JPPIPA 11(10) (2025)

Jurnal Penelitian Pendidikan IPA

http://jppipa.unram.ac.id/index.php/jppipa/index

Inflammatory Marker Profile of Sepsis Patients at Royal Prima General Hospital

Lenny[1*], Primta Bangun[2], Alvin Abrar Harahap[2]

[1] Medical Student, Faculty of Medicine, Dentistry, and Health Sciences, Universitas Prima Indonesia, Medan, Sumatera Utara, Indonesia.
[2] Faculty of Medicine, Dentistry, and Health Sciences, Universitas Prima Indonesia, Medan, Sumatera Utara, Indonesia.

Received: August 11, 2025
Revised: September 04, 2025
Accepted: October 25, 2025
Published: October 31, 2025

Corresponding Author:
Lenny
lennypratama22@gmail.com

DOI: 10.29303/jppipa.v11i10.12745

Abstract: Sepsis is a serious complication that remains a leading cause of death worldwide, especially among young children and the elderly. Delayed diagnosis remains a major challenge, highlighting the need to develop accurate diagnostic modalities, including inflammatory markers derived from routine blood counts. This study aimed to describe the profile of inflammatory markers in sepsis patients at Rumah Sakit Umum Royal Prima Medan in 2024. This observational study employed a cross-sectional design, analyzing 81 medical records of sepsis patients from Royal Prima General Hospital in 2024, selected using simple random sampling. The variables measured included socio-demographic characteristics (age and sex), leukocyte profile (total leukocyte count, eosinophils, basophils, neutrophils, lymphocytes, and monocytes), and inflammatory indices (NLR, PLR, PNR, LMR, and NLPR). Most sepsis patients were male (50.6%) in the early elderly age group (33.3%), with median leukocyte counts of 17,350 cells/µL, neutrophils at 14,660 cells/µL, and lymphocytes at 1,279 cells/µL. The inflammatory marker indices showed trends of NLR 13.21, PLR 290.74, LMR 1.30, PNR 21.50, and NLPR 0.004. These results support the potential of routine blood inflammatory markers as indicators for sepsis progression.

Keywords: LMR; NL; NLPR; PLR; PNR

Introduction

Recently, many diseases can be caused by various factors, one of which is lifestyle. Poor lifestyle may lead to multiple diseases, which range from non-life-threatening to life-threatening, and these can also be either communicable or non-communicable. Sepsis is one of the complications of infection, which may become more serious in both infants and the elderly (Sanjaya et al., 2022; Huang et al., 2019). Many studies have reported that both sepsis and septic shock have become the leading cause of death worldwide. Each year, millions of sepsis-related deaths are reported worldwide, prompting the World Health Organization (WHO) to establish strategies aimed at reducing its global burden (La Via et al., 2024; Staa et al., 2024).

The Global Burden of Disease Report in 2017 estimated 48.9 million cases of sepsis worldwide, and 11 million of these cases led to death. Age-specific mortality rates for younger than 5 years old, 5-19 years old, and older than 20 years old were 20-23 million cases, 4-9 million cases, and 23-27 million cases, respectively. Furthermore, the leading causes of sepsis in children under 5 years old were diarrhea, lower respiratory tract infections, and newborn-related diseases (Virk et al., 2025; Watson et al., 2024; Wilcox et al., 2022).

Sepsis is commonly found in low-income countries, and it can be affected by various factors. Some countries in Asia reported sepsis as the major cause of morbidity. Sixteen countries, including Indonesia, reported that 10.9% of sepsis cases had various rates of septic shock in some Intensive Care Units (ICUs). Indonesia showed an aligned trend of sepsis incidence rate with other Asian

How to Cite:
Lenny, Bangun, P., & Harahap, A. A. (2025). Inflammatory Marker Profile of Sepsis Patients at Royal Prima General Hospital. *Jurnal Penelitian Pendidikan IPA*, *11*(10), 47–53. https://doi.org/10.29303/jppipa.v11i10.12745

countries, which was up to 30.29% and mortality rate ranging from 11.56% to 49%. It was affected by several factors, including limited health center accessibility, delayed diagnosis and treatment, and the distribution of infection agents (Jumarta et al., 2024; Stenberg et al., 2023; Brianssoulis et al., 2021; Turnip, 2022).

