



## ASSOCIATION BETWEEN SEPSIS AND MORTALITY AMONG PATIENTS WITH PNEUMONIA ADMITTED TO THE INTENSIVE CARE UNIT

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### ABSTRACT

Pneumonia is one of the leading causes of morbidity and mortality worldwide, particularly among patients admitted to the Intensive Care Unit (ICU). This condition is often associated with sepsis, which can worsen prognosis and increase the risk of death. This study aimed to determine the association between demographic characteristics, length of stay, sepsis, and qSOFA score with mortality among pneumonia patients admitted to the Intensive Care Unit. This study was an analytical observational study with a retrospective cohort design using medical record data of pneumonia patients admitted to the ICU at Adam Malik General Hospital Medan. A total of 74 patients who met the inclusion and exclusion criteria were included. Data were analyzed using univariate and bivariate analyses with Chi-square and Fisher's exact tests. Statistical significance was set at  $p < 0.05$ , and the strength of association was measured using Odds Ratio (OR) with a 95% confidence interval. Most patients were aged 56–65 years and >65 years, each accounting for 25.7%, and were predominantly male (59.5%). The most common comorbidity was kidney disease (AKI/CKD) at 33.8%. The mean length of ICU stay was  $13.81 \pm 7.97$  days. Mortality among pneumonia patients with sepsis was 75.7%. There was no significant association between sex and mortality ( $p=0.698$ ) or age and mortality ( $p=0.247$ ). A significant association was found between length of ICU stay and mortality ( $p=0.029$ ). In addition, qSOFA score was significantly associated with mortality ( $p=0.004$ ), with an OR of 5.409 (95% CI: 1.575–18.577). Length of stay, sepsis, and qSOFA score were significantly associated with mortality among pneumonia patients in the ICU, while demographic characteristics showed no significant association.

Keywords: intensive care unit; mortality; pneumonia; sepsis

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## INTRODUCTION

Pneumonia remains one of the leading causes of infection-related morbidity and mortality worldwide, particularly among patients admitted to the Intensive Care Unit (ICU). According to the Global Burden of Disease 2019 report, lower respiratory tract infections continue to rank among the leading causes of death globally. Despite significant advances in diagnostic modalities and therapeutic interventions, severe pneumonia is still associated with a high mortality rate, ranging from 20% to 50% (Xie et al., 2024). Pneumonia is also frequently associated with sepsis, a condition that significantly worsens prognosis and increases the risk of death (Harsini et al., 2024; Purba et al., 2020).

Sepsis is defined as a life-threatening organ dysfunction caused by a dysregulated host response to infection and remains one of the major causes of mortality worldwide (Prest et al., 2022; Madkour et al., 2022). Pneumonia is the most common source of infection leading to sepsis among ICU patients. The coexistence of pneumonia and sepsis is associated with prolonged hospitalization, increased healthcare costs, and higher mortality rates. Furthermore, patients with severe sepsis or septic shock often require mechanical ventilation, which subsequently increases the risk of developing ventilator-associated pneumonia (VAP) (Darkwah et al., 2024).

Several studies have identified advanced age, kidney disease, septic shock, and acute respiratory distress syndrome (ARDS) as factors associated with poor outcomes in ICU patients with pneumonia. However, evidence regarding factors influencing mortality among pneumonia patients in the ICU remains limited and has yielded inconsistent findings (Prest et al.,2022 ; Li et al.,2016). In Indonesia, particularly in North Sumatra, data concerning mortality among patients with pneumonia-associated sepsis are still scarce. Previous studies have demonstrated that the lungs are the primary source of infection in septic patients and are strongly associated with increased mortality (Fataya et al.,2023; Fadrian et al.,2025; Ren et al.,2022; He et al.,2016).

