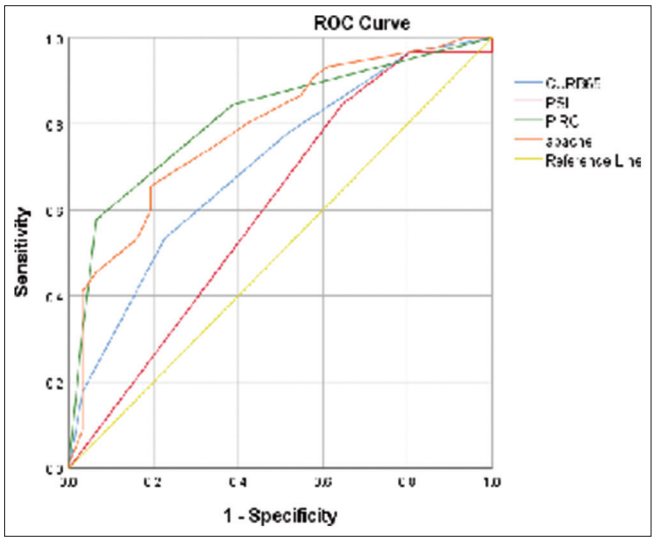


**Figure 1:** Evaluation of scoring systems in predicting mortality with receiver operating characteristic curves

on physicians, hospital location, physical conditions, and many other factors. Our hospital is in Istanbul, the most crowded and industrialized city of our country. It is a university hospital with its location on the main connections of the city, easy to access, accepting patients from outside the city, accommodating all clinics and many treatment methods offered by modern medicine, and therefore, it is regarded as a source of hope and acceptance even for the end-stage patients in every branch. We think that the main reason for the higher mortality rate in our study compared to other researchers may be that the majority of our patients were admitted to the ICU as intubated and they required long-term IMV. Therefore, it can be said that at least some of our patients are clinically very severe on admission to the hospital.

In the retrospective study of Cabre *et al*.,[10] which included 1191 CAP patients, it was stated that the mortality rate was 11.9% in the 65–84 years' age group, 20.7% in the age group over 84, and advanced age was associated with increased mortality. Khawaja *et al*.[11] reported that 54% of the patients over 65 years of age with SCAP who were admitted to the ICU non-survived, 52% survived, the difference was not statistically significant and no relationship between advanced age and mortality in accordance with the results of our study. Studies have shown that CAP is more common in men, need for hospitalization and ICU, and mortality are higher, and male gender is associated with the poor prognosis.[12,13] In the study of Angele *et al*.,[14] it has been reported that cellular immunity in women is more developed than men, and female sex steroids protect the immune system in trauma and sepsis. In our study, it was determined that 71 (58.7%) of the patients were male, 50 (41.3%) were female, and it was observed that 31 (62%) of female patients and 59 (83.1%) of male patients dead. Similar to the literature, the mortality in men was found to be higher in our study, and it was statistically significant. We also think that the reason for this may be due to the more developed immunity in women.

It has been reported that death develops in the first 30 days after the diagnosis in 25%–50% of SCAP patients requiring ICU and the cause of death is generally associated with comorbid diseases.[15] When the literature is reviewed, COPD is the most common comorbid

