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Analysis of the Use of the SOFA Score in Predicting Mortality among Critically Ill Patients

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Abstract

Introduction: Sepsis is one of the main causes of morbidity and mortality in critical patients in the Intensive Care Unit (ICU). Delays in identifying organ dysfunction are an important factor that increases the risk of death. The Sequential Organ Failure Assessment (SOFA) Score is an assessment tool that is widely used to measure the extent of organ damage and predict mortality in sepsis patients.
Objective: To know the output results of sepsis and sepsis shock patients and which indicators of the SOFA Score affect the patient's output.
Methods: Quantitative research with a retrospective cohort design with a total population of 102 patients with a sample of 53 patients assisted by scoring assessment using the MDCalc application.
Results: overall output experienced mortality with the indicators that affected the SOFA Score score, namely; MAP, FiO2, Ventilator Use, Billirubin, and GCS. Other indicators that affect output include; RR, Glucose, and Leukocytes.
Conclusion: This study confirms that SOFA Score can be used as an effective prediction tool to assess the prognosis of sepsis patients, as well as sepsis shock so that it can assist health workers in clinical decision-making and therapy planning more appropriately.

Keywords: ICU, mortality, sepsis shock, SOFA score

Introduction

The first scoring system used in the intensive care unit (ICU) room was Acute Physiology and Chronic Health Evaluation (APACHE). Acute Physiology and Chronic Health Evaluation (APACHE) is a milestone to help medical personnel predict ICU outcomes. There are many scoring systems that are commonly used in intensive care unit (ICU) rooms, one of which is Sequential Organ Failure Assessment (SOFA) (Quintairos et al., 2023) which is the most widely used scoring system in intensive care units (ICUs) (Moreno et al., 2023). The Sequential Organ Failure Assessment (SOFA) score was first developed in 1994 at the Sepsis-Related Problems Working Group Consensus Conference of the European Society of Intensive Care Medicine in Versailles and published in 1996 (Moreno et al., 2023).

From the group of experts, they made the opinion that the initial purpose in the determination of the SOFA Score was to evaluate the deterioration of organ function with some simple and objective indicators, all of which are easy to measure in hospitals at all levels and should not go beyond the scope of routine testing in intensive care rooms (X. Wang et al., 2023). The use of SOFA Score is intended for sepsis patients to assess the morbidity and mortality rates of these patients. The SOFA Score measurement parameters consist of assessments of respiration (PaO2/FiO2), central nervous system (Glasgow coma Scale [GCS]), cardiovascular (Mean arterial pressure [MAP]), coagulation system (platelets), liver (bilirubin), and renal (serum creatinine) (Iskandar & Siska, 2020).

Sepsis is a life-threatening (Thakur et al., 2023) condition in which organ dysfunction occurs due to infection that creates physiological, biological, and biochemical abnormalities that are the effects of the body's abnormal response (Do et al., 2023). The newly published Global Burden of Disease Report highlights that sepsis is common, with an incidence rate of 50 million cases worldwide each year (van der Poll et al., 2021). Sepsis is a disease with a poor prognosis and is the first factor in morbidity and mortality in various developed countries as well as in various developing countries. The cause of high mortality of sepsis patients is caused by the late identification of sepsis and treatment that is still not optimal, which is the cause of the high mortality rate in sepsis (Baihaqi et al., 2022). Data from the WHO on sepsis shows that there were an estimated 49 million cases of sepsis and there were 11 million sepsis-related mortality rates that occurred worldwide in 2017, accounting for about 20% of all causes of death globally (World Health Organisation, 2020). From the WHO data, we can see that sepsis is not something that can be considered trivial. The disease has supported 11 million deaths from around the world. However, data on the prevalence of sepsis in Indonesia is still limited (Dharma et al., 2020).

