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International Journal of Medical and Biomedical Studies (IJMBS) is an International, peer-reviewed, open access, online journal dedicated to the rapid publication of full-length original research papers, short communications, invited reviews, Case studies and editorial commentary and news, Opinions & Perspectives and Book Reviews written at the invitation of the Editor in all areas of the Medical and Biomedical Studies.

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The Relationship Between Hemoglobin Levels and Neutrophil-Lymphocyte Ratio with Mortality in Sepsis Patients

Muthia A Charunnisa, Pusparini Pusparini

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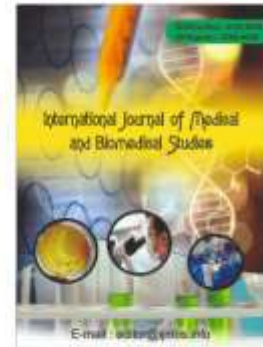
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The Relationship Between Hemoglobin Levels and Neutrophil–Lymphocyte Ratio with Mortality In Sepsis Patients

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Abstract:

Sepsis is a life-threatening clinical syndrome characterized by organ dysfunction caused by a dysregulated host immune response to infection. In sepsis, decreased hemoglobin (Hb) levels may exacerbate tissue hypoxia, while alterations in the immune response are reflected by an increased neutrophil–lymphocyte ratio (NLR) due to lymphocyte apoptosis. Previous studies have reported inconsistent findings; therefore, further research is needed. This study aimed to evaluate the association of Hb levels, NLR, and mortality in patients with sepsis. This cross sectional utilized secondary data obtained from the medical records of 59 sepsis patients treated at Budhi Asih Regional General Hospital, east Jakarta, Indonesia, between January–December 2025 who met the inclusion and exclusion criteria. Data were analyzed using the Chi-square test to assess the association between Hb levels, NLR values, and mortality in sepsis patients. A total of 59 sepsis patients were included in the analysis, with an overall mortality rate of 40.7%. Hemoglobin levels were not significantly associated with mortality ($p = 0.982$), whereas NLR was significantly associated with mortality ($p = 0.003$). Hemoglobin levels were not associated with mortality in sepsis patients, whereas NLR was significantly associated with mortality.

Keywords: mortality, hemoglobin, neutrophil lymphocyte ratio

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Introduction

Sepsis is a life-threatening clinical syndrome, characterized by organ dysfunction due to the host's irregular immune response to infection.(1,2) Each year, it is estimated that about 49 million cases of sepsis occur worldwide, with 11 million deaths or about 19.7% of the total global deaths.(3) The incidence of sepsis in Indonesia reaches around 30.29%, with reported mortality rates ranging from 11.56% to 49%.(4) In the early phase of sepsis, a decrease in hemoglobin (Hb) levels can lead to tissue and organ hypoxia. In the advanced phase, the degree

of damage can deteriorate rapidly (5,6), thereby increasing the risk of mortality in patients with critical conditions. (7) In sepsis, there is also stimulation of lymphocyte apoptosis which causes an increase in the value of the neutrophil–lymphocyte ratio (NLR). (8)

Hemoglobin is the main protein in erythrocytes that acts as oxygen carriers from the lungs to the body's tissues and returns some of the carbon dioxide from the tissues to the lungs.(9) Hb levels are the main parameters that play an important

role in determining the adequacy of oxygen supply in sepsis.(10) The neutrophil-lymphocyte ratio, calculated from a simple ratio of the number of neutrophils and lymphocytes in the peripheral blood, is a biomarker that represents two main components of the immune system: the innate immune response and adaptive immunity.(11) The neutrophil-lymphocyte ratio is currently identified as a potential marker in assessing the severity of sepsis(12) and mortality in sepsis patients.(13)

Research by Sheng et al. against 37,441 sepsis patients, it was shown that low Hb levels (<10.2 g/dL) every 1 g/dL decrease was associated with a 4.6% increase in adjusted OR mortality, while high Hb levels (>10.2 g/dL) every 1 g/dL increase were associated with a 7.6% increased risk.(14) Shi et al. showed that the NLR on day 5 had a predictive value for mortality in sepsis patients compared to measurements on previous days (area under curve/AUC = 0.589 with an optimal cut-off of 15.85).(13) Chebl et al. indicated that NLR values were not shown to be significantly associated with mortality during hospital stay, with an OR value of 1.451 and not achieving statistical significance ($p = 0.103$). (15)

