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The Correlation Between Neutrophil Count and the Severity of Ischemic Stroke Based on National Institutes of Health Stroke Scale (NIHSS)

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A B S T R A C T

Background*:** Leukocytosis is well known to be a significant indicator of inflammatory response and have predictive value on the functional outcome in ischemic stroke.Numerous studies have analyzed the correlation between leukocyte count and the severity of ischemic stroke based on National Institutes of Health Stroke Scale (NIHSS). However, studies specifically focused on neutrophil count are still limited. The aim of this study is to explore the correlation between neutrophil count and ischemic stroke severity evaluated using NIHSS.Method*:** This analytical observational study used cross-sectional design and purposive sampling, with a total sample of 27 ischemic stroke patients. The neutrophil count and NIHSS scorewere collected at admission and then analyzed using Spearman correlation test. ***Results*:** This research found a significant relationship between neutrophil count and ischemic stroke severity based on NIHSS, with a p-value of <0.001. The correlation coefficient is 0.858, indicating a linear and very strong correlation.***Conclusion*:** There was a significant correlation between neutrophil count and the severity of ischemic stroke based on NIHSS score.

Keywords: Ischemic stroke, neutrophil count, stroke severity, NIHSS.

INTRODUCTION

Stroke is a clinical condition caused by a sudden disruption in cerebral circulation. This condition results in focal neurological deficit that can be observedphysically [1]. Stroke is one of the leading causes of death worldwide and its incidence continues to increase [2]. The ischemic condition that happened in the central nervous system induces the recruitment of leukocytes, mainly neutrophils, to the brain tissue [1]. This type of white clood cell causes brain tissue damage by releasing inflammatory mediators, reactive oxygen species (ROS), and various proteolytic enzymes, which affect the severity of the patient's condition [3].

Numerous studies have been completed to explore the association between leukocyte count and ischemic stroke. Leukocytosis has been known to be an indicator of inflammatory response in many conditions, including in acute ischemic stroke [4]. Early leukocytosis has been found to be relatedtoinfarct volume in the brain [5]. Plenty of studies have also analyzed the correlation between leukocyte count and the severity of ischemic stroke as evaluated using NIHSS. They found a significant correlation between leukocyte count and the NIHSS score, with higher leukocyte levels associated with increased stroke severity [6]. Another study using the neutrophil-lymphocyte ratio also showed a positive correlation with increased NIHSS score [7].

Neutrophils play a crucial role in stroke outcomes. The presence of this white blood cell type in peripheral blood can serve as an early indicator of stroke severity [8]. The increase of the circulating neutrophilsoccurs several hours after stroke onset and is associated with stroke severity, infarct volume, and worsening neurological outcomes [9]. Neutrophil count has been shown to be an independent predictor of stroke outcome as measured by NIHSS[10, 11].

Therefore, this study aims to explore the correlation between neutrophil count and the ischemic stroke severity, as evaluated using NIHSS.

METHODS

This analytical observational research used a cross-sectional study design. The population of this study was total ischemic stroke patients treated at the inpatient installation of Rumah Sakit Umum (RSU) Amelia Pare, Indonesia from July 2024 to September 2024. The sampling of this research was conducted using purposive methods, collectinga total sample of 27 ischemic stroke patients.

Samples must fulfill inclusion criterias, as follow: (1) ischemic stroke patients with onset less than 72 hours; (2) complete medical record. Excluded samples are (1) patients with mixed ischemic and hemorrhagic stroke; (2) patients with psychiatric conditions that hinder the ability to perform the NIHSS assessment; (3) incomplete medical record.

The independent variable of this study is neutrophil count, while the dependent variable is the NIHSS score. The neutrophil count and NIHSS scorewere collected at the admission. Prior to data collection, the participants must provide informed consent, after getting fully informed about the purpose of the study, the procedures involved, the potential health benefits, and any possible risks that may arise during or after the procedure.

The data processing was carried out using SPSS. The neutrophil count and NIHSS scorewere analyzed to establish the frequency and percentage of each variable.To determine the statistical correlation, the data was analyzed using Spearman correlation test. The result will be considered significant if the p value is <0.05.

RESULTS

This study was conducted from July to September 2024 at RSU Amelia Pare using primary data of NIHSS scores and secondary data in the form of neutrophil count from laboratory examination. The data was collected from 27 samples of ischemic stroke patients.

