

The Relationship Between Leukocytes Numbers and Consciousness Level of Craniotomy Patients at The Jemursari Islamic Hospital Surabaya in 2018-2019

Ainul Rofiq¹, Utami Ambarsari², Hafizh Auliyah Sodali³, Misbakhul Munir³

¹Departement of Anesthesiology and Reanimation, Faculty of Medicine, Universitas Nahdlatul Ulama Surabaya, Jawa Timur, Indonesia

²Departement of Radiology, Faculty of Medicine, Universitas Nahdlatul Ulama Surabaya, Jawa Timur, Indonesia

³Faculty of Medicine, Universitas Nahdlatul Ulama Surabaya, Jawa Timur, Indonesia

Correspondence:
Misbakhul Munir,
Jl. Jemursari No. 51-57, Surabaya,
East Java, Indonesia
Zip Code: 60237

Email: munirdr04@gmail.com

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Abstract

This study investigates the correlation between leukocyte number and the patient's awareness level after craniotomy surgery, both high (leukocytosis) and low (leukopenia). Several studies reveal that an increase in leukocytes affects mortality rates due to the high level of leukocytes affecting our body's functionalities, including awareness. Previous studies revealed that a leukocyte count exceeding $17.5 \times 10^6/L$ was associated with a lower GCS score, a longer hospital stay, and worsening CT scan results, regardless of the type of focal lesion that occurred. This study uses observational methods in the form of retrospective case studies. The data was collected from the medical records of the Operation room at Jemursari Islamic Hospital in 2018-2019 with a sample size of 89. The research was conducted at Jemursari Islamic Hospital Surabaya from May 2018 to August 2019. Data were analyzed using the Spearman correlation test with $p < 0.05$. Results showed no significant relationship between the leukocyte count and the consciousness level of post-craniotomy patients. Future research could estimate the specific effects on the morphology of specific leukocyte cells that are elevated in post-craniotomy patients. This research is expected to provide insight into the effect of leukocytes on consciousness to reduce patient mortality after craniotomy.

Keywords

Craniotomy, leucocytes, patient



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INTRODUCTION

The craniotomy is a surgical procedure that opens the cranium to access the brain. Craniotomy means making a hole (s) in the skull (cranium). Traumatic brain injury is the most common reason for craniotomy (1). In many countries, traumatic brain injury is the leading cause of death and disability in the early decades of life. An estimated 1.4 million people experience a traumatic brain injury each year in the United States, and more than 5 million people experienced disability from traumatic brain injury (2). The operation is performed in a hospital with an adequate neurosurgical department and Intensive Care Unit (ICU) (3). Craniotomy procedure, like any other operative procedure, carries a death risk. The research conducted at Dr Kariadi Semarang from February 2010 to February 2012 reveals that 51 of 103 dead patients underwent craniotomy surgery treated at the High Care Unit (HCU) and ICU (4).

In comparison, white blood cells or leucocytes, other cells found in the blood, has a different function from erythrocytes. White blood cells or leukocytes play a role in defending the body against foreign objects that possible harm the survival of the individual (5). Leucocytes type consisting of granular (include basophils, eosinophils, rod neutrophils, neutrophils) and agranular (includes lymphocytes, monocytes, and plasma cells) (6). As an immune system

component, white blood cells flow in the human blood and kill germs or diseases. The normal white blood cell count (WBC) in peripheral blood is in the reference range from 3.2×10^3 to 10×10^3 WBC/ μ L (7). Leukocytes are the main cell of the body defence system. Leukocytes serve for protection, the body's defences against infection, and kill mutant cells (8). Monocytes, the largest blood cells, are the second layer of body defence that can phagocytose and belong to macrophages (9). An increase in the percentage of monocytes in the leukocyte count indicates inflammation (10).

Some research shows that leukocytosis without infection is associated with increased hospital mortality, but this finding is not supported by complete data. Al-Gahtany (6) in Saudi Arabia found a significant association between leukocyte count and GCS (Glasgow Coma Scale) score. Leukocyte count exceeding 18×10^6 /L has a predictive value for low GCS scores (6). Likewise, Gurkanlar *et al.* (11) in Turkey show that leukocyte counts have a significant relationship to GCS scores, length of stay in the hospital, worsening head CT scan results, Glasgow Outcome Scale (GOS), and leukocyte counts exceeding 17.5×10^6 /L. In addition, patients with traumatic subarachnoid hematoma had a higher mean leukocyte rate than a normal one. Therefore, this study would assess a relationship

between the blood leukocyte count and the GCS score in craniotomy surgery patients in the ICU room at Jemursari Islamic Hospital.