Methods

This study is an observational analytical research with a design cross-sectional which uses secondary data from the medical records of sepsis patients at Budhi Asih Regional General Hospital, east Jakarta, Indonesia for the period January–December 2025. Sepsis patients are defined based on the diagnosis recorded in the medical records according to the criteria sepsis-3, that is, the presence of life-threatening organ dysfunction with an increased sequential organ failure assessment (SOFA) ≥ 2 points. The research sample was taken using the total sampling. Inclusion criteria include sepsis

patients aged 15–65 years, have complete medical record data, and available data on Hb, neutrophil, and lymphocyte levels. Exclusion criteria include patients with a history of Hb abnormalities and patients who are pregnant. A total of 59 patients who met the research criteria were included in the analysis. Hemoglobin levels are defined as the concentration of hemoglobin in the blood obtained from laboratory tests when the patient is first treated and expressed in grams per deciliter (g/dL). Neutrophil-lymphocyte ratio is defined as the ratio between the absolute number of neutrophils and the absolute number of lymphocytes obtained from a complete blood count examination upon the patient's admission to the hospital. The relationship between Hb and NLR levels and mortality of sepsis patients was analyzed using the Chi-square or Fisher's exact. This research has obtained approval from the Research Ethics Committee of the Faculty of Medicine, Trisakti University with ethics number 015/KER/FK/02/2026 and approval from the Health Research Ethics Committee of Budhi Asih Regional General Hospital with ethics number e-71/KEP-ETIK/VI/2026.

Results

The characteristics of the respondents showed that all subjects were in the age group of 15–65 years and dominated by female as many as 36 sepsis patients (61.0%). Based on Hb levels, the majority of patients were in the category of moderate anemia, which was 26 patients (44.1%). Based on the NLR category, most of the patients were in the mild to moderate inflammatory category (NLR ≤ 7), which was 33 patients (55.9%), while patients with the category critical stress and severe systemic inflammation (NLR >17) a total of 11 patients (18.6%). Based on mortality status, it is known that 35 patients (59.3%) survived (Tabel 1).

Table 1. Distribution of respondent characteristics and research variables

Characteristics	Frequency (n)	Percentage (%)
Age		
15–65 years old	59	100
Gender		
Male	23	39.0
Female	36	61.0
Hb		
Normal	14	23.7
Mild anemia	8	13.6
Moderate anemia	26	44.1
Severe anemia	11	18.6
NLR		
≤ 7 : Mild to moderate inflammation	33	55.9
> 7–17 : Inflammation and severe stress	15	25.4
> 17 : Critical stress and severe systemic inflammation	11	18.6
Mortality of Sepsis Patients		
Survived	35	59.3
Died	24	40.7

Hb : hemoglobin, NLR : neutrophil-lymphocyte ratio, n : total, % : percentage

Table 2. The relationship between Hb and NLR and mortality of sepsis patients

Variable	Mortality of sepsis patients		p-value
	survived n(%)	Died n(%)	
Hb (g/dL)			
Normal (women ≥ 12; man ≥ 13)	8(57.1)	6(42.9)	0.982
Mild anemia (women 11-11.9; man 11-12.9)	5(62.5)	3(37.5)	
Moderate anemia (women and man 8-10.9)	15(57.7)	11(42.3)	
Severe anemia (women and man < 8)	7(63.6)	4(36.4)	
NLR			
≤ 7 : Mild to moderate inflammation	25(75.8)	8(24.2)	<0.003*
> 7–17: Inflammation and severe stress	8(53.3)	7(46.7)	
> 17 : Critical stress and severe systemic inflammation	2(18.2)	9(81.8)	

Hb : hemoglobin, NLR : neutrophil-lymphocyte ratio, n : total, % : percentage

*p<0.05 Chi-square test

Based on Table 2, the Chi-square test results shows there is no significant association between Hb levels and mortality of sepsis patients with p value = 0.982, whereas the results of the Chi-square test between NLR and mortality in sepsis patients showed a value of p = 0.003. These results show that the heavier the inflammatory category based on the

NLR value, the higher the proportion of patients who die. This incident can be seen from the increase in the percentage of deaths in each NLR category.