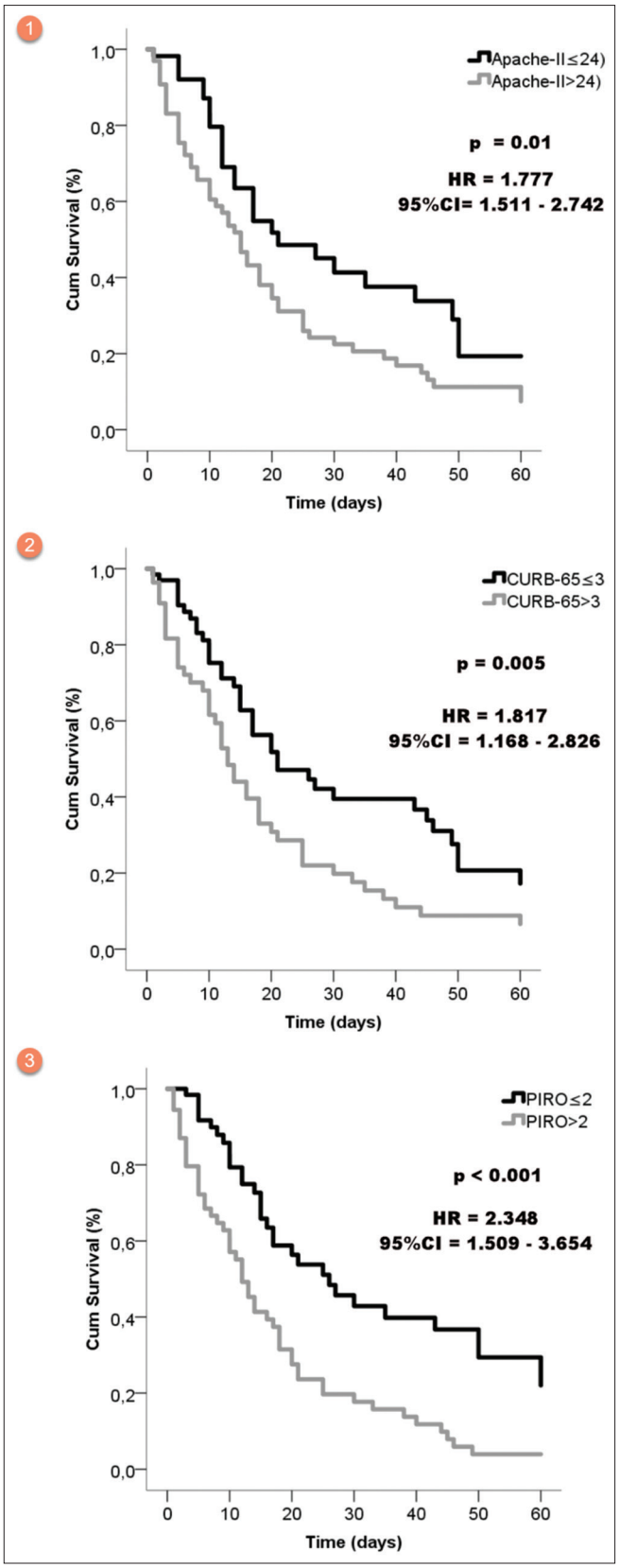


**Figure 2:** 60-day survival rates of groups

disease, followed by hypertension, heart failure, diabetes, cerebrovascular disease and malignancy. Studies show that 33.3%–54% of CAP patients and 79.2%–82% of SCAP patients requiring ICU had comorbid diseases.[16] In the study of Gutierrez *et al*.,[17] comorbidity rate was found to be 53.7% and it was stated that mortality was significantly higher in those with at least one comorbid disease. In our study, at least one comorbid disease was found in 92% of patients, but no effect of the presence of comorbidity on mortality was observed as in accordance with the results of Khawaja *et al*.[11] and Tudose *et al*.[18]

Chest X-ray is very useful in patients with CAP in diagnosis, in the differential diagnosis of pneumonia, assessing the severity of the disease and controlling the effectiveness of treatment. The mortality was higher in patients with multilobar involvement and it was shown that the severity of the disease increased in these patients in the most of clinical studies.[17,19] In our study, it was found that multilobar involvement was the least seen in the radiological evaluation of patients, but the mortality was the highest in accordance with the results of the researches. In addition, in our study, it was determined radiologically that bilateral involvement was observed the most similar to the results of Paganin *et al*.,[7] there was a significant relationship between bilateral involvement and mortality in accordance with the results of Erdem *et al*.,[6] different than Paganin *et al*.[7]

The presence of pleural effusion has been observed in different rates in the literature. Although it was reported between 1.7% and 37%, the presence of parapneumonic effusion was found to be 30.5% in our study, similar to the study of Khawaja *et al*.,[11] and it was determined that the presence of pleural effusion was effective on mortality.

The necessity of IMV and the presence of septic shock is one of the determining factors for admission to ICU in patients with SCAP.[20] The presence of shock and inotropic use in patients who are admitted to ICU according to the ATS criteria are also indicators of poor prognosis.[3] When we scan the literature, there are studies with different results regarding the relationship between IMV use and mortality. It has been reported that 37%–60% of patients admitted to ICU may require IMV, and IMV use and the presence of septic shock are associated with increased ICU mortality in most publications.[8,20] Similar results were obtained in our study, and a significant relationship was found between admission to ICU as intubated and administration of IMV and mortality. At the same time, in our study, septic shock was detected in 22.3% of the patients, and mortality was 96.3% in these patients. As a result, it was observed that the presence of sepsis and septic shock and the use of inotropic increased mortality. Khawaja *et al*.[11] stated that they did not find a significant relationship between the use of MV and mortality in their study

including SCAP cases, they reported that only septic shock was independently associated with mortality.

In our study, no significant relationship was found between CRP values and mortality, while a significant relationship between PCT values and mortality were determined. Different results have been observed in the literature on this subject. Chalmers *et al*.[21] stated that having a CRP value below 100 mg/l at hospital admission reduces 30-day mortality, necessity of MV and/or inotropic and the risk of complicated pneumonia, and can be considered as an independent marker in CAP. Vught *et al*.[22] reported that there may be no CRP response despite severe disease in accordance with our study. Que *et al*.[23] stated that mortality increased even with low CRP values (<169.5 mg/l), and they did not find a significant relationship between PCT values and mortality. In the study including four prospective multicenter adult pneumonia cases,[24] 11 risk factors were found on admission to ICUs; male gender, age under 80, at least one comorbid disease, Respiratuvar Rate >30/min, WBC < 4000/mm$^3$ or >20,000/mm$^3$, Heart Rate >125/min, presence of multilobar involvement or pleural effusion, $SaO_2$ <90% or $pO_2$ <60 mmHg, pH <7.35 in ABG, Na <130 mmol/L, BUN >20 mg/dl. Similarly, in our study, it was observed that values of $SaO_2$, pH and $pO_2$ in ABG taken on admission to the ICU were statistically different between non-survivor and survivor. In the study conducted by Mirsaeidi *et al*.[25] on patients with CAP, it was found that the platelet count was associated with 30-day mortality, but they did not find a relationship between WBC count and mortality. In our study, it was found that WBC values were not significant in predicting the severity of pneumonia and mortality, in accordance with the studies of Mirsaeidi *et al*.,[25] but unlike them, the PCT elevation was significant.