In clinical practice, a rapid and simple screening tool is required to identify patients at a higher risk of death. The Quick Sequential Organ Failure Assessment (qSOFA) score is widely used because it consists of only three clinical parameters: altered mental status, respiratory rate, and systolic blood pressure. A qSOFA score of  $\geq 2$  has been shown to be associated with an increased risk of mortality and may serve as an effective early screening tool for patients with suspected sepsis (Freud et al.,2017; Seymour et al.,2016). Although its sensitivity is lower than that of the full SOFA score, qSOFA remains clinically valuable because it is easy to apply and does not require laboratory testing (Jain et al., 2023). To analyze the association between various risk factors and mortality among patients with pneumonia-associated sepsis admitted to the Intensive Care Unit at Adam Malik General Hospital, Medan.

## **METHOD**

### **Study Design and Participants**

This analytical observational study employed a retrospective cohort design and was conducted in the Intensive Care Unit (ICU) of Adam Malik General Hospital, Medan. Data were obtained from the medical records of patients diagnosed with pneumonia and admitted to the ICU during the study period. Participants were selected using a total sampling method based on predefined inclusion and exclusion criteria. Samples were selected to represent the study population using a non-probability sampling technique, specifically convenience sampling. A total of 74 patients with pneumonia who met the eligibility criteria were included in the analysis.

The inclusion criteria comprised patients aged  $\geq 18$  years with a diagnosis of pneumonia who were admitted to the ICU and had complete medical records. Patients with incomplete clinical data or those who did not meet the diagnostic criteria were excluded from the study. Ethical approval for the study was obtained from the Health Research Ethics Committee of the Faculty of Medicine, Universitas Sumatera Utara, and Adam Malik General Hospital, Medan with letter number 91/KEPK/USU/2026.

### **Study Variables**

The dependent variable in this study was in-hospital mortality during ICU admission, categorized as either survived or deceased. Independent variables included demographic characteristics (age and sex), comorbidities, length of ICU stay, the occurrence of sepsis, and the Quick Sequential Organ Failure Assessment (qSOFA) score. Age was categorized according to the distribution of the study population, while qSOFA scores were classified into two groups: qSOFA score of 2 and qSOFA score of 3.

### **Statistical Analysis**

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) software. Univariate analysis was performed to describe the characteristics of the study population. Categorical variables were presented as frequencies and percentages, whereas continuous variables were expressed as mean  $\pm$  standard deviation (SD), minimum value, and maximum value.

Bivariate analysis was conducted to evaluate the association between independent variables and mortality among patients with pneumonia admitted to the ICU. Associations between sex, age group, length of ICU stay, and qSOFA score with mortality were assessed using the Chi-square test. The strength of association was expressed as Odds Ratios (ORs) with corresponding 95% Confidence Intervals (95% CIs). A p-value of <0.05 was considered statistically significant.

## RESULT

### Demographic Characteristics of the Study Population

A total of 74 patients with pneumonia-associated sepsis admitted to the Intensive Care Unit (ICU) were included in this study. More than half of the patients were aged  $\geq 56$  years (51.4%), with the largest age groups being 56–65 years and >65 years, each accounting for 25.7% of the study population. Regarding sex distribution, the majority of patients were male (59.5%) (Table 1).

**Table 1. Demographic Characteristics of the Study Population**

| Demographic Characteristics | Frequency (n = 74) | Percentage (%) |
|-----------------------------|--------------------|----------------|
| <b>Age</b>                  |                    |                |
| 18–25 years                 | 7                  | 9.5            |
| 26–35 years                 | 5                  | 6.8            |
| 36–45 years                 | 11                 | 14.9           |
| 46–55 years                 | 13                 | 17.6           |
| 56–65 years                 | 19                 | 25.7           |
| >65 years                   | 19                 | 25.7           |
| <b>Sex</b>                  |                    |                |
| Male                        | 44                 | 59.5           |
| Female                      | 30                 | 40.5           |

The most frequently observed comorbidity was kidney disease (AKI/CKD), affecting 25 patients (33.8%), followed by hypertension (27.0%) and stroke/intracerebral hemorrhage (ICH)/neurological disorders (24.3%). Other comorbidities included chronic obstructive pulmonary disease (COPD) (18.9%), electrolyte or metabolic disorders (17.6%), diabetes mellitus (16.2%), malignancy (14.9%), anemia (13.5%), and congestive heart failure (10.8%) (Table 2). Since individual patients could present with more than one comorbidity, the total frequency of comorbid conditions exceeded the number of study participants. In this study, kidney disease (AKI/CKD) was defined as renal impairment that had been diagnosed prior to the onset of pneumonia-associated sepsis. Renal dysfunction developing during the course of sepsis was not classified as a pre-existing comorbidity.