Discussion

Based on the results of this study, it was found that the majority of sepsis patients were in the age range of 15–65 years as many as 59 patients (100%) and dominated

by female patients as many as 36 patients (61.0%). Epidemiological studies conducted by Bouza et al. showed similar results where there was a significant incidence rate of 16.36 cases per 100,000 people with sepsis in Spanish hospitals in the age range of 20–44 years with an increased incidence occurring in women compared to men.(16) Other research conducted by Arvaniti et al. showed the prevalence of sepsis patients in 2,337 patients including 40–59 years of age at 28.2%, 60–69 years of age at 26.6%, and 70–79 years of age at 28.5%. This difference is likely due to differences in the inclusion criteria used. In addition, differences in the number of samples and characteristics of the study population can also affect the age distribution obtained. (17)

In this study, as many as 26 sepsis patients (44.1%) experienced moderate anemia. These results are in line with research conducted by Jiang et al. which states that anemia is one of the most common hematologic complications found in sepsis patients. Sepsis patients show significantly lower hemoglobin (Hb) levels due to systemic inflammatory responses that interfere with iron metabolism and erythropoiesis, so significant decreases generally also occur in other hematologic parameters such as plasma iron and ferritin. (18)

The study also suggested that most sepsis patients had a high NLR in the light to medium category (55.9%). These findings suggest that the majority of patients have experienced activation of systemic inflammatory responses characterized by increased neutrophils and decreased lymphocytes. These results are in line with research conducted by Chebl et al. which states that NLR is an indicator of increased inflammation in sepsis patients and is related to disease severity and mortality. Sepsis-induced tissue injury causes an acute inflammatory response in which neutrophils play an important role. Sepsis

patients tend to have elevated cortisol levels and are in conditions of neuroendocrine stress that have been found to be associated with lymphopenia. This causes NLR to be higher in patients who do not survive than in those who survive due to systemic inflammation. (15)

In this study, as many as 24 patients (40.7%) died, while 35 patients (59.3%) survived. This figure is in line with research conducted by Machado et al. in 331 sepsis patients in the emergency department, 32% reported hospital mortality. (19) These results are also in line with Chebl et al. which reported the mortality of sepsis patients was 36.4%. The similarity of these mortality rates shows that sepsis still has a high mortality rate despite the availability of various therapeutic modalities and intensive care. High mortality in sepsis can be caused by an uncontrolled systemic inflammatory response, which triggers endothelial dysfunction, microcirculation disorders, coagulation imbalances, and ends in multiorgan dysfunction. In addition, sepsis patients generally have comorbid factors, older age, and delays in diagnosis or therapy that contribute to an increased risk of death. (15)

Based on the results of bivariate analysis conducted in this study, it was found that there was no significant relationship between mortality in sepsis patients and Hb levels indicated by the value of $p=0.982$. These results are in line with Gultom et al., where in 21 sepsis patients studied, it was found that there was no significant relationship between Hb <12 and mortality in 28 days of sepsis patients ($p=0.28$), so Hb could not be determined as a predictor of mortality in sepsis patients. (20) The absence of a relationship between Hb levels and mortality in this study may be due to the fact that death in sepsis patients is more determined by the degree of organ dysfunction that occurs due to an uncontrolled immune response to infection than by the Hb level itself. (2)

Other research conducted by Sheng et al. found a nonlinear relationship between Hb and mortality of sepsis patients. Where the risk of mortality was found to decrease in patients with Hb below 10.2 g/dL which increased but increased in patients with Hb above 10.2 g/dL. (14) Study by Chen et al. also showed a negative correlation between Hb and the 28-day mortality risk in sepsis patients in the range of 4.1–10.4 g/dL but there was a positive correlation in the range of 12.8–20.7 g/dL. These findings suggest that Hb is not always linearly related to mortality and therefore cannot be used as a single predictor of sepsis patient outcomes.(21)