Al-Gahtany (6) showed a significant relationship between leukocyte count and GCS score, where a high leukocyte total (exceeding $14.18 \times 10^6/L$) is associated with the low GCS scores (6). Rovlias & Kotsou (12), from a prospective analysis of 125 patients, find that severe head injuries had a significantly higher leukocyte count than moderate and mild head injuries. The study of Gurkanlar *et al.* (11) on 59 head injury patients found that a leukocyte count exceeding $17.5 \times 10^6/L$ was a predictive factor for poor GCS score, prolonged hospital stay, and worsening CT scan results, regardless of the type of focal lesion that occurred. Syed Shahzad Hussain *et al.* (13) in Pakistan show that patients with severe head injuries experienced increased total leukocytes.

Some literature proposes that catecholamines and corticosteroids have a significant role in increased leukocytes in the injured patient. Corticosteroids increase the leukocyte count by releasing leukocyte cells from their storage sites in the bone marrow into the bloodstream (14). In the brain, the microglia cell bodies become hypertrophied by a long process after trauma. Then microglia cell bodies branch in the first sixty minutes after trauma (15). Microglial cells express MHC class I and II antigens. These antigens are presented to lymphocytes in

regional lymph nodes and activate lymphocytes circulating in the central nervous system (12).

Furthermore, new leukocytes are increased in severe head injuries. Leukocyte cells are less elastic than erythrocytes, requiring a higher pressure to push them into small diameter capillaries. In a state of decreased perfusion pressure, the capillaries can act as a net and trap leukocyte cells to increase the leukocyte count. After this process, the leukocyte cells stick to the endothelium and cannot be released even though the perfusion pressure has returned to normal (15).

The purpose of this study was to determine the relationship between the leukocytes number and the consciousness level of craniotomy patients at the Jemursari Islamic hospital Surabaya in 2018-2019. In addition, this research is expected to provide scientific information about the relationship between the number of leukocytes and the level of awareness in craniotomy surgery patients at the ICU Jemursari Islamic Hospital. The research results on post craniotomy patients at the Jemursari Islamic Hospital in Surabaya during 2018-2019 can give essential information for surgery doctors.

MATERIALS AND METHODS

We performed an analytical observational study without direct treatment

to subjects and used a case study design with a retrospective approach. The Health research ethics committee has approved this research at the Jemursari Islamic Hospital Surabaya by letter number 0102/KEPK-RSI JS/IX/2019. The data collected is secondary data collected from the operation room of the Jemursari Islamic Hospital in Surabaya for the period 2018-2019.

The population in this study was the medical records of post craniotomy patients at the Jemursari Islamic Hospital in Surabaya from May 2018 to August 2019. The sample in this study was the medical records of post craniotomy patients at the Jemursari Islamic Hospital in Surabaya in May 2018 - August 2019 grouped into the inclusion or exclusion criteria. Sampling was done by purposive sampling. Inclusion criteria for Craniotomy Patients are Post-Craniotomy GCS Data and Post-Craniotomy Complete Blood (Leukocyte) Lab Results. Exclusion criteria are Incomplete Medical Records such as missing GCS and Leukocyte Laboratory Data.

The collected data were analyzed and grouped based on the inclusion and exclusion criteria. Thus, these data are considered valid and reliable for our study. The collected data were entered into a computer system for tabulation and statistical analysis using SPSS software (version 17.0). Baseline data were analyzed using quantitative techniques where variables are expressed as frequencies and

percentages or as mean with standard deviation. Both the independent and dependent variables use a nominal measurement scale. The correlation between the leukocyte count and the patient's level of consciousness was analyzed using the Spearman correlation test. Statistical significance was defined if $P < 0.05$.