Based on the information above, early diagnosis and management of sepsis become an essential step to prevent further progression of sepsis. It was in line with Vie et al. (2024), who reported that delayed diagnosis of sepsis contributed to an increase in comorbidity rates, especially in low-income countries. Therefore, the development of new diagnostic modalities with high accuracy is crucial to prevent delayed sepsis diagnosis (La Via et al., 2024; Mwiseneza et al., 2024; Ali et al., 2025; Alharbi, 2021; Alshammary et al., 2025; Moore et al., 2019).

Several studies have been conducted to develop new parameters for diagnosing sepsis as soon as possible. These parameters included Neutrophil-To-Lymphocyte Ratio (NLR), Platelet-To-Lymphocyte Ratio (PLR), Lymphocyte-To-Monocyte Ratio (LMR), Platelet-To-Neutrophil Ratio (PNR), and Neutrophil-Lymphocyte-Platelet Ratio (NLPR). Zhang et al. (2024) reported that increased NLR and NPR in sepsis patients were significantly correlated with increased 28-day mortality rates. Another study by Wen et al. (2024) reported similar findings, demonstrating that NLR and neutrophil percentage can serve as early biomarkers for predicting mortality in hospitalized sepsis patients, with threshold values of NLR ≥ 10.769 and neutrophil percentage ≥ 87.70%. In addition, Qiu et al. (2024) also found that NLR and PLR were statistically associated with increased mortality, especially in sepsis patients with lymphopenia (La Via et al., 2024; Qiu et al., 2024; Wen et al., 2024; Weng et al., 2023).

Some studies have been performed to develop new diagnostic parameters to predict the progression of sepsis, especially inflammatory markers from routine blood parameters. However, most of these previous studies were limited to predicting the mortality of sepsis patients. Therefore, this study aimed to investigate the inflammatory marker profile in sepsis patients at Royal Prima General Hospital, Medan.

Method

This observational study used a cross-sectional model to describe the inflammatory profile in sepsis patients at Royal Prima General Hospital, Medan. All procedures in this study have been approved by the Komite Etik Penelitian Kesehatan (KEPK) of Universitas Prima Indonesia, with letter number 008/KEPK/UNPRI/V/2025.

This study selected 81 sepsis patients from 2024 at Royal Prima General Hospital using the simple random Sampling technique. Both inclusion and exclusion criteria were used to outline this sample. Inclusion criteria were sepsis patients aged 18 years or older who underwent an initial complete blood count with a length of stay of more than 24 hours. Meanwhile, exclusion criteria were all patients who did not fulfill the inclusion criteria.

This study also measured socio-demography and some inflammatory markers as research variables. Socio-demography included age and sex. Meanwhile, inflammatory markers included leucocyte count, differential count of leucocytes, NLR, PLR, LMR, PNR, and NLPR.

All these data were analyzed using descriptive statistics to describe all research variables. Socio-demographic characteristics, including age and sex, were described in terms of frequency and percentage. Meanwhile, the inflammatory markers were expressed as the median with the minimal to Maximal value for non-normal distribution data and as the Mean with Standard deviation for normal distribution data. All these data were described in a table, a graphic (Bar and Histogram), and narration.

Result and Discussion

Initially, the distribution of socio-demographic characteristics from sepsis patients in 2024 at Royal Prima General Hospital is described in Table 1.

Table 1. Socio-Demographic Characteristics of Sepsis Patients at Royal Prima General Hospital in 2024

Socio-Demographic Characteristics	Frequency	Percentage
Age		
Early Adulthood (26-35 years old)	5	6.2
Late Adulthood (36-45 years old)	6	7.4
Early Elderly (46-55 years old)	27	33.3
Late Elderly (56-65 years old)	19	23.5
Senior (≥ 65 years old)	24	29.6
Sex		
Male	41	50.6
Female	40	49.4

Table 1 showed that the majority of sepsis patients at Royal Prima Hospital were in the early elderly age group (46-55 years), and the lowest number was in the early adult group (26-35 years), which comprised five patients (6.2%). In addition, Table 1 also showed that the percentage of male sepsis patients (50.6%) was slightly higher than that of female patients (49.4%). The distribution of socio-demographics in sepsis patients is also shown in Figure 1.