Meanwhile, research conducted by Jung et al. involving 2,265 sepsis shock patients showed that low Hb levels (Hb <7 g/dL) were significantly associated with a two-fold increase in mortality in sepsis shock patients compared to the 9 g/dL $\geq$ Hb group. (22) The study found that mortality increased as Hb levels decreased, so Hb was considered a factor related to patient outcomes. Other research conducted by Zhu et al. also found similar findings in which there was a significant association between Hb levels and the prognosis of sepsis patients ($p=0.0008$). (23)

In this study, it was found that NLR levels had a significant relationship with the mortality of sepsis patients ($p=0.003$). Most patients with mild to moderate inflammatory NLR were in the survived group, while most patients with critical stress and severe systemic inflammation was in the died group. These findings suggest that increased NLR is associated with an increased risk of mortality in sepsis patients and can be used as a prognosis indicator in sepsis patients. Similar findings were also put forward by Liu et al. where in 264 patients diagnosed with sepsis it was found that NLR levels had a significant relationship with the mortality of sepsis patients ($p<0.001$). This study states that NLR is an independent predictor factor in mortality

for 28 days of patients with sepsis. Neutrophils play a vital role in innate immunity, as the first line of defense cells that provide rapid detection and elimination of pathogens. In addition, lymphocytes are a key cell type of adaptive immunity, which provides a wider and more refined repertoire of antigen recognition. Therefore, NLR reflects a balance between innate and adaptive immunity. (24) More research by Lorente et al. conducted on 203 sepsis patients also found significantly higher NLR values in the non-survivor groups on days 1, 4 and 8 ($p<0.001$). (25)

Different results of the study were stated by Schupp et al. involving 104 patients with sepsis and sepsis shock showed that NLR did not show strong performance as a predictor of mortality at 30 days compared to other clinical parameters. These differences in results may be due to differences in sample counts, patient characteristics, and variations in the severity of sepsis in the study population. (26) Research conducted by Chebl et al. nor did we find a significant association between NLR and mortality of sepsis patients after adjusting for confounding factors ($p=0.103$). The difference in results may be due to differences in population characteristics, NLR categorization methods, and the presence of other clinical factors that are more dominant in influencing mortality in the study population. (15) Thus, the identification of risk factors that contribute to mortality in sepsis patients is important as a basis for the development of effective treatment strategies to reduce mortality. (27)

In conclusion Hb levels showed no significant association with mortality in sepsis, whereas NLR value were significantly associated with mortality. These findings indicated that NLR has the potential to serve as a simple, easily obtainable laboratory parameter to assist in the early identification of sepsis patients at risk of poor outcomes. Incorporating NLR

into the initial assessment as expected to support risk stratification, clinical monitoring, and more precise therapeutic decision making. Further research is needed, taking into account factors that may influence sepsis patients mortality such as comorbidities, source of infection, culture result, other infection biomarkers, ICU length of stay.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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The Relationship Between Hemoglobin Levels and Neutrophil–Lymphocyte Ratio with Mortality In Sepsis Patients

By Pusparini Pusparini

The Relationship Between Hemoglobin Levels and Neutrophil–Lymphocyte Ratio with Mortality In Sepsis Patients

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Conflict of interest: No conflict of interest

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Keywords: mortality, hemoglobin, neutrophil lymphocyte ratio

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Introduction

Sepsis is a life-threatening clinical syndrome, characterized by organ dysfunction due to the host's irregular immune response to infection. (22) Each year, it is estimated that about 49 million cases of sepsis occur worldwide, with 11 million deaths or about 19.7% of the total global deaths. (3) The incidence of sepsis in Indonesia reaches around 30.29%, with reported mortality rates ranging from 11.56% to 49%. (4) In the early phase of sepsis, a decrease in hemoglobin (Hb) levels can lead to tissue and organ hypoxia. In the advanced phase, the degree

of damage can deteriorate rapidly (5,6), thereby increasing the risk of mortality in patients with critical conditions. (7) In sepsis, there is also stimulation of lymphocyte apoptosis which causes an increase in the value of the neutrophil–lymphocyte ratio (NLR). (8)