When the reliability of scoring systems in predicting prognosis was evaluated, it was determined that PIRO had the best performance. Consistent with our results, in studies conducted with ICU patients, Erdem *et al*.[6] reported that only 1 point increase in PIRO score caused 1.9 times increase in mortality, Rello *et al*.[5] observed that the PIRO score of 4 and above increased mortality. In the study of Aydoğdu *et al*.,[8] pneumonia scoring systems (ATS criteria, CURB-65, PSI) and ICU scoring systems (APACHE II, Sequential Organ Failure Assessment) were compared to predict mortality of patients with SCAP who needed MV and only the APACHE II score (>20 points) was evaluated as an independent predictor of mortality. In our study, APACHE II score as similar to the study of Aydoğdu *et al*.,[8] the CURB-65 score as similar to the study of Tudose *et al*.,[18] were found to be statistically significant in predicting mortality.

The diagnosis and treatment of CAP is started by the evaluating the clinical, laboratory and radiological findings together, and no microbiolaogical etiology agent cannot be detected in more than half of the cases. Therefore, treatment is often. The most frequently identified pathogens in studies on CAP in the literature were *Streptococcus pneumoniae*, *Haemophilus influenzae* and *Moraxella catarrhalis*. In a multicentric study by Köksal *et al*.,[26] 137 (62.8%) of 218 patients with CAP have been found to have microbiolaogical etiological agents and the most frequently detected agents were reported as *S. pneumoniae*, *Mycoplasma pneumoniae* and Respiratory syncytial virus. Fidan *et al*.[27] detected microbiolaogical etiology agents at a rate of 7% in sputum culture and 4% in blood culture in their study and reported that *S. pneumoniae* was the leading microbiolaogical etiology agent. In our study, 22.3% of the microbiolaogical etiology agents were found in the trachea culture and 8.2% in the blood culture, and the superiority of the detected agents to each other in terms of mortality was not determined. We think that the low number of patients included in the study is also effective in these results.

In our literature searches, studies investigating the effects of nutrition, tracheostomy and re-intubation on mortality in patients with SCAP could not be found. However, there are many studies investigating the effects of these parameters on mortality in patients admitted to ICU.

Protein energy malnutrition leads to complications such as nosocomial infection and multiple organ failure, leading to an increase in both the duration of ICU and an increase in morbidity and mortality. Although it is known that early enterally feeding provides a reduction in the duration of hospitalization, MV, infection, multiple organ failure, and thus mortality in ICU patients,[25] Uysal *et al*.[28] found that enterally feeding was effective in the development of ventilator-associated pneumonia. In the same study, parenterally nutrition has been shown to increase opportunistic microorganism colonization and the infection risk. Çolpan *et al*.[29] determined the enterally nutrition as a risk factor for mortality in their study where they determined the mortality rate as 46.7%. In our study, it was found that enterally, parenterally, and combined (enterally + parenterally) nutrition did not correlate with mortality.

Many researchers[29,30] reported that tracheostomy increases the risk of nosocomial infections and mortality. In our study, we determined a significant relationship between tracheotomy and mortality, and this may be due to the longer stay in ICU of patients who underwent tracheostomy.

The need for re-intubation could develop in 10%–20% of cases following planned extubation of general ICU

patients. Bacakoğlu *et al*.[30] included re-intubation and tracheostomy as leading risk factors for the development of multiple antibiotic-resistant hospital infections in their study and found that these factors had an effect on mortality. In our study, unlike the literature, re-intubation had no effect on mortality. We think that the low number of re-intubated cases in our study may be related to this.

### Limitations

Our results have some limitations: First, this was a retrospective study and represented of a single center. Further studies including multicenter studies concerning more cases are needed to confirm the pneumonia scoring systems, for the prediction of mortality in CAP. Second, we included the cases which admitted to the ICU within 24 h after admission to our hospital. Hence, these scoring systems were not evaluated in the patients admitted to ICU after the first 24 h during the hospitalization of the patients. This issue may be a subject to another study.

## Conclusions

It was concluded that, among the parameters evaluated in our study such as male gender, intubation, tracheostomy, application of IMV, the presence of sepsis, septic shock, multilobar, bilateral infiltration and pleural effusion on chest radiography, inotropic support, low $SaO_2$, pH, $pO_2$, $SpO_2$ value, may be the factors affecting mortality in CAP patients followed in the ICU, and the PCT increase, APACHE II, CURB65, and PIRO scores can be used as markers for predicting mortality. In addition, we think that new interventions and measures to reduce mortality can guide in future research.

### Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

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