We declare that there is no intervention on the research subjects. Patient data confidentiality was protected by not including the patient's name and identity to comply with research ethics. Data processing will be performed in the following ways:

- Collecting medical records of craniotomy patients in 2018
- Collecting data per month proportionally until the samples number reaches the target
- Entering the required data per medical record into the recapitulation table
- Entering data including patient's initials, age, gender, level of consciousness (GCS number), and the leukocyte count in the table.

RESULTS

We found that ninety samples of patients selected by the purposive sampling technique had met the inclusion criteria. The sample characteristics were described based on the leukocytes number and the consciousness level of the patient.

Table 1. Data on age range and gender of post-craniotomy patients at the Jemursari Islamic hospital, Surabaya, 2018

Patient		Freq (n=90)	Percentage (%)
Age (years)	0-20	2	2.2
	21-40	16	17.8
	41-60	68	75.6
	> 60	4	4.4
Gender	Male	20	22.2
	Women	70	77.8

We found that the highest population age group is 41-60 years of 68 (75.6%), and the lowest population age group is 0- 20 years of 2 (2.2%) (Table 1). Eighty-three research subjects were male (20 people or 22.2%) and female subjects (70 people or 77.8%).

Table 2. Data on the number of leukocytes in post craniotomy patients at Jemursari Islamic Hospital Surabaya in 2018

Number of Leukocytes	Freq (n=90)	Percentage (%)
High	73	81.1%
Normal	17	18.9%
Total	90	100.0%

We found that 73 patients (81.1%) have an increase in leukocyte numbers, and 17 patients (18.9%) have normal leukocytes numbers (Table 2).

Table 3. Data on Awareness Level of Post Craniotomy Patients at Jemursari Islamic Hospital Surabaya in 2018

Level of Consciousness	Freq (n=90)	Percentage (%)
Nomal	84	93.3
Decreased	6	6.7

The patients with normal consciousness levels were 84 (93.3%), and those with

decreased consciousness levels were 6 (6.7%) (Table 3).

The Spearman's Correlation statistical test of Leukocyte Count and Awareness Level shows a not significance value of 0.026 ($P > 0.05$), which means that there was no significant relationship between the number of leukocytes and the level of consciousness in post craniotomy patients. The correlation of the two variables between the consciousness level and the leukocytes number is very weak by the correlation coefficient of -0.126.

DISCUSSION

The highest craniotomy patient age group is 41-60 years (75.6%) (Table 1), indicating that most of the craniotomy patients at the Jemursari Islamic Hospital Surabaya are older people or one with degenerative diseases that require craniotomy surgery. These results are in line with (16), in which the incidence of brain tumors increased rapidly at the age of 40-70 years in 2014-2016 and then increased sharply in its development. On the other hand, male craniotomy patients were 83 (22.2%) and 77.8% female. This result shows that most of the craniotomy patients at the Jemursari Islamic Hospital are women. This data aligns with the research conducted at RSUD Dr. Hasan Sadikin Bandung in 2010–2013 that most brain tumor sufferers were women (17).

Several reports propose the role of catecholamines and corticosteroids in the presence of trauma due to craniotomy (Table 2). Corticosteroids increase the leukocyte number by releasing them from their storage sites in the bone marrow into the bloodstream (14). In the brain, the microglia cell bodies become hypertrophied by a long process after trauma. Then microglia cell bodies branch in the first sixty minutes after trauma (15). Microglial cells express MHC class I and II antigens. These antigens are presented to lymphocytes in regional lymph nodes and activate lymphocytes circulating in the central nervous system (12).

Because leukocyte cells are less elastic than erythrocytes, they require more force to be pushed into small capillaries. When the perfusion pressure is low, the capillaries act as a net, trapping leukocyte cells and increasing the leukocyte count. Even though the perfusion pressure has returned to normal, the leukocyte cells have adhered to the endothelium and cannot be released (15).

There were 84 (93.3%) patients with normal consciousness levels and six patients with decreased consciousness levels (6.7 percent) (Table 3). The number of craniotomy patients who experience an increase in leukocytes is above 50%. This result does not fit the findings of Guranlar *et al.* that higher leukocyte counts (more than $17.5 \times 10^6/L$) are correlated to poor GCS scores, length of hospital stay, and worsening

CT scan results in 59 head injury patients (11).