Hemoglobin is the main protein in erythrocytes that acts as oxygen carriers from the lungs to the body's tissues and returns some of the carbon dioxide from the tissues to the lungs. (30) Hb levels are the main parameters that play an important

role in determining the adequacy of oxygen supply in sepsis.(10) The neutrophil-lymphocyte ratio, calculated from a simple ratio of the number of neutrophils and lymphocytes in the peripheral blood, is a biomarker that represents two main components of the immune system: the innate immune response and adaptive immunity.(11) The neutrophil-lymphocyte ratio is currently identified as a potential marker in assessing the severity of sepsis(12) and mortality in sepsis patients.(13)

Research by Sheng et al. against 37,441 sepsis patients, it was shown that low Hb levels (<10.2 g/dL) every 1 g/dL decrease was associated with a 4.6% increase in adjusted O₂ mortality, while high Hb levels (>10.2 g/dL) every 1 g/dL increase were associated with a 7.6% increased risk.(14) Shi et al. showed that the NLR on day 5 had a predictive value for mortality in sepsis patients compared to measurements on previous days (area under curve/AUC = 0.589 with an optimal cut-off of 15.85).(13) Chebl et al. indicated that NLR values were not shown to be significantly associated with mortality during hospital stay, with an OR value of 1.451 and not achieving statistical significance ($p = 0.103$). (15)

Methods

This study is an observational analytical research with a design cross-sectional which uses secondary data from the medical records of sepsis patients at Budhi Asih Regional General Hospital, east Jakarta, Indonesia for the period January–December 2025. Sepsis patients are defined based on the diagnosis recorded in the medical records according to the criteria sepsis-3, that is, the presence of life-threatening organ dysfunction with an increased sequential organ failure assessment (SOFA) ≥ 2 points. The research sample was taken using the total sampling. Inclusion criteria include sepsis

patients aged 15–65 years, have complete medical record data, and available data on Hb, neutrophil, and lymphocyte levels. Exclusion criteria include patients with a history of Hb abnormalities and patients who are pregnant. A total of 59 patients who met the research criteria were included in the analysis. Hemoglobin levels are defined as the concentration of hemoglobin in the blood obtained from laboratory tests when the patient is first treated and expressed in grams per deciliter (g/dL). Neutrophil-lymphocyte ratio is defined as the ratio between the absolute number of neutrophils and the absolute number of lymphocytes obtained from a complete blood count examination upon the patient's admission to the hospital. The relationship between NLR levels and mortality of sepsis patients was analyzed using the Chi-square or Fisher's exact. This research has obtained approval from the Research Ethics Committee of the Faculty of Medicine, Trisakti University with ethics number 015/KER/FK/02/2026 and approval from the Health Research Ethics Committee of Budhi Asih Regional General Hospital with ethics number e-71/KEP-ETIK/VI/2026.

Results

The characteristics of the respondents showed that all subjects were in the age group of 15–65 years and dominated by female as many as 36 sepsis patients (61.0%). Based on Hb levels, the majority of patients were in the category of moderate anemia, which was 26 patients (44.1%). Based on the NLR category, most of the patients were in the mild to moderate inflammatory category (NLR ≤ 7), which was 33 patients (55.9%), while patients with the category critical stress and severe systemic inflammation (NLR > 17) a total of 11 patients (18.6%). Based on mortality status, it is known that 35 patients (59.3%) survived (Tabel 1).

Table 1. Distribution of respondent characteristics and research variables

Characteristics	Frequency (n)	Percentage (%)
Age		
15–65 years old	59	100
Gender		
Male	23	39.0
Female	36	61.0
Hb		
Normal	14	23.7
Mild anemia	8	13.6
Moderate anemia	26	44.1
Severe anemia	11	18.6
NLR		
≤ 7 : Mild to moderate inflammation	33	55.9
> 7–17: Inflammation and severe stress	15	25.4
> 17 : Critical stress and severe systemic inflammation	11	18.6
Mortality of Sepsis Patients		
Survived	35	59.3
Died	24	40.7