Table 1: Distribution of Neutrophil Count and NIHSS in Ischemic Stroke Patients

	Frequency	**Percentage (%)**
Neutrophil Count		
<2.500 cells/µL	0	0
2.500 - 7.000cells/µL	19	70.4
>7.000cells/µL	8	29.6
NIHSS		
Minor	11	40.7
Moderate	15	55.6
Moderate to Severe	1	3.7

The results showed that out of a total of 27 ischemic stroke patients, 19 (70.4%) patients had neutrophil counts between 2.500-7.000 cells/µL and 8 (29.6%) patients had neutrophil counts >7.000 cells/µL. Based on the NIHSS score, there were 11 (40.7%) patients with minor stroke, 15 (55.6%) patients with moderate stroke, and 1 (3.7%) patient with moderate to severe stroke.

Table 2: Correlation Between Neutrophil Count and NIHSS

		Neutrophil Count (cells/µL)				**Total**		***p***	***r***
		<7.000		**>7.000**					
		n	%	n	%	n	%		
NIHSS	**Minor**	11	40.7	0	0	11	40.7	<.001	0.858
	Moderate	8	28.6	7	25.9	15	55.6		
	Moderate to Severe	0	0	1	3.7	1	3.7		
Total		19	70.4	8	29.6	27	100		

All patients with minor stroke have neutrophil counts of less than 7.000 cells/µL. Of the 15 patients with moderate stroke, 8 patients had neutrophil counts of less than 7.000 cells/µL and the remaining 7 patients had neutrophil counts above 7.000 cells/µL. There was only one patient with moderate to severe stroke and the neutrophil count was higher than 7.000 cells/µL.

Spearman correlation test showed the result of p-value <0.001 ($\alpha = 0.05$) which means there is a significant correlation between neutrophil count and ischemic stroke severity based on NIHSS. The correlation coefficient was

found to be 0.858, indicating a directly proportional and very strong correlation.This result means that the higher the number of neutrophils, the more severe the ischemic stroke.

DISCUSSION

This study found 8 ischemic stroke patients with neutrophil count above the normal value, which is 7.000 cells/µL [12]. The other 19 ischemic stroke patients had normal neutrophil counts. This could happen because the increase in leukocyte count, especially neutrophils, is related to the infarct volume [13]. The increase in the area of infarct is directly proportional to the increase in the number of leukocytes and neutrophils. Therefore, the results of the normal neutrophil count in these patients might occur because the infarct volume is not too large [6].

Neutrophil count is also associated with stroke severity and worsening neurological outcomes [9]. In line with the results of this study, it was found that most patients with normal neutrophil counts (58%) had minor stroke. All patients with moderate to severe stroke had neutrophil counts above normal values.

This study showed a significant correlation between the neutrophil count and the severity of ischemic stroke based on NIHSS. This finding is in line with the study by Fang *et al*., [11]. Multiple stepwise logistic regression analysis conducted in the study by Fang *et al.*, [11] showed that the number of neutrophils could significantly predict high NIHSS results.

The correlation coefficient results showing the strength of the relationship between the two variables were obtained at 0.858 which is included in the category of a very strong correlation strength level. A positive correlation coefficient means that the correlation is directly proportional. These results indicate that the higher the number of neutrophils, the more severe the severity of ischemic stroke patients will be. Similar results can be found in a study by Fang *et al*., [11]. In this study, the number of neutrophils increased progressively from stroke with mild, moderate, to severe severity [11].

This study has several limitations, the most prominent one is this study only assessed neutrophil count as a factor that influences the severity of ischemic stroke. This study did not investigate other factors that play a role in ischemic stroke severity. With a cross-sectional study design, this study only assessed the correlation between the neutrophil count taken at one time, when the patient was first admitted to the hospital.

CONCLUSION

There was an increase in the number of neutrophils above normal values in patients with moderate and moderate to severe stroke severity. The results of the Spearman correlation test showed a significant relationship that was directly proportional and very strong between the neutrophil count and the severity of ischemic stroke based on NIHSS at RSU Amelia Pare. Other studies may be needed to identify other factors that play a role in determining the severity of ischemic stroke.

DECLARATIONS

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Conflict of Interest: The authors declare no conflicts of interest.