The data obtained is sourced from medical record data at Raden Mattaher Jambi Hospital from 2015-2024, sepsis patients at Raden Mattaher Jambi Hospital have significant increases and decreases. From the data obtained from medical records, the highest number of sepsis patients at Raden Mattaher Jambi Hospital occurred in 2018 with a total death rate of 42 people. From previous studies, the study was conducted to determine the relationship between the initial SOFA Score assessment and the mortality of critical patients treated in the intensive care unit. Previous studies conducted assessments using SOFA Score through the medical records of patients who had just entered the intensive care unit during the last 24 hours. Previous studies conducted research on the relationship between sofa score assessment using medical records The previous researcher used 115 patient medical records to conduct his research (Sari et al., 2021).

Other previous studies using prospective cohort study methods obtained results. If the SOFA score is greater than or equal to 7, the mortality result is 3.8 times higher for sepsis. In

the previous study, the SOFA Score assessment parameters examined for all respondents, only calculated the results from platelets. Meanwhile, the laboratory examination of the level Serum creatinine was only administered in 95% of subjects who experienced death, while serum bilirubin parameters were obtained in 48% of subjects with improved outcomes, and by 59% in subjects who experienced death (Iskandar & Siska, 2020).

There is a suggestion in previous studies that have been found. Previous researchers suggested that future research on the same topic conduct serial SOFA Score calculations in order to get maximum results in looking at the mortality rate of patients with sepsis (Sari et al., 2021). This study will also be assisted by one of the mobile applications called MDCalc to assist researchers in calculating sofa scores on patient mortality from the medical records of sepsis patients.

Several studies published in *Genius Journal* have reported that individual clinical and laboratory indicators commonly assessed in intensive care units are closely associated with mortality outcomes (Palupi et al., n.d.). Advanced age has been shown to increase mortality risk due to decreased physiological reserve in critically ill patients (Mahardika et al., n.d.). Respiratory parameters such as PaO_2 and FiO_2 are strongly related to mortality, where impaired oxygenation and increased oxygen requirements reflect severe respiratory dysfunction (Febriyanti et al., n.d.). Neurological impairment assessed by Glasgow Coma Scale (GCS) demonstrates that lower scores are associated with poor prognosis (Febriyanti et al., n.d.). In addition, elevated serum creatinine indicating renal dysfunction and decreased platelet counts reflecting coagulation disorders have been identified as important predictors of mortality in critically ill and sepsis patients (Thalib & Isa).

Based on the description above, it can be known that sepsis is a disease with high morbidity and mortality. And it is the cause of death globally with a percentage of 20%. From the data on sepsis incidence, the researcher is interested in researching the disease with the calculation of the SOFA Score in assessing the disease.

Objective

It is known the characteristics of the respondents of sepsis and sepsis shock patients to know the results of the calculation of the patient's SOFA Score by looking at the output results and the average output of the patient with the results of the indicators that most affect the patient's output.

Method

The type of research uses quantitative methods with a research design using a retrospective cohort. Which was carried out at the Raden Mattaher Hospital, Jambi City, by looking at the patient's medical records in the medical record room.

In this study, the population of sepsis and sepsis shock patients is at a total of 102 patients from January 2022 to December 2024 with the distribution of diagnoses for sepsis shock patients as many as 70 patients and sepsis patients as many as 32 patients. With the inclusion criteria of patients aged > 16 years and patients who are confirmed to have sepsis and sepsis shock. For the exclusion criteria, patients with incomplete/non-meeting SOFA Score calculation requirements and patients with forced discharge or referral to other hospitals.

The technique used in sampling used the purposive sampling method with the results obtained amounted to 53 patients with a division of 21 patients with a diagnosis of sepsis and 32 patients obtained with a diagnosis of sepsis shock.

In this study, the secondary data source is in the form of patient medical records from Raden Mattaher Hospital, Jambi City. There are several instruments and measurement tools used in this study such as patient medical records, patient personal data sheets, inclusion and exclusion criteria sheets, SOFA Score assessment sheets and SPSS version 29. SPSS as a measuring tool is used after all the data needed on the instrument is then processed according to research needs.