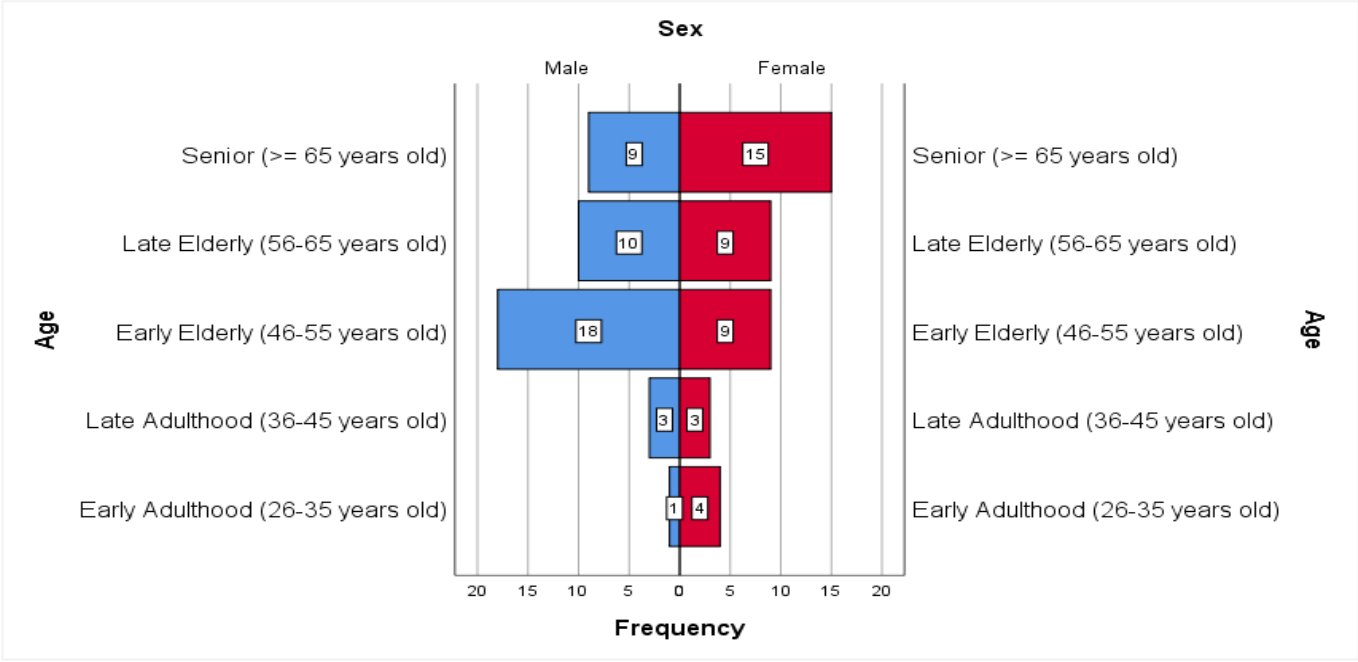

Figure 1. Socio-demographic characteristics of sepsis patients at Royal Prima General Hospital in 2024

Figure 1 showed that the majority of male sepsis patients were aged 46-55 years old (Early elderly), and the female sepsis patients were aged more than 65 years old (senior). It was in line with other studies performed by Purnamasari et al. (2020), who reported that most sepsis patients at Dr. H. Abdul. Moeloek Regional Hospital, Lampung, tended to affect the male patient population, with 100 patients (52.1%). However, Purnamasari et al. (2025) also reported results that contradicted the age characteristics in this current study, which found that the majority of sepsis patients at Dr. H. Abdul were under 18 years old. Moeloek Regional Hospital, Lampung, had the highest number of patients from the 18-59 years age group, with 111 patients (56.9%). However, another study by Hennessy et al. (2020) reported a similar result, indicating that increasing age is associated with an increase in the number of sepsis cases, with the highest number of cases found in those aged 85 years or older, specifically 506 cases (Hennessy et al., 2020; Purnamasari et al., 2025; Bladon et al., 2024; Chousterman et al., 2017).

Variation in these results may be due to differences in the studied sample. However, all these studies showed that men were a more vulnerable group to experience sepsis; this may be due to various factors, one of which is smoking. The majority of sepsis patients at Dr. H. Abdul Moeloek Regional Hospital, Lampung, were caused by lung infections or pneumonia. However, further research is still needed to validate this hypothesis. In addition, a study by Hennessy et al. (2020) also reported that the number of sepsis cases increases with age. It could be due to immune factors or body resistance, where older age groups have a more vulnerable body defense system that degenerates with increasing age. This previous finding aligns with the current study on age characteristics in sepsis patients at Royal Prima Medan General Hospital, which showed that elderly patients were the most affected. After that, the analysis of the distribution of leucocyte count and its types is described in Table 2.