Ethical approval: This research was approved by *KomisiEtikPenelitian Kesehatan* Universitas Ciputra with clearance number No. 128/EC/KEPK-FKUC/VI/2024 and Rumah Sakit Amelia Pare with approval number No. 007A.3506036/Diklat/VII/2024. All research participants provided written consent before participating in this study.

REFERENCES

1. Hammer, G. D., & McPhee, S. J. (2018). *Pathophysiology of Disease: An Introduction to Clinical Medicine 8E*. McGraw-Hill Education / Medical.
2. Chugh, C. (2019). Acute Ischemic Stroke: Management Approach. *Indian Journal of Critical Care Medicine*, *23*(2), 140–146. https://doi.org/10.5005/jp-journals-10071-23192
3. Kömürcü, H. F. (2022b). The role of neutrophils, lymphocytes, and platelets in ischemic stroke. *BOĞAZİÇİ TIP DERGİSİ*, *9*(4), 279–285. https://doi.org/10.14744/bmj.2022.48030
4. Boehme, A. K., Kumar, A. D., Lyerly, M. J., Gillette, M. A., Siegler, J. E., Albright, K. C., Beasley, T. M., & Martin-Schild, S. (2014). Persistent Leukocytosis—Is this a Persistent Problem for Patients with Acute Ischemic Stroke? *Journal of Stroke and Cerebrovascular Diseases*, *23*(7), 1939–1943. https://doi.org/10.1016/j.jstrokecerebrovasdis.2014.02.004

5. Quan, K., Wang, A., Zhang, X., & Wang, Y. (2019). Leukocyte count and adverse clinical outcomes in acute ischemic stroke patients. *Frontiers in Neurology*, 10. https://doi.org/10.3389/fneur.2019.01240
6. Hafsoh, T. Y., Adam, O. M., &Tehupuring, S. E. (2020). HubunganJumlahLekositdenganDerajatKeparahanPasien Stroke IskemikBerdasarkan National Institute of Health Stroke Scale. *Hang Tuah Medical Journal*, *17*(2), 130. https://doi.org/10.30649/htmj.v17i2.163
7. Iyigundogdu, I., Derle, E., Kibaroglu, S., & Can, U. (2021). Neutrophil to lymphocyte ratio, stroke severity and short term clinical outcomes in acute ischemic stroke. *Neurology Asia*, *26*(3), 479–484. https://doi.org/10.54029/2021cmz
8. Cai, W., Liu, S., Hu, M., Huang, F., Zhu, Q., Qiu, W., Hu, X., Colello, J., Zheng, S. G., & Lu, Z. (2020). Functional dynamics of neutrophils after ischemic stroke. *Translational Stroke Research*, *11*(1), 108–121. https://doi.org/10.1007/s12975-019-00694-y
9. Amalia, L., &Dalimonthe, N. Z. (2020). Clinical significance of Platelet-to-White Blood Cell Ratio (PWR) and National Institute of Health Stroke Scale (NIHSS) in acute ischemic stroke. *Heliyon*, *6*(10), e05033. https://doi.org/10.1016/j.heliyon.2020.e05033
10. Zhang, X., Xue, J., Yang, W., Xu, X., Sun, H., Hu, L., Liu, L., & Yue, Y. (2020). Inflammatory markers as independent predictors for stroke outcomes. *Brain and Behavior*, *11*(1). https://doi.org/10.1002/brb3.1922
11. Fang, Y., Tong, M., Sung, P., Chen, Y., Chen, C., Tsai, N., Huang, C., Chang, Y., Chen, S., Chang, W., Lu, C., & Yip, H. (2017). Higher neutrophil counts and neutrophil-to-lymphocyte ratio predict prognostic outcomes in patients after non-atrial fibrillation-caused ischemic stroke. *Biomedical Journal*, *40*(3), 154–162. https://doi.org/10.1016/j.bj.2017.03.002
12. Hoffman, R., Benz, E. J., Silberstein, L. E., Heslop, H. E., Weitz, J. E., Salama, M. E., & Abutalib, S. A. (2023). *Hematology: Basic Principles and Practice 8E*. Elsevier.
13. Tarkanyi, G., Karadi, Z. N., Szabo, Z., Szegedi, I., Csiba, L., &Szapary, L. (2020). Relationship between leukocyte counts and large vessel occlusion in acute ischemic stroke. *BMC Neurology*, *20*(1). https://doi.org/10.1186/s12883-020-02017-3