Table 2.

Distribution of Comorbidities Among Patients with Pneumonia-Associated Sepsis Admitted to the Intensive Care Unit

| Comorbidity                                  | f  | %    |
|----------------------------------------------|----|------|
| Hypertension (HT/HHD)                        | 20 | 27.0 |
| Diabetes mellitus (DM)                       | 12 | 16.2 |
| Kidney disease (AKI/CKD)                     | 25 | 33.8 |
| Chronic obstructive pulmonary disease (COPD) | 14 | 18.9 |
| Stroke / ICH / neurological disorders        | 18 | 24.3 |
| Congestive heart failure (CHF)               | 8  | 10.8 |
| Malignancy (tumor/cancer)                    | 11 | 14.9 |
| Anemia                                       | 10 | 13.5 |
| Electrolyte/metabolic disorders              | 13 | 17.6 |

The mean length of ICU stay among patients with pneumonia-associated sepsis was  $13.81 \pm 7.97$  days, ranging from 2 to 25 days (Table 3). These findings indicate substantial variability in the duration of ICU hospitalization among study participants.

Table 3.

Descriptive Statistics of ICU Length of Stay Among Patients with Pneumonia-Associated Sepsis

| Variable | n | Mean $\pm$ SD | Minimum | Maximum |
|----------|---|---------------|---------|---------|
|----------|---|---------------|---------|---------|

|                           |    |              |   |    |
|---------------------------|----|--------------|---|----|
| Length of ICU stay (days) | 74 | 13.81 ± 7.97 | 2 | 25 |
|---------------------------|----|--------------|---|----|

Most patients died during hospitalization, accounting for 56 cases (75.7%), whereas 18 patients (24.3%) survived (Table 4). Regarding ICU admission characteristics, 69 patients (93.2%) underwent a single ICU admission episode, while 5 patients (6.8%) experienced recurrent ICU admissions (Table 5). Among patients with recurrent ICU admissions, the previous ICU episode ended with survival, whereas the outcome recorded in this study was based on the final ICU admission episode.

Table 4.

Distribution of Mortality Status Among Patients with Pneumonia-Associated Sepsis Admitted to the Intensive Care Unit

| Mortality Status | f  | %    |
|------------------|----|------|
| Survived         | 18 | 24.3 |
| Deceased         | 56 | 75.7 |

Table 5.

Distribution of ICU Admission Episodes Among Patients with Pneumonia-Associated Sepsis

| Variable                 | f  | %     |
|--------------------------|----|-------|
| Single ICU admission     | 69 | 93.2  |
| Recurrent ICU admissions | 5  | 6.8   |
| Total                    | 74 | 100.0 |

The mean SOFA score was  $10.24 \pm 5.87$ , with values ranging from 1 to 24 (Table 6). This finding suggests that most patients experienced moderate-to-severe organ dysfunction during their ICU stay.

Table 6.

Descriptive Statistics of SOFA Scores Among Patients with Pneumonia-Associated Sepsis Admitted to the Intensive Care Unit

| Variable   | n  | Mean ± SD        | Minimum | Maximum |
|------------|----|------------------|---------|---------|
| SOFA score | 74 | $10.24 \pm 5.87$ | 1       | 24      |

### Association Between Risk Factors and Mortality

Bivariate analysis demonstrated no significant association between sex and mortality among patients with pneumonia-associated sepsis admitted to the ICU ( $p = 0.698$ ). Although mortality was higher among male patients (77.3%) than female patients (73.3%), the difference was not statistically significant ( $OR = 1.236$ ; 95% CI: 0.423–3.616). Likewise, no significant association was found between age group and mortality ( $p = 0.247$ ), although the highest mortality proportions were observed among patients aged 36–45 years and 56–65 years (Tables 7 and 8).