Table 2. Leucocyte Characteristics of Sepsis Patients at Royal Prima General Hospital in 2024

Leucocyte Characteristics	Median	Min	Max
No. Leucocytes (cell/ µL)	17.350	3.770	516.790
No. Eosinophile (cell/ µL)	30.00	0	5.685
No. Basophile (cell/ µL)	43.00	0	29.457
No. Neutrophile (cell/ µL)	14.660	2.066	434.620
No. Lymphocyte (cell/ µL)	1.279	283	16.537
No. Monocyte (cell/ µL)	905	192	13.953

Table 2 showed that the number of leucocytes in sepsis patients in this study tended to be high, ranging from 3,770 to 516,790 cells/µL, with a mean of 17,350 cells/µL. It indicates that most sepsis patients suffer from leucocytosis. According to its type, neutrophils were the most common type of leucocyte found in sepsis patients, with a median of 14,660 cells/µL, indicating a dominance of neutrophils in sepsis patients. On the other hand, the sepsis patient showed a tendency towards a normal number of lymphocytes and monocytes, which was within the normal range. Although some cases of sepsis had higher lymphocyte or monocyte counts above normal values. Lastly, eosinophils and basophils revealed a tendency for very

low numbers, which were 30 and 43 cells/μL, respectively.

This study showed that sepsis patients have a leukocytosis condition with a predominance of neutrophils. However, it differed from previous studies. He et al. (2023) reported that sepsis in Gansu Province Hospital tended to have a leucocyte number of 9.620 × 10^9/μL, which was within the normal range. The difference in results was due to some factors that were not measured in this study, including socio-demographic factors that were affected by socio-economic factors (He et al., 2023; Bray & Kennedy, 2020). Even though this study demonstrated a more reliable leucocyte number, based on Sepsis Criteria in 2016, the sepsis initially showed an increasing leucocyte number as a response to initial pathogen invasion. The Leucocyte count alone does not confirm an infection. Additional newer diagnostic tools, such as a differential leukocyte count, procalcitonin, or bacterial culture and sensitivity testing, may also be required (Chiu & Legrand, 2021; Fleischmann-Struzek et al., 2020; Martin et al., 2003).

This study also showed that the dominance of neutrophils, which is known as the "Soldier of the body" for the innate immune system. Neutrophils can survive between 7-10 days in peripheral circulation and identify pathogens by various receptors on their cell surface, one of which is Toll-like receptors (TLRs) (Baratawidjaja & Rengganis, 2014; Prakoeswa, 2020). The dominance of neutrophils in this study was opposite to the study by He et al., who reported a tendency of lower neutrophil number (7.560 cells/μL) than the current study. However, another study by Jang et al. at Wonju Severance Christian Hospital reported a higher value, which was 13,500 cells/μL, in line with the current study (He et al., 2023; Jang et al., 2022). This variation can be caused by several factors, including shifts in infection patterns. Neutrophils are the initial defence body system and play a role in the innate immune response during infection. A low neutrophil count may indicate exposure to a weakened pathogen or infectious agent. Another possible explanation for a low neutrophil count is that the acquired immune system is overtaking the innate immune system. Furthermore, based on parameters in the peripheral blood count, various types of inflammatory marker indices were formulated, and the results are described in Table 3.

Table 3. Inflammatroy Marker Indices Characteristics of Sepsis Patients at Royal Prima General Hospital in 2024

Inflammatroy Marker Indices	Median	Min	Max
NLR	13.21	1.10	95.30
PLR	290.74	9.33	1.959.44
LMR	1.30	0.27	14.37
PNR	21.50	0.40	168.90
NLPR	0.004	0.00	0.15

Table 3 showed that the median NLR (Neutrophil-to-Lymphocyte Ratio) was 13.21, with a range of 1.10 to 95.30. Meanwhile, the PLR (Platelet-to-Lymphocyte Ratio) showed a median value of 290.74, with a range of 9.33 to 1,959.44. Another inflammatory marker, the LMR (Lymphocyte-to-Monocyte Ratio), had a median value of 1.30. The PNR (Platelet-to-Neutrophil Ratio) had a median value of 21.50, with a wide range of 0.40 to 168.90. Finally, the NLPR (Neutrophil-to-Lymphocyte-Platelet Ratio) showed high variation in values, with a minimum value of 0, a maximum of 0.15, and a median of 0.004.

