

Correlation between Glasgow Coma Scale (GCS) Score and Lesion Location with Mortality in Patients with Ischemic Stroke

Neva Galih Pramesti¹, Sulistyani Sulistyani^{1*}, Busyra¹, Erika Diana Risanti¹

¹ Faculty of Medicine, Universitas Muhammadiyah Surakarta, Surakarta, Indonesia

Abstract

Purpose: This study evaluated the correlation between GCS scores and lesion locations with mortality in ischemic stroke patients.

Methodology: This cross-sectional study analyzed secondary data from 50 ischemic stroke inpatients at RSUD dr. Soeratto Gemolong between August 2022 and August 2024. GCS scores were categorized as severe (≤ 8), moderate (9–12), and mild (13–15). Lesion locations were classified as supratentorial or infratentorial. The relationship between these variables and mortality was analyzed using the chi-square test.

Results: A significant correlation was found between GCS scores and mortality ($p = 0.001$). Patients with severe GCS scores had a 54% mortality rate compared to 8% in patients with mild scores. No significant association was observed between lesion location and mortality ($p = 0.118$), although patients with supratentorial lesions showed a higher mortality rate (40%) than those with infratentorial lesions (28%).

Applications/Originality/Value: GCS scores are a strong predictor of mortality in ischemic stroke patients, highlighting their importance in early risk stratification. Lesion location, while showing trends, was not significantly associated with mortality. The findings support healthcare policy improvements, personalized care, and future research into comprehensive stroke management. Further research is needed to explore these factors comprehensively and improve patient outcomes.

Introduction Section

Stroke is a neurological disorder characterized by the sudden cessation of blood flow to the brain, which can occur due to either blockage (ischemic stroke) or rupture of blood vessels (hemorrhagic stroke). This interruption leads to brain tissue damage and even death, as the affected areas are deprived of oxygen and nutrients (Salaudeen, Bello, Danraka, & Ammani, 2024). Ischemic stroke is the most prevalent type, accounting for 62.4% of all stroke cases worldwide and contributing significantly to death and long-term disability, posing substantial health and economic challenges (Pu et al., 2023).

Globally, stroke is the second leading cause of death, responsible for 11.6% of all mortalities (Pu et al., 2023). About 8–12% of ischemic strokes are fatal compared to 37–38% of hemorrhagic strokes. It depends on the severity of the stroke, advanced age, comorbidities and the effectiveness of treating complications (Balami, Chen, Grunwald, & Buchan, 2011). The Survei Kesehatan Indonesia (SKI) in 2023 reported a national stroke incidence rate of 8.3%, with the Central Java province slightly higher at 8.4% (Kemenkes, 2023). Additionally, stroke is the leading cause of death in most hospitals in Indonesia, with a mortality rate of 14.5% (Wicaksana, Wati, & Muhartomo, 2017). The World Stroke Organization (WSO) reports that approximately 3.3 million people die from ischemic stroke annually, with a global case fatality rate of 13.5% (Feigin et al., 2021). Indonesia has the highest mortality rate related to ischemic stroke in Southeast Asia, with 193.3 deaths per 100,000 person-years (Yamanie et al., 2024).

Several factors have been identified as predictors of mortality in ischemic stroke. Yamanie et al. (2024) found that NIHSS scores, uric acid levels, cardiovascular disease, pneumonia, sepsis, and GCS scores at admission were key determinants of in-hospital mortality among ischemic stroke patients. Lesion location also influences prognosis and severity (Yassi et al., 2015).

The Glasgow Coma Scale (GCS) is widely used to assess the level of consciousness and predict long-term outcomes in patients (Healy et al., 2019). Mosisa et al. (2023) reported that stroke patients with GCS scores ≤ 8 had a 7.71 times higher likelihood of death compared to those with scores of 13–15. Patients with poor GCS scores are more

* Corresponding author: sul271@ums.ac.id

likely to die, typically because of complications such as aspiration pneumonia and intracranial pressure. Admas et al. (2022) also showed that patients with severe GCS disturbances were 2.38 times more likely to die than those with mild or normal GCS scores, whereas patients with moderate impairment GCS had 2.16 times more risk of mortality compared to normal/mild impairment GCS, suggesting that patients with low GCS scores are at higher risk due to higher probability of developing acute phase neuro-medical stroke complications. However, some research has presented differing results; for example, Vahdati et al. (2019) found that GCS scores were not significantly related to prognosis in terms of hospital length of stay due to limitations in evaluating brainstem reflexes and complex motor responses (Admas et al., 2022; Mosisa et al., 2023; Vahdati et al., 2019).