The data collection technique used in this study is document analysis with information collected from various existing written sources such as archives, reports, books, and records. With patient medical record research instruments, patient personal data sheets, inclusion and exclusion criteria sheets and SOFA Score assessment sheets. The tool used to process the results of the instrument is SPSS version 29. The data processing techniques carried out are data editing to check and improve data from questionnaires, data coding to convert data to quantitative, data enrty to transfer and transfer coding results to software, and data tabulation to present data from the results obtained from questionnaires.

Result

Table 1. Frequency of Respondents

Characteristics	Frequency (f)	Percentage (%)
Gender		
Man	30	56.6%
Woman	23	43.4%
Age		
17 – 25	2	3.8%
26 – 35	5	9.4%
36 – 45	8	15.1%
46 – 55	8	15.1%
56 – 65	13	24.5%
Total	53	100.0%

Tabel 2. Patient Score Frequency

Score Rate		
Low	35	64.2%
high	18	35.8%
Diagnosis		
Sepsis	21	38.9%
Syok Sepsis	32	59.3%
Patient Output		
Live	2	3.7%
Died	51	94.4%
Total	53	100.0%

Tabel 3. Descriptive Differences in Patient Indicators

Indicator	Live Patients N = 2 Mean/Median	Patient Died N = 51 Mean/Median	Descriptive Differences
RR	22.00	24.79	+ 2.79
Pulse	96.50	99.15	+ 2.65
Temperature	36.000	36.508	+ 0.508
FiO2	95.00	74.41	−20.599
Platelet	299.20	275.65	− 23.55
GCS	9.00	7.92	−1.08
Billirubin	1.5500	2.1472	+ 0.5972
MAP	103.50	92.05	−11.45
Creatinin	2.3500	1.572	− 0.778
Glukosa	102.50	142	_+ 39.50
Leukosit	16.4400	18.529	+ 2.089
Ventilator	Iya	Iya	-
PaO2	340	196	-144
Age	73.00	55	−18.00
SOFA Results	5	6 (max 13)	+ 1
Long Treatment	7	5	− 2

The average patient in this study was male with the age range obtained in the most patients was between the ages of 59-70 with a total of 19 patients. The score level is relatively low with the most diagnoses being in sepsis shock with the highest output result being mortality. From the descriptive table, it is known that several influential indicators are: GCS, FiO2, ventilator use, creatinine, pulse, MAP, and leukocytes.

Discussion

From the results of the study, the characteristics of patients have adult to elderly age with the youngest age being at the age of 21 years and the oldest being at the age of 82 years. This is in line with GBD research (2023) which explains that old age shows a very strong association with increased mortality. And explained again from research by (Verschoor et al., 2024)., explaining that fragility will increase with age in a linear manner. Based on the results of the study, this is in line with the previous journal where the older the age, the higher the mortality rate. This is in line with the results obtained that the most patients were obtained at the age of > 65 years. However, age is not only a chronological way to predict mortality, but requires another objective assessment of the patient's health condition.

Based on the results of the study, patients have an average SOFA Score of 7 which reflects the severity of moderate to severe organ dysfunction. This is in line with previous research which explained that SOFA results with a score of ≥7 have a mortality rate of 72.6%, which is higher than that of patients who have a SOFA score of ≤7 with a percentage of 35.8% (Sari et al., 2021). And from other studies conducted by Tuba Shariq *et al*., a higher SOFA score is significantly related to an increase in ICU patient mortality. Based on the results of the study, previous studies conducted by SOFA Score can be used as an independent predictor in predicting ICU patient mortality. The assessment of the SOFA Score as a continuous variable is considered better to describe the severity of organ function.