The increase in NLR value in the current study is in line with a previous study by Jang et al. (2022), which showed the NLR value of sepsis patients in Wonju Severance Christian to be 19.3. This NLR value not only acts as a prognostic predictor but also acts as a mortality predictor for some diseases, including diabetes, cancer, or other abdominal operation procedures (Jang et al., 2022; Dewitte et al., 2018).

The PLR value in the current study also showed a similar trend to the findings of Rizal et al. (2020), who reported a cut-off value of 272.22 with a sensitivity of 84% and a specificity of 80.49%. In comparison, the median PLR in the current study was higher (290.74), indicating an association with increased 28-day mortality rates. The higher mortality rate may be related to platelets (thrombocytes), which can secrete serotonin that attracts other leukocytes, including neutrophils, monocytes, and lymphocytes. Thus, this mechanism may contribute to the elevated PLR value (Rizal et al., 2021; Wang et al., 2022; Abebe, 2024).

LMR value has been widely studied in relation to apoptosis, necrosis, or sepsis pathogenesis. LMR has been reported to be high in various conditions, such as fever, which can cause bacterial infections (tending to lower values), peritonitis, and pancreatitis (Djordjevic et al., 2018; Naess et al., 2017; Rizal et al., 2021). However, other studies also reported that LMR positively correlated with the survival rate of sepsis patients. It may be due to downregulation of the expression of some lymphocyte surface cell receptors, such as T-bet, GATA3, and ROR-γt, which contribute to the regulation of T Helper cells (Hu et al., 2024).

Unlike other inflammatory markers, the PNR has been less extensively studied in patients with sepsis. However, based on the role of platelets, which secrete serotonin and attract neutrophils, the PNR value may be affected. A study by Yeter et al. (2022), conducted at a tertiary hospital in Ankara, Turkey, reported that a lower PNR value (<0.05), accompanied by higher vitamin D levels, was associated with increased survival rates in ICU patients with shock sepsis (Yeter & Topeli, 2022; Emam et al., 2011; Dimitrov et al., 2025).

NLPR and NLR have been widely studied as prognostic indicators in sepsis patients Shi et al. (2022) reported that the cut-off value for NLPR varied based on hospitalization duration and tended to decrease over time. The current study measured only the initial NLPR value, and it was lower than the 1st to 3rd day cut-off value, suggesting a better prognosis in sepsis patients. However, since the NLPR in the current study was measured only at the initial diagnosis of sepsis, deterioration during hospitalization cannot be ruled out. Therefore, further studies with a more comprehensive design are still required (Shi et al., 2022).

Conclusion

Overall, it can be concluded that most sepsis patients were male and belonged to the early elderly age group. These patients had a median leukocyte count of 17,350 cells/μL, a median neutrophil count of 14,660 cells/μL, and a median lymphocyte count of 1,279 cells/μL. The inflammatory marker indices showed elevated levels, with NLR of 13.21, PLR of 290.74, LMR of 1.30, PNR of 21.50, and NLPR of 0.004. These findings suggest that haematological parameters and inflammatory indices may serve as potential early biomarkers in sepsis identification.

Acknowledgments
Place acknowledgments, including information on grants received, before the references, in a separate section, and not as a footnote on the title page.

Author Contributions
Conceptualization, Lenny and Primta Bangun; methodology, Lenny and Primta Bangun.; software, Lenny; validation, Primta Bangun and Alvin Abrar Harahap; formal analysis, Lenny; investigation, Lenny; resources, Primta Bangun; data curation, Lenny; writing—original draft preparation, Lenny; writing—review and editing, Primta Bangun and Alvin Abrar Harahap; visualization, Lenny; supervision, Primta Bangun and Alvin Abrar Harahap; project administration, Primta Bangun. All authors have read and agreed to the published version of the manuscript.

Funding
This research received no external funding.

Conflicts of Interest
All authors declare no conflict of interest.

References

Abebe, D. (2024). Diagnostic significance of complete blood cell count and hemogram-derived markers for neonatal sepsis at Southwest Public Hospitals, Ethiopia. *World Journal of Clinical Pediatrics, 13*(2), 92392. https://doi.org/10.5409/wjcp.v13.i2.92392

Alharbi, A. (2021). A Potential Role of Vitamin D on Platelet Leukocyte Aggregation and Pathological Events in Sepsis: An Updated Review. *Journal Inflamm Res, 30*(14), 3651-3664. https://doi.org/10.2147/jir.s321362