Hb : hemoglobin, NLR : neutrophil-lymphocyte ratio, n : total, % : percentage

Table 2. The relationship between Hb and NLR and mortality of sepsis patients

Variable	Mortality of sepsis patients		p-value
	survived n(%)	Died n(%)	
Hb (g/dL)			
Normal (women ≥ 12; man ≥ 13)	8(57.1)	6(42.9)	0.982
Mild anemia (women 11-11.9; man 11-12.9)	5(62.5)	3(37.5)	
Moderate anemia (women and man 8-10.9)	15(57.7)	11(42.3)	
Severe anemia (women and man < 8)	7(63.6)	4(36.4)	
NLR			
≤ 7 : Mild to moderate inflammation	25(75.8)	8(24.2)	<0.003*
> 7–17: Inflammation and severe stress	8(53.3)	7(46.7)	
> 17 : Critical stress and severe systemic inflammation	2(18.2)	9(81.8)	

Hb : hemoglobin, NLR : neutrophil-lymphocyte ratio, n : total, % : percentage

*p<0.05 Chi-square test

Based on Table 2, the Chi-square test results shows there is no significant association between Hb levels and mortality of sepsis patients with p value = 0.982, whereas the results of the Chi-square test between NLR and mortality in sepsis patients showed a value of p = 0.003. These results show that the heavier the inflammatory category based on the

NLR value, the higher the proportion of patients who die. This incident can be seen from the increase in the percentage of deaths in each NLR category.

Discussion

Based on the results of this study, it was found that the majority of sepsis patients were in the age range of 15–65 years as many as 59 patients (100%) and dominated

by female patients as many as 36 patients (61.0%). Epidemiological studies conducted by Bouza et al. showed similar results where there was a significant incidence rate of 16.36 cases per 100,000 people with sepsis in Spanish hospitals in the age range of 20–44 years with an increased incidence occurring in women compared to men.(16) Other research conducted by Arvaniti et al. showed the prevalence of sepsis patients in 2,337 patients including 40–59 years of age at 28.2%, 60–69 years of age at 26.6%, and 70–79 years of age at 28.5%. This difference is likely due to differences in inclusion criteria used. In addition, differences in the number of samples and characteristics of the study population can also affect the age distribution obtained. (17)

In this study, as many as 26 sepsis patients (44.1%) experienced moderate anemia. These results are in line with research conducted by Jiang et al. which states that anemia is one of the most common hematologic complications found in sepsis patients. Sepsis patients show significantly lower hemoglobin (Hb) levels due to systemic inflammatory responses that interfere with iron metabolism and erythropoiesis, so significant decreases generally also occur in other hematologic parameters such as plasma iron and ferritin. (18)

The study also suggested that most sepsis patients had a high NLR in the light to medium category (55.9%). These findings suggest that the majority of patients have experienced activation of systemic inflammatory responses characterized by increased neutrophils and decreased lymphocytes. These results are in line with research conducted by Chebl et al. which states that NLR an indicator of increased inflammation in sepsis patients and is related to disease severity and mortality. Sepsis-induced tissue injury causes an acute inflammatory response in which neutrophils play an important role. Sepsis

patients tend to have elevated cortisol levels and are in conditions of neuroendocrine stress that have been found to be associated with lymphopenia. This causes NLR to be higher in patients who do not survive than in those who survive due to systemic inflammation. (15)

In this study, as many as 24 patients (40.7%) died, while 35 patients (59.3%) survived. This figure is in line with research conducted by Machado et al. in 331 sepsis patients in the emergency department, 32% reported hospital mortality. (19) These results are also in line with Chebl et al. which reported the mortality of sepsis patients was 36.4%. The similarity of these mortality rates shows that sepsis still has a high mortality rate despite the availability of various therapeutic modalities and intensive care. High mortality in sepsis can be caused by an uncontrolled systemic inflammatory response, which triggers endothelial dysfunction, microcirculation disorders, coagulation imbalances, and ends in multiorgan dysfunction. In addition, sepsis patients generally have comorbid factors, older age, and delays in diagnosis or therapy that contribute to an increased risk of death. (15)