Table 7.

Association Between Sex and Mortality Among Patients with Pneumonia-Associated Sepsis Admitted to the ICU

| Sex    | Survived f (%) | Deceased f (%) | Total | p-value | OR (95% CI)         |
|--------|----------------|----------------|-------|---------|---------------------|
| Female | 8 (26.7)       | 22 (73.3)      | 30    | 0.698   | 1.236 (0.423–3.616) |
| Male   | 10 (22.7)      | 34 (77.3)      | 44    |         |                     |
| Total  | 18 (24.3)      | 56 (75.7)      | 74    |         |                     |

\**Chi-square test*

Table 8.

Association Between Age Group and Mortality Among Patients with Pneumonia-Associated Sepsis Admitted to the Intensive Care Unit

| Age Group   | Survived n (%) | Deceased n (%) | Total | p-value |
|-------------|----------------|----------------|-------|---------|
| 18–25 years | 3 (42.9)       | 4 (57.1)       | 7     | 0.247   |
| 26–35 years | 1 (20.0)       | 4 (80.0)       | 5     |         |
| 36–45 years | 1 (9.1)        | 10 (90.9)      | 11    |         |
| 46–55 years | 5 (38.5)       | 8 (61.5)       | 13    |         |
| 56–65 years | 2 (10.5)       | 17 (89.5)      | 19    |         |
| >65 years   | 6 (31.6)       | 13 (68.4)      | 19    |         |
| Total       | 18 (24.3)      | 56 (75.7)      | 74    |         |

*\*Chi-square test*

A significant association was observed between ICU length of stay and mortality ( $p = 0.029$ ). Patients who survived had a longer mean ICU stay than those who died ( $18.11 \pm 7.86$  days vs.  $12.43 \pm 7.47$  days) (Table 9).

Table 9.

Association Between ICU Length of Stay and Mortality Among Patients with Pneumonia Admitted to the Intensive Care Unit

| Mortality Status | n  | Mean $\pm$ SD (days) | Minimum | Maximum | p-value |
|------------------|----|----------------------|---------|---------|---------|
| Survived         | 18 | $18.11 \pm 7.86$     | 7       | 30      | 0.029   |
| Deceased         | 56 | $12.43 \pm 7.47$     | 2       | 37      |         |

*\*Chi-square test*

Furthermore, qSOFA score was significantly associated with mortality ( $p = 0.004$ ). Mortality was higher among patients with a qSOFA score of 3 compared with those with a qSOFA score of 2 (89.5% vs. 61.1%). Patients with a qSOFA score of 3 had a 5.409-fold greater risk of death than those with a qSOFA score of 2 (OR = 5.409; 95% CI: 1.575–18.577) (Table 10).

Table 10.

Association Between qSOFA Score and Mortality Among Patients with Pneumonia Admitted to the Intensive Care Unit

| qSOFA Score | Survived f (%) | Deceased f (%) | Total | p-value | OR (95% CI)          |
|-------------|----------------|----------------|-------|---------|----------------------|
| 3           | 4 (10.5)       | 34 (89.5)      | 38    | 0.004   | 5.409 (1.575–18.577) |
| 2           | 14 (38.9)      | 22 (61.1)      | 36    |         |                      |
| Total       | 18 (24.3)      | 56 (75.7)      | 74    |         |                      |

*\*Chi-square test***DISCUSSION**

The majority of patients with pneumonia-associated sepsis admitted to the Intensive Care Unit were aged  $\geq 56$  years (51.4%) and predominantly male (59.5%). These findings are consistent with epidemiological evidence indicating that advanced age is a major risk factor for severe pneumonia due to immunosenescence, an increased burden of comorbidities, and a decline in physiological reserve (World Health Organization.,2023; Murray et al 2015; Torres et al.,2013; Ari et al., 2025; Cillóniz et al., 2019). The predominance of male patients is also in agreement with previous studies reporting a higher incidence of pneumonia among men than women, which may be attributable to sex hormone-mediated differences in immune responses (Falagas et al.,2007; Roved et al.,2017).