Ali, M., Salim, S. Y., Sheikh, F., & Fox-Robichaud, A. (2025). Sepsis Research in Canada: An Environmental Scan of Sepsis Investigators, Research, and Funding. *PLOS Global Public Health, 5*(4), 1-12. https://doi.org/10.1371/journal.pgph.0003606

Alshammary, R. A. A., Khadim, M. M., Al-Karawi, A. S., & Al-Budairi, A. S. (2025). Biomarkers of Sapsis Severity: A Comparative Evaluation of Immunological and Biochemical Parameters. *Al-Anbar Medical Journal*, *21*(4), 255-262. https://doi.org/10.33091/amj.2025.159680.2222

Baratawidjaja, K. G., & Rengganis, I. (2014). *Imunologi Dasar*. Badan Penerbita Fakultas Kedokteran Universitas Indonesia.

Bladon, S., Ashiru-Oredope, D., & Cunningham, N. (2024). Rapid Systematic Review on Risks and Outcomes of Sepsis: The Influence of Risk Factors Associated With Health Inequalities. *International Journal for Equity in Health*, *23*(1), 23-34. https://doi.org/10.1186/s12939-024-02114-6

Briassoulis, P., Illia, S., Briassouli E., & Miliariki, M. (2021). The Lonely Glutamine Tree in the Middle of the Infinite Critically Ill Forest. *Critical Care*, *25*(1), 376-377. https://doi.org/10.1186/s13054-021-03743-x

Bray, C., & Kennedy, C. (2020). Improving Timely Sepsis Care Using the Surviving Sepsis Campaign One-Hour Bundle in a Rural Emergency Department. *Journal of the American Association of Nurse Practitioners*, *33*(3), 246-253. https://doi.org/10.1097/jxx.0000000000000436

Chiu, C., & Legrand, M. (2021). Epidemiology of sepsis and septic shock. *Current Opinion in Anaesthesiology*, *34*(2), 71–76. https://doi.org/10.1097/ACO.0000000000000958

Chousterman, B. G., Swirski, F. K., & Weber, G. F. (2017). Cytokine Storm and Sepsis Disease Pathogenesis. *National Library of Medicine*, *39*(5), 517-528. https://doi.org/10.1007/s00281-017-0639-8

Dewitte, A., Lepreux, S., Villeneuve, J., & Rigothier, C. (2018). Correction to: Blood Platelets and Sepsis Pathophysiology: A New Therapeutic Prospect in Critically Ill Patients? *Annals of Intensive Care*, *8*(1), 1-18. https://doi.org/10.1186/s13613-018-0378-6

Dimitrov, E., Muman, A., Minkov, A., Enchev., & Yovtchev, Y. (2025). How to Identify High-Risk Patients for Fatal Outcome Due to Local Peritonitis?-A Retrospective Analysis. *Journal of Emergency Medicine, Trauma and Acute Care*, *25*(2),

1-7. https://doi.org/10.5339/jemtac.2025.12

Djordjevic, D., Rondovic, G., Surbatovic, M., Stanojevic, I., Udovicic, I., Andjelic, T., Zeba, S., Milosavljevic, S., Stankovic, N., Abazovic, D., Jevdjic, J., & Vojvodic, D. (2018). Neutrophil-to-Lymphocyte Ratio, Monocyte-to-Lymphocyte Ratio, Platelet-to-Lymphocyte Ratio, and Mean Platelet Volume-to-Platelet Count Ratio as Biomarkers in Critically Ill and Injured Patients: Which Ratio to Choose to Predict Outcome and Nature of Bacte. *Mediators of Inflammation*, *2018*. https://doi.org/10.1155/2018/3758068

Emam, A. A., Mousa, S. G., & Ahmed, K. Y. (2011). Inflammatory Biomarkers in Patients With Asymptomatic Primary Hyperparathyroidism. *Medical Principles and Practice*, *21*(3), 249-253. https://doi.org/10.1159/000334588

Fleischmann-Struzek, C., Mellhammar, L., & Rose, N. (2020). Incidence and mortality of hospital- and ICU-treated sepsis: results from an updated and expanded systematic review and meta-analysis. *Intensive Care Medicine*, *46*, 1552–1562. https://doi.org/10.1007/s00134-020-06151-x

He, Y., Liu, Q., Wei, L., Sun, Z., Li, W., Geng, F., Lu, Z., & Zhang, H. (2023). The Value of Peripheral Blood Leukocyte Parameters in the Early Diagnosis and Clinical Prognosis of Sepsis. *International Journal of Analytical Chemistry*, *2023*. https://doi.org/10.1155/2023/6052085