Lesion location has also been explored as a factor influencing ischemic stroke severity. Currently, stroke syndromes are further classified into supratentorial and infratentorial strokes, depending on which area of the brain parenchyma is affected and where it is located in relation to the cerebral tentorium. Supratentorial compartment stroke comprises the stroke due to occlusion of the internal carotid artery and its branches. In contrast, infratentorial compartment refers to strokes caused by the vertebral artery and its branches (Deollikar, Raut, Toshniwal, Kumar, & Acharya, 2024; Padwale et al., 2024). Padwale et al. (2024) found that patients with infratentorial lesions had higher mortality and poorer recovery outcomes than those with supratentorial lesions. Supratentorial strokes had superior recovery rates, whereas infratentorial strokes presented a markedly elevated mortality rate. Conversely, Kramer et al. (2022) reported a higher mortality rate in patients with supratentorial lesions (73%) compared to infratentorial lesions (27%). On the other hand, Lathifah (2018) observed no significant relationship between lesion location and mortality, indicating a need for further investigation.

This study hypothesizes that lower GCS scores and specific lesion locations are associated with higher mortality rates in ischemic stroke patients. The findings could enhance clinical understanding and improve early risk stratification, aiding in developing targeted treatment plans and improving survival rates.

Method

This study employed an analytic observational method with a cross-sectional approach and was conducted at Rumah Sakit Umum Daerah (RSUD) dr. Soeratno Gemolong from August 2022 to August 2024. Secondary data were obtained from the medical records of ischemic stroke inpatients. The sample was selected using a purposive sampling technique, ensuring that participants met specific inclusion criteria: patients with a confirmed diagnosis of ischemic stroke, complete medical data including CT scan readings, documented GCS scores at admission, and age over 45 years. Exclusion criteria were established to minimize bias, excluding patients who died from non-stroke-related causes such as heart disease, diabetes mellitus, or sepsis. The sample size was 50 patients.

Data were systematically extracted from medical records, ensuring completeness and accuracy. The independent variables included GCS scores at admission, categorized into ≤ 8 (severe), 9–12 (moderate), and 13–15 (mild), and the lesion location as identified by CT scans, classified as supratentorial or infratentorial. The dependent variable was patient mortality, defined as survival or death during the hospital stay. Data collection involved careful review and extraction of patient demographic information, GCS scores, lesion locations, and outcomes.

Univariate analysis was performed to describe patient data, including distributions of age, sex, GCS categories, lesion locations, and mortality rates. Bivariate analysis assessed the relationship between independent variables (GCS Score and lesion location) and dependent variable (mortality) using the chi-square test. The data were processed and analyzed using statistical software to ensure accuracy and reliability. The significance level was set at $p < 0.05$, providing a robust threshold for determining statistical significance. Subgroup analyses were performed to explore trends within the data, such as variations in outcomes based on age, sex, and lesion characteristics, although these were not the primary focus of the study.

The Health Research Ethics Commission of RSUD dr. Soeratno Gemolong approved this study with ethical approval number 800.2.2.1/1580/05.1.2/IX/2024. All data were handled in compliance with ethical guidelines to maintain patient confidentiality and adhere to research regulations.

Result and Discussion

A total of 50 patients were included in the study. A summary of the patient's characteristics can be found in Table 1.