The length of treatment in this study has results that patients who have high scores have relatively fast treatment times. From the literature made by Artrien Adhiputri *et al*, it is explained that high SOFA Score results are often associated with shorter ICU stay times, but this relationship does not reflect an improvement in clinical conditions. Patients with high SOFA Score results show a degree of heavy organ function so that the chances of survival during treatment are lower. This is in line with the results of the study where the length of treatment of patients is classified as a fast time with high SOFA Score results. The use of SOFA Score as a screening tool must be carried out with strict monitoring, periodic organ evaluation, and interventions carried out quickly to prevent the progression of organ dysfunction that can lead to early death.

In the respiratory system, the components in this study consist of PaO2, FiO2, RR, and the use of ventilators related to mortality output in this study. From other literature related to the respiratory system, it is explained that although the deceased patient was given high enough oxygen, the lung condition of the deceased patient was not able to improve oxygenation so that the patient experienced mortality. From the research Douin *et al*. explained that high FiO2 can increase the risk of death, especially in patients with a state of hyperoxia (SpO2 > 96%). With higher yields, the higher the risk of mortality. The use of the PaO2/FiO2 ratio as an important parameter in the initial assessment of monitoring critical patients, especially sepsis patients or patients who are admitted to the ICU. In addition, periodic PaO2/FiO2 monitoring is a highly recommended activity to assess how the patient responds to respiratory therapy, including in the provision of oxygen and mechanical ventilation (Bi et al., 2023). The study also explained that increased RR has also been reported to be associated with an increased risk of mortality in various clinical conditions (Sasmita et al., 2025). and another study also explained that an increase in RR per breath per minute was associated with an 8% increased risk of mortality (Zhang et al., 2024).

The results obtained in the study of GCS in patients with deceased outpurs had lower values than in living patients. These findings indicate that decreased levels of consciousness are associated with an increased risk of death. This is in line with previous research that explains that a decrease in GCS values has a very strong relationship with increased mortality. Physiologically, a decrease in GCS usually reflects the presence of intracranial pressure, cerebral edema, intracranial hemorrhage, or diffuse damage to brain tissue. Based on another study conducted by (Kokeguchi et al., 2025)., it is explained that a significant decrease in GCS values is associated with increased mortality in patients with traumatic brain injury (TBI). Patients with lower GCS scores with a median GCS of 6 (six) showed a mortality rate of 33% (Kokeguchi et al., 2025). In this study, the results obtained are the same as the existing literature where the results of low GCS patients have high mortality with the highest frequency being at 3 where the number has a ≤ result of 7. From this, it can be seen that patients with decreased consciousness with low outcomes ≤ 7 have an association with a higher risk of mortality. patients with GCS ≤ 7 should be treated immediately aggressively, including airway–breathing–circulation stabilization and if necessary intubation.

The results obtained in this study related to kidney function show that creatini levels have increased which reflects impaired kidney function. Based on research conducted by Hanif *et al*. The initial SOFA Score was significantly associated with mortality of sepsis patients in the ICU. This right is explained because the kidney function component of the SOFA Score is assessed through creatinine levels where when there is an increase in creatinine levels directly, the SOFA Score results will increase. From other literature, it is explained that an increase in creatinine can reflect acute kidney injury (AKI) which is known to accelerate the

occurrence of multiorgan failure through fluid balance (D. Wang et al., 2024). In this study, the results obtained are also in line with the previous literature where high creatinine levels have a high mortality rate. If there is a patient with an increase in creatinine levels followed by an increase in SOFA Score results, the patient must immediately enter the high-risk category, creatinine level checks must be carried out immediately when the patient is admitted to the emergency room/ICU, especially in patients with suspected sepsis or patients with perfusion disorders.