Hennessy, D. A., Soo, A., Niven, D. J., Jolley, R. J., Posadas-Calleja, J., Stelfox, H. T., & Doig, C. J. (2020). Socio-demographic characteristics associated with hospitalization for sepsis among adults in Canada: a Census-linked cohort study. *Canadian Journal of Anesthesia*, *67*(4), 408–420. https://doi.org/10.1007/s12630-019-01536-z

Hu, X., Qin, X., Gu, X., Wang, H., & Zhou, W. (2024). Effect of lymphocyte-to-monocyte ratio on survival in septic patients: an observational cohort study. *Archives of Medical Science*, *20*(3), 790–797. https://doi.org/10.5114/aoms.2020.92692

Huang, M., Cai, S., & Su, J. (2019). The Pathogenesis of Sepsis and Potential Therapeutic Targets. *International Journal of Molecular Scienses (IJMS)*, *20*(21), 5376. https://doi.org/10.3390/ijms20215376

Jang, J. Y., Yoo, G., Lee, T., Uh, Y., & Kim, J. (2022). Identification of the robust predictor for sepsis based on clustering analysis. *Scientific Reports*, *12*(1), 1–8. https://doi.org/10.1038/s41598-022-06310-8

Jumarta, N., Halimuddin, & Bahri, T. S. (2024). Pengetahuan Perawatan tentang Sepsis di Ruangan Intestive Care Unit. *JIM FKep*, *8*(01), 78–82.

La Via, L., Sangiorgio, G., Stefani, S., Marino, A., Nunnari, G., Cocuzza, S., La Mantia, I., Cacopardo, B., Stracquadanio, S., Spampinato, S., Lavalle, S., & Maniaci, A. (2024). The Global Burden of Sepsis and Septic Shock. *Epidemiologia*, *5*(3), 456–478. https://doi.org/10.3390/epidemiologia5030032

Martin, G. S., Mannio, D., Eaton, S., & Moss, M. (2003). The Epidemiology of Sepsis the United States From 1979 Through 2000. *The New-England Medical Review and Journal, 348*(16), 1546-1554. https://doi.org/10.1056/NEJMoa022139

Mwiseneza, I., Nkomeja, A., Umuhoza, A., & Mukwesi, C. (2024). Factors Related to Sepsis in Critical Care Setting in Rwanda Selected Referral Hospital. *African Journal of Health Sciences*, *36*(6), 652-662. https://doi.org/10.4314/ajhs.v36i6.4

Moore, W., Vermuelen, A., Taylor, R., & Kihara, D. (2019). Improving 3-Hour Sepsis Bundled Care Outcomes: Implementiation of a Nurse-Driven Sepsis Protokol in the Emergency Department. *Journal of Emergency Nursing*, *45*(6), 690-698. https://doi.org/10.1016/j.jen.2019.05.005

Naess, A., Nilssen, S. S., Mo, R., Eide, G. E., & Sjursen, H. (2017). Role of neutrophil to lymphocyte and monocyte to lymphocyte ratios in the diagnosis of bacterial infection in patients with fever. *Infection*, *45*(3), 299–307. https://doi.org/10.1007/s15010-016-0972-1

Purnamasari, D., Yasin, N. M., & Andayani, T. M. (2025). Evaluasi Penggunaan Antibiotik Empiris pada Pasien Sepsis di Intensive Care Unit RSUD Dr. H. Abdul Moeloek Provinsi Lampung. *Jurnal Surya Medika*, *11*(2), 103–109. https://doi.org/10.33084/jsm.v11i2.8683

Prakoeswa, F. R. S. (2020). Peran Sel Limfosit dalam Imunologi: Artikel Review. *Jurnal Sains dan Kesehatan*, *2*(4), 525-537. http://dx.doi.org/10.25026/jsk.v2i4.212

Qiu, X., Wang, Q., Zhang, Y., Zhao, Q., Jiang, Z., & Zhou, L. (2024). Prognostic Value of Neutrophils-to-Lymphocytes Ratio and Platelets-to-Lymphocytes Ratio in Sepsis Patients With Lymphopenia. *Biomarker Insights*, *19*. https://doi.org/10.1177/11772719231223156

Rizal, T. S., Irwanto, F. H., Zainal, R., & Saleh, M. I. (2021). Correlation of Platelet-Lymphocyte Ratio (PLR) as 28-Days Sepsis Mortality Predictor in Intensive Care Unit of RSMH Palembang. *Journal of Anesthesiology and Clinical Research*, *1*(2), 43–62. https://doi.org/10.37275/jacr.v1i2.137