Table 1. Sample Characteristic

| Characteristic | Mortality Group | | Total (n = 50) |
|-------------------|-------------------|----------------|-------------------|
| | Deceased (n = 34) | Alive (n = 16) | |
| Sex | | | |
| Male | 14 (28%) | 10 (20%) | 24 (48%) |
| Female | 20 (40%) | 6 (12%) | 26 (52%) |
| Age (years) | | | |
| 45-54 | 5 (10%) | 0 (0%) | 5 (10%) |
| 55-64 | 10 (20%) | 6 (12%) | 16 (32%) |
| 65-74 | 8 (16%) | 10 (20%) | 18 (36%) |
| ≥75 | 11 (22%) | 0 (0%) | 11 (22%) |
| Lesion Location | | | |
| Supratentorial | 20 (40%) | 13 (26%) | 33 (66%) |
| Infratentorial | 14 (28%) | 3 (6%) | 17 (34%) |
| GCS Score | | | |
| Severe (3 – 8) | 27 (54%) | 1 (2%) | 28 (56%) |
| Moderate (9 – 12) | 3 (6%) | 1 (2%) | 4 (8%) |
| Mild (13 – 15) | 4 (8%) | 14 (28%) | 18 (36%) |

Of the total sample, 34 patients (68%) died from their condition, while 16 patients (32%) survived. According to the distribution of sex, 24 patients (48%) were male, with 14 (28%) in the deceased group and 10 (20%) in the alive group. Females made up 26 patients (52%), with more of them in the deceased group (20 patients, 40%) than the living group (6 patients, 12%). Women accounted for a higher proportion of mortality than men. Yun et al. (2023) found that women perform poorer in motor skills, cognitive functions, and activities of daily living (ADLs) after a stroke. Age appears to play a role in mortality, with patients over 75 years showing a higher probability to die than those under 75 years. This finding is similar with recent research by Furlan et al. (2021), which highlighted older age as a risk factor for poor results due to potentially lower physiological reserves and the presence of comorbid conditions. Regarding lesion location, most participants (66%) have supratentorial lesions, while the remaining 34% have infratentorial lesions, which may reflect a higher prevalence or clinical focus on supratentorial lesions. According to Kramer et al. (2022) supratentorial strokes, particularly those affecting large vascular territories such as the middle cerebral artery, are associated with extensive infarction, cerebral edema, and a higher risk of herniation, leading to elevated mortality rates. In terms of clinical severity based on the Glasgow Coma Scale (GCS), 56% of participants fall into the severe category (scores 3–8), 8% are in the moderate range (scores 9–12), and 36% are classified as mild (scores 13–15), these results align with findings by Mosisa et al. (2023) and Admas et al. (2022), who reported that severe GCS scores are strongly associated with higher mortality due to higher probability of developing stroke complications. The predominance of severe cases suggests focusing on more critical conditions, which could influence the study's findings. Overall, the distribution of lesion location and GCS scores highlights the study's emphasis on specific clinical characteristics that may affect the interpretation and applicability of the findings.

Table 2. Bivariate Analysis Results of the Relationship Between GCS Score and Lesion Location with Ischemic Stroke Mortality

| Characteristic | Mortality Group | | Total N (%) | P-value |
|------------------------|-----------------|--------------|----------------|---------|
| | Deceased, N (%) | Alive, N (%) | | |
| Lesion Location | | | | 0.118 |
| Supratentorial | 20 (40) | 13 (26) | 33 (66) | |
| Infratentorial | 14 (28) | 3 (6) | 17 (34) | |
| GCS Score | | | | 0.001 |
| Severe (3 – 8) | 27 (54) | 1 (2) | 28 (56) | |
| Moderate (9 – 12) | 3 (6) | 1 (2) | 4 (8) | |
| Mild (13 – 15) | 4 (8) | 14 (28) | 18 (36) | |

The GCS scores demonstrated a significant relationship with mortality ($P = 0.001$) in ischemic stroke, underscoring their role as a reliable indicator of clinical outcomes. The GCS was designed to objectively, easily, methodically evaluate the neurological status of patients with impaired. The score is used to monitor neurological