The most common comorbidities identified in this study were kidney disease (AKI/CKD), hypertension, and neurological disorders. These findings support previous reports demonstrating that comorbid conditions play a significant role in increasing the severity of pneumonia, the risk of sepsis, and mortality among critically ill patients (Ari et al.,2025; Cillóniz et al.,2019). Renal dysfunction has been shown to impair immune responses and increase the risk of multiple organ dysfunction, whereas neurological disorders may predispose patients to aspiration, one of the major mechanisms underlying the development of pneumonia (Pickkers et al.,2021).

The mean length of ICU stay was  $13.81 \pm 7.97$  days, and the overall mortality rate reached 75.7%. This high mortality rate is consistent with recent evidence showing that severe pneumonia is associated with substantial mortality, particularly when complicated by septic shock, acute respiratory distress syndrome, multiple organ failure, acute kidney injury, and metabolic acidosis (Xie et al., 2024). Similar findings were also reported in respiratory ICU and Indonesian sepsis cohorts, in which pneumonia was frequently identified as an important source of infection and was associated with a high risk of mortality among critically ill patients (Madkour et al., 2022; Fadrian et al., 2025). Length of ICU stay was significantly associated with mortality ( $p = 0.029$ ), with survivors demonstrating a longer duration of ICU hospitalization than non-survivors. Although

prolonged ICU stay has been associated with poor outcomes in critically ill patients, the shorter ICU stay among non-survivors in the present study may indicate that a considerable proportion of deaths occurred during the early phase of ICU admission, likely reflecting greater disease severity at presentation (Driessen et al., 2021; Reaven et al., 2022; Rodrigues et al., 2024).

The mean SOFA score in this study was  $10.24 \pm 5.87$ , indicating moderate-to-severe organ dysfunction among the study population. The SOFA score has been widely recognized as a reliable predictor of mortality in patients with sepsis and is extensively used to assess the degree of organ failure (Singer et al., 2016; Ferreira et al., 2001). Higher SOFA scores are associated with an increased risk of multiorgan failure and death. Bivariate analysis demonstrated that neither sex ( $p = 0.698$ ) nor age ( $p = 0.247$ ) was significantly associated with mortality. Although advanced age and male sex have frequently been reported as risk factors for adverse outcomes, their effects in the present study may have been overshadowed by more influential factors, such as disease severity, organ dysfunction, and the presence of comorbidities (Falagas et al., 2007; Roved et al., 2017; Murray et al., 2015; Torres et al., 2013).

In contrast, qSOFA score was significantly associated with mortality ( $p = 0.004$ ). Patients with a qSOFA score of 3 had a 5.4-fold higher risk of death compared with those with a qSOFA score of 2. This finding supports previous studies demonstrating that qSOFA is a simple yet effective screening tool for identifying patients with infection who are at high risk of clinical deterioration and mortality (Seymour et al., 2016; Singer et al., 2016; Leone et al., 2025; Rhodes et al., 2017). Therefore, the use of qSOFA may facilitate the early identification of high-risk patients, enabling timely and appropriate interventions that may reduce mortality.

## CONCLUSION

Patients with pneumonia-associated sepsis admitted to the Intensive Care Unit of Adam Malik General Hospital, Medan, were predominantly aged  $\geq 56$  years and male, with an overall mortality rate of 75.7%. Kidney disease (AKI/CKD) was the most frequently observed comorbidity. The analysis demonstrated that age and sex were not significantly associated with mortality, whereas length of ICU stay and qSOFA score showed significant associations with mortality. Patients with a qSOFA score of 3 had a 5.409-fold greater risk of death than those with a qSOFA score of 2.

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