Sanjaya, B. D., Djuang, M. H., Muniro, F. D., & Chiuman, L. (2022). Sepsis Risk Factors in Elderly Patients At Royal Prima Medan General Hospital. *Jambura Journal of Health Sciences and Research*, *4*(3), 596–603. https://doi.org/10.35971/jjhsr.v4i3.12488

Shi, Y., Yang, C., Chen, L., Cheng, M., & Xie, W. (2022). Predictive value of neutrophil-to-lymphocyte and platelet ratio in in-hospital mortality in septic patients. *Heliyon*, *8*(11), e11498. https://doi.org/10.1016/j.heliyon.2022.e11498

Stenberg, H., Li, X., Pello-Esso, W., & Lonn, S. L. (2023). The Effects of Sociodemographic Factors and Comorbidities on Sepsis: A Nationwide Swedish Cohort Study. *Preventive Medicine Reports, 35*(1), 1-8. https://doi.org/10.1016/j.pmedr.2023.102326

Staa, T. P. V., Pate, A., Martin, G. P., & Sharma, A. (2024). Sepsis and Case Fatality Rates and Associations With Deprivation, Ethnicity, and Clinical Characteristics: Poplation-Based Case-Control Study With Linked Primary Care and Hospital Date in England. *Infection, 52*(4), 1-11. https://doi.org/10.1007/s15010-024-02235-8

Turnip, R. S., Fadilla, N., Ganefianty, A., & Fahmi, I. (2022). Ther Role of Nurses in Sepsis Patients in Critical Care Units: A Narrative Review. *Journal of Health Research Forikes Voice, 13*(1), 18-23. https://doi.org/10.33846/sf13104

Virk, H. S., Biemond, J. J., Earny, V. A., Chowdhury, S., Frölke, R. I., Khanna, S. M., Shanbhag, V., Rao, S., Acharya, R. V, Balakrishnan, J. M., Eshwara, V. K., Varma, M. D., Poll, T. Van Der, Wiersinga, W. J., & Mukhopadhyay, C. (2025). Unraveling Sepsis Epidemiology in a Low- and Middle- Income Intensive Care Setting Reveals the Alarming Burden of Tropical Infections and Antimicrobial Resistance : A Prospective Observational Study (MARS-India). *Clinical Infectious Diseases*, *80*(1), 101–107. https://doi.org/10.1093/cid/ciae486

Wang, G., Mivefroshan, A., Yaghoobpoor, S., Khanzadeh, S., Siri, G., Rahmani, F., & Aleseidi, S. (2022). Prognostic Value of Platelet to Lymphocyte Ratio in Sepsis: A Systematic Review and Meta-analysis. *BioMed Research International*, *2022*(I). https://doi.org/10.1155/2022/9056363

Watson, R. S., Carrol, E. D., Carter, M. J., Kissoon, N., Ranjit, S., & Schlapbach, L. J. (2024). The burden and contemporary epidemiology of sepsis in children. In *The Lancet Child and Adolescent Health* (Vol. 8, Issue 9, pp. 670–681). Elsevier. https://doi.org/10.1016/S2352-4642(24)00140-8

Wen, X., Zhang, Y., Xu, J., Song, C., Shang, Y., Yuan, S., & Zhang, J. (2024). The early predictive roles of NLR and NE% in in-hospital mortality of septic patients. *Heliyon*, *10*(4), e26563. https://doi.org/10.1016/j.heliyon.2024.e26563

Weng, L., Xu, Y., Yin, P., & Wang, Y. (2023). National Incidence and Mortality of Hospitalized Sepsis in Cina. *Critical Carei, 27*(1), 84. https://doi.org/10.1186/s13054-023-04385-x

Wilcox, M. E., Daou, M., Dionne, J., & Dodek, P. (2022). Protocol for a Scoping Review of Sepsis Epidemiology. *Systematic Reviews, 11*(1). https://doi.org/10.1186/s13643-022-02002-6

Yeter, H. H., & Topeli, A. (2022). The Significance of Systemic Immune-Inflammatory Index and Platelet-Neutrophil Ratio on Early Mortality in Septic Shock Patients and their Association with Vitamin D and Parathyroid Hormone Ratio. *Acta Medica*, *53*(4), 384–393. https://doi.org/10.32552/2022.actamedica.856