Based on the results of bivariate analysis conducted in this study, it was found that there was no significant relationship between mortality in sepsis patients and Hb levels indicated by the value of $p=0.982$. These results are in line with Gultom et al., where in 21 sepsis patients studied, it was found that there was no significant relationship between Hb <12 and mortality in 26 days of sepsis patients ($p=0.28$), so Hb could not be determined as a predictor of mortality in sepsis patients. (20) The absence of a relationship between Hb levels and mortality in this study may be due to the fact that death in sepsis patients is more determined by the degree of organ dysfunction that occurs due to an uncontrolled immune response to infection than by the Hb level itself. (2)

Other research conducted by Sheng et al. found a nonlinear relationship between Hb and mortality of sepsis patients. Where the risk of mortality was found to decrease in patients with Hb below 17.2 g/dL which increased but increase in patients with Hb above 10.2 g/dL. (14) Study by Chen et al. also showed negative correlation between Hb and the 28-day mortality risk in sepsis patients in the range of 4.1–10.25 g/dL but there was a positive correlation in the range of 12.8–20.7 g/dL. These findings suggest that Hb is not always linearly related to mortality and therefore cannot be used as a single predictor of sepsis patient outcomes. (21)

Meanwhile, research conducted by Jung et al. involving 2,265 sepsis shock patients showed that low Hb levels (Hb <7 g/dL) were significantly associated with a two-fold increase in mortality in sepsis shock patients compared to the 9 g/dL ≥ Hb group. (22) The study found that mortality increased as Hb levels decreased, so Hb was considered a factor related to patient outcomes. Other research conducted by Zhu et al. also found similar findings in which there was a significant association between Hb levels and the prognosis of sepsis patients ($p=0.0008$). (23)

In this study, it was found that NLR levels had a significant relationship with the mortality of sepsis patients ($p=0.003$). Most patients with mild to moderate inflammatory NLR were in the survived group, while most patients with critical stress and severe systemic inflammation was in the died group. The findings suggest that increased NLR is associated with an increased risk of mortality in sepsis patients and can be used as a prognosis indicator in sepsis patients. Similar findings were also put forward by Liu et al. where in 264 patients diagnosed with sepsis it was found that NLR levels had a significant relationship with the mortality of sepsis patients ($p<0.001$). This study states that NLR is an independent predictor factor in mortality

for 28 days of patients with sepsis. Neutrophils play a vital role in innate immunity, as the first line of defense cells that provide rapid detection and elimination of pathogens. In addition, lymphocytes are a key cell type of adaptive immunity, which provides a wider and more refined repertoire of antigen recognition. Therefore, NLR reflects a balance between innate and adaptive immunity. (24) More research by Lorente et al. conducted on 203 sepsis patients also found significantly higher NLR values in the non-survivor groups on days 1, 4 and 8 ($p<0.001$). (25)

Different results of the study were stated by Schupp et al. involving 104 patients with sepsis and sepsis shock showed that NLR did not show strong performance as a predictor of mortality at 30 days compared to other clinical parameters. These differences in results may be due to differences in sample counts, patient characteristics, and variations in the severity of sepsis in the study population. (26) Research conducted by Chebl et al. nor did we find a significant association between NLR and mortality of sepsis patients after adjusting for confounding factors ($p=0.103$). The difference in results may be due to differences in population characteristics, NLR categorization methods, and the presence of other clinical factors that are more dominant in influencing mortality in the study population. (15) Thus, the identification of risk factors that contribute to mortality in sepsis patients is important as a basis for the development of effective treatment strategies to reduce mortality. (27)

In conclusion Hb levels showed no significant association with mortality in sepsis, whereas NLR value were significantly associated with mortality. These findings indicated that NLR has the potential to serve as a simple, easily obtainable laboratory parameter to assist in the early identification of sepsis patients at risk of poor outcomes. Incorporating NLR

into the initial assessment as expected to support risk stratification, clinical monitoring, and more precise therapeutic decision making. Further research is needed, taking into account factors that may influence sepsis patients mortality such as comorbidities, source of infection, culture result, other infection biomarkers, ICU length of stay.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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