In this study, related to the cardiovascular system in the pulse and MAP indicators, the results of patients having MAP and pulse were lower than in live patients. In previous studies related to MAP indicators from research journals conducted by (Schuurmans et al., 2024). Explains that a decrease in MAP values defined as hypotension during treatment in the ICU is one of the most consistent and significant risk factors associated with increased mortality. From the study, and the results of previous studies related to pulse From other studies explain that increased pulse values in patients when maintained above 85 bpm should be interpreted as an important indicator of an irregular host response (*dysregulated host response*) and is often a manifestation of worsening cardiovascular dysfunction (Ning et al., 2024).

And in inflammatory and metabolic responses such as leukocytes, blood glucose, platelet, and bilirubin levels in patients describe strong inflammation and metabolic stress. Based on previous research linked to an increase in initial glucose levels when patients were hospitalized, it was closely linked to long-term mortality. Leukocyte levels explain that leukocytosis at the time of hospital admission is an independent predictor of increased mortality in intensive care. Based on previous research, glucose levels when patients are hospitalized are closely associated with increased short-term and long-term mortality. Hyperglycemia reflects metabolic stress and systemic inflammation that exacerbates endothelial damage, increases the risk of cardiovascular disease, and is an independent predictor of mortality (Djupsjö et al., 2022).

Previous research on patient leukocyte levels has shed light on the association between high NMLR and mortality reflecting the presence of complex pathophysiological sepsis (Guo et al., 2023). Another study also explains that at the time of hospitalization, leukocytosis is an independent predictor of increased mortality in intensive care (Smith et al., 2023).

Platelet values were explained in previous studies that a decrease in platelet count was associated with increased mortality in patients with critical illness, especially in conditions with severe infections and sepsis (Liu et al., 2020) And from the study that was also explained, a decrease in platelet count has a significant relationship with increased mortality. In the article, it is explained that patients with low platelet counts ($<192 \times 10^9$/L) have a higher risk of 365-day mortality compared to the group of patients with normal platelet values (R. Wang & Dai, 2022).

Regarding bilirubin levels, previous research explained that the increase in billirubin levels was proven to be between increased billirubin levels and increased mortality in critical patients (Yang et al., 2021). Another study also explains that an increase in bilirubin has a close and significant relationship with an increase in ARDS patients (Study, 2025).

From the results found, the increase in glucose, leukocyte, billirubin levels and a decrease in platelet levels in patients who had a fairly high mortality output resulted in the difference obtained between living and dead patients at glucose levels of + 39.50 with the highest mean result being in deceased patients, in the mean leukocyte level the difference was at +2.089 with the highest number being in deceased patients, Then from the mean of the billirubin indicator, the descriptive difference obtained was at +0.5972 with a higher mean

in patients with deceased output and in platelet levels that decreased with the mean difference result being at AGKA – 23.55 with the lowest value result being in patients with deceased output.

Of the 4 (four) indicators, the mortality output of patients had higher results than live patients. This explains the effect of increasing and decreasing the 4 (four) indicator levels on patient mortality output. From this, it is important to monitor and examine the 4 (four) indicators.

At glucose levels, strict monitoring should be carried out because hyperglycemia and hypoglycemia can worsen clinical conditions and increase the risk of mortality. Differential leukocyte levels should be tested for the initial phase used to identify inflammation, infection, and severe physiological stress. Platelet and billirubin levels in patients should also be closely monitored as the previous indicator which is used to be an early sign of sepsis or multi-organ failure, reflecting liver dysfunction due to sepsis or systemic inflammation. From this, changes from the 4 (four) parameters must be immediately integrated into the SOFA score assessment to detect early clinical deterioration.

Conclusion

From the results of the research that has been carried out overall, the conclusion that can be drawn is that the SOFA Score is effective in predicting the mortality of critical patients with sepsis and sepsis shock in the ICU room. Indicators of hemodynamic respiration, neurological, inflammatory, and metabolic status showed significant differences between living and dying patients. The results of the study remain supportive of previous research which confirms that the SOFA Score is a valid, practical, and important scoring measurement tool used to identify risks and clinical decision-making for critical patients and can also be assisted using the MDCalc application.

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