The Spearman's Correlation statistical test of Leukocyte Count and Awareness Level gave a nonsignificant value of 0.026 ($P > 0.05$), indicating no significant relationship between the number of leukocytes and the level of consciousness in post-cranial surgery patients. The relationship between the two variables is not unidirectional. The higher awareness level is not correlated to the higher leukocyte number. This result is not in line with the research by Al-Gahtany (6) in Saudi Arabia, which showed a significant relationship between leukocyte count and GCS score (leukocyte count exceeding $14.18 \times 10^6/L$ is correlated to low GCS scores) (6).

The increase in leukocytes itself can occur due to the inflammatory response in the body, stimulated by both microbes and non-microbes. The case related to this study is an increase in leukocytes due to tissue and muscle damage, where the response produced by one person is different from another (18). Decreased level of consciousness is caused by the failure of the projection and reception of afferent impulses by the reticular activating system (RAS) and the brain's two hemispheres so that alertness and awareness are not achieved (19). This condition can be caused by various factors, for example, lesion destruction caused by infection and trauma. It is often characterized by an increase in leukocytes as an indication

of inflammation (18).

These results indicate that the leukocyte number alone cannot indicate infection or trauma, especially trauma to the center of consciousness. Subsequent investigations need to be performed to assess other factors, including the presence of infection or trauma associated with loss of consciousness. These factors can be combined with the leukocyte count, although the leukocyte count is not an ideal biomarker. Deepak (20) shows that the leukocyte count can be used to evaluate and measure brain injury after intracranial surgery and can have enormous utility in routine neurosurgical treatment.

In the subsequent research, we need to collect a larger population to get more accurate and significant results. Further studies need to analyze the impact of craniotomy surgery on the morphology of specific leukocytes so that the specific effects of these cells can be estimated. Improvements to research data can be made by recording medical records of research locations and classifying research data.

We found that 73 patients (81.1%) have an increase in leukocyte numbers, and 17 patients (18.9%) have normal leukocyte numbers (Table 2). This mechanism occurs in the presence of trauma due to craniotomy. The patients with normal consciousness levels were 84 (93.3%), and those with decreased consciousness levels were 6 (6.7%) (Table 3).

This result is in accordance with the fact that the percentage of craniotomy patients with increased leukocytes is more than 50%. The Spearman's Correlation statistical test of Leukocyte Count and Awareness Level gave a non-significant value of 0.026 ($P > 0.05$), indicating no significant relationship between the number of leukocytes and the level of consciousness in post-craniotomy patients. This result is different from Al-Gahtany's research (6) in Saudi Arabia which showed a significant relationship between leukocyte count and GCS scores. An increase in leukocytes number can occur due to an inflammatory response in the body, stimulated by both microbes and non-microbial, such as lesions damaged by infection and trauma (18).

These findings suggest that the number of leukocytes alone cannot indicate infection or trauma, particularly trauma to the center of consciousness. Other factors, such as the presence of infection or trauma associated with loss of consciousness, must be investigated further.

CONCLUSIONS

In conclusion, most of the craniotomy patients at Jemursari Islamic Hospital Surabaya are elderly and female patients, where elderly patients often have degenerative diseases that require craniotomy surgery.

AUTHOR CONTRIBUTIONS

Ainul Rofiq: conceptualization, methodology, supervision. Utami Ambarsari: conceptualization, methodology, supervision. Hafizh Auliyani Sodali: data curation, writing-original draft preparation, visualization, investigation, writing-reviewing and editing. Misbakhul Munir: data curation, writing-original draft

preparation, visualization, investigation, writing-reviewing and editing.

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CONFLICT OF INTEREST

There are no conflicts of interest.

REFERENCES

1. Kourbeti IS, Vakis AF, Ziakas P, et al. Infections in patients undergoing craniotomy: Risk factors associated with post-craniotomy meningitis. *J Neurosurg.* 2015;122(5):1113-1119. doi:10.3171/2014.8.JNS132557
2. Wang HC, Lin YJ, Tsai NW, et al. Serial plasma deoxyribonucleic acid levels as predictors of outcome in acute traumatic brain injury. *J Neurotrauma.* 2014;31(11):1039-1045. doi:10.1089/neu.2013.3070
3. Marcovitch H. *Black's Medical Dictionary.* 41 edition. A & C Black Publishers; 2005.
4. Pribadi H. Angka kematian pasien kraniotomi di ICU dan HCU RSUP Dr. Kariadi. [Mortality rate of craniotomy patients in ICU and HCU Dr. Kariadi]. *media Medika muda.* Published online 2012.
5. Sadikin M. Blood biochemistry, [Biokimia darah]. Widya Medika; 2002.
6. Al-gahtany M. Serum leukocyte count (WBC) levels as an indicator for severity of traumatic brain injury in Saudi Arabia patients. *Egypt J Neurosurg.* 2015;30(2):145-150. <http://www.ejns.edu.eg/beta/images/June2015/FI N145-150.pdf>
7. Walker HK, Hall WD, Hurst JW. *Clinical methods : The history, physical, and laboratory examinations.* 3rd ed. Butterworth-Heinemann; 1990.
8. Giyartika F, Keman S. The differences of improving leukosit in radiographers at Islamic Hospital Jemursari Surabaya. *J Kesehatan Lingkungan.* 2020;12(2):97. doi:10.20473/jkl.v12i2.2020.97-106
9. Khasanah MN, Harjoko A CI. Klasifikasi sel darah putih berdasarkan ciri warna dan bentuk dengan metode k-nearest neighbor. [Classification of white blood cells based on characteristics of color and shape using the k-nearest neighbor method]. *IJEIS;* 2016.
10. Adisti SP, Subagya Y AR. Korelasi antara numeric rating scale dengan peningkatan monosit pada pasien hernia nucleus pulposus lumbal. [Correlation Between Numeric Rating Scale With Increased Monocytes In Lumbar Nucleus Pulposus Hernia Patients]. *Callosum Neurol;* 2018.
11. Gürkanlar D, Lakadamyali H, Ergun T, Yilmaz C, Yücel E, Altinörs N. Predictive value of leucocytosis in head trauma. *Turk Neurosurg.* 2009;19(3):211-215.
12. Rovlias A, Kotsou S. After severe head injury using simple clinical and laboratory variables. *J Neurotrauma.* 2004;21(7):886-893.
13. Shahzad HS, Ahmad KU, Raza A, Hafeez A, Ashraf N, Shahid S. Leukocytosis: predictor of radiological and neurological outcome of patients of traumatic brain injury presented to Jinnah Hospital, Lahore. *Pakistan J Neurol Surg.* 2019;23(4):300-307. doi:10.36552/pjns.v23i4.386
14. Hazeldine J, Lord JM, Belli A. Traumatic brain injury and peripheral immune suppression: primer and prospectus. *Front Neurol.* 2015;6 (November). doi:10.3389/fneur.2015.00235
15. Niryana W. Hubungan antara hitung leukosit dalam darah dengan derajat cedera kepala, adanya fokal lesi dan perdarahan subaraknoid traumatik di RSUP Sanglah Denpasar. [The relationship between the leukocyte count in the blood with the degree of head injury, the presence of focal

- lesions and traumatic subarachnoid hemorrhage at Sanglah Hospital Denpasar]. *Medicina (B Aires)*. 2019;50(1):96-100.
doi:10.15562/medicina.v50i1.428
16. Radinal YSP, Amrosia N. Primary brain tumor with hemiparesis dextra and paresis nerve ii, iii, iv, vi. *medula*. 2014;2(3).
 17. Gunadi SV, Suryanti S, Yohana R. The Distribution of meningioma in Dr. Hasan Sadikin General Hospital Bandung Period 2010–2013. *Althea Med J*. 2018;5(3):157-160.
doi:10.15850/amj.v5n3.1062
 18. Abbas AK, Aster JC, Kumar V. *Buku ajar patologi robbins*. 9 edition. (Maria Ham Meilania Saraswati, ed.). Elsevier Saunders; 2015.
 19. Aninditha T, Prawiroharjo P. *Buku Ajar neurologi*. Departemen Neurologi FKUI-RSCM; 2017.
 20. Deepak A, Nilesh K, Bhawani, SS. Leukocytosis after routine cranial surgery: A potential marker for brain damage in intracranial surgery. *Asian J Neurosurg*. 2016;2:109-113.