status of critically ill patients (Bhaskar, 2017). The GCS objectively evaluates the level of consciousness, which directly reflects the severity of brain injury and the extent of neurological compromise. Patients with severe GCS scores (3–8) exhibited an alarmingly high mortality rate of 54%, compared to just 8% for those with mild scores (13–15). A low GCS score (≤ 8) often signifies extensive brain damage or dysfunction in critical regions, such as the cerebral cortex, brainstem, or thalamus—areas essential for maintaining consciousness and basic physiological functions. Severe brain injury associated with low GCS scores can impair vital processes, including respiratory control, protective reflexes, and hemodynamic stability, making patients more prone to life-threatening complications. Furthermore, low GCS scores are frequently associated with larger infarcts or brain edema, which can exacerbate intracranial pressure (ICP) and lead to herniation syndromes. These conditions disrupt the brain's ability to maintain homeostasis, resulting in secondary injuries and, in many cases, death. Compounding these risks, patients with low GCS scores are at heightened risk of developing complications such as aspiration pneumonia, sepsis, and systemic infections due to immobility, impaired protective reflexes, and diminished consciousness. These secondary issues further elevate the likelihood of mortality, as supported by studies from Admas et al. (2022), Iluț et al. (2023), and Mosisa et al. (2023). However, limitations in the GCS's design must also be considered. For example, as highlighted by Vahdati et al. (2019), the scale does not effectively evaluate complex brainstem reflexes or detailed eye movements. This limitation may explain why some patients with low GCS scores survive despite grim prognostic indicators, as their clinical outcomes may depend on factors beyond the scale's scope. Thus, while the GCS is invaluable for assessing ischemic stroke severity, its interpretation should be integrated with other clinical and diagnostic tools to provide a more comprehensive prognostic evaluation.

The p-value for lesion location in this study was 0.118, indicating no statistically significant relationship between lesion location and mortality in ischemic stroke patients. Despite this lack of statistical significance, the findings provide valuable insights. Supratentorial lesions were more prevalent, accounting for 66% of cases compared to 34% for infratentorial lesions. Patients with supratentorial lesions also exhibited a slightly higher mortality rate (40%) than those with infratentorial lesions (28%), though the difference was not significant. Supratentorial lesions, involving the cerebral hemispheres, are typically associated with larger areas of infarction that can severely impair motor, sensory, and cognitive functions. The relatively higher mortality rate in these cases may be attributed to complications such as cerebral oedema and herniation, which are more common when major arteries, such as the middle cerebral artery (MCA), are involved. These complications can lead to increased intracranial pressure, compromising blood flow and oxygen delivery to critical brain regions, ultimately worsening clinical outcomes. Supporting this, Kramer et al. (2022) reported a 73% mortality rate in supratentorial lesions, primarily due to massive brain swelling and secondary complications. Infratentorial lesions, while less common, often involve the cerebellum or brainstem, areas critical for maintaining life-sustaining functions such as respiration, cardiovascular regulation, and consciousness. The proximity of these lesions to the brainstem makes them particularly dangerous, as even small infarcts can disrupt essential autonomic functions, leading to severe clinical outcomes. Padwale et al. (2024) highlighted that infratentorial lesions, particularly those affecting the brainstem, were associated with higher mortality and poorer recovery compared to supratentorial lesions. This is due to the critical nature of brainstem structures and their role in maintaining life-sustaining functions. However, the data in the current study suggest a lower mortality rate for infratentorial lesions, possibly due to differences in sample size, stroke severity, or access to advanced care, which could mitigate the traditionally poor prognosis associated with these lesions.

The lack of a statistically significant relationship between lesion location and mortality in this study may be due to several factors. A critical consideration is the variability in lesion size and severity within each category. Not all supratentorial or infratentorial strokes are of equal severity. Larger infarcts or those involving critical vascular territories, such as the MCA in supratentorial strokes or the basilar artery in infratentorial strokes, are more likely to result in severe outcomes. Since this study did not analyze infarct size, smaller or less severe strokes may have diluted the observed association between lesion location and mortality. Consistent with this, Yamanie et al. (2024) emphasized that infarct size is often a stronger predictor of mortality than lesion location alone. Advancements in stroke care may also have influenced the findings. Modern therapeutic approaches, including thrombolysis, mechanical thrombectomy, and aggressive management of complications, can reduce brain damage and improve survival regardless of lesion location. For example, timely surgical interventions, such as decompressive craniectomy for supratentorial strokes or suboccipital craniectomy for infratentorial strokes, have significantly improved outcomes in patients with severe strokes. These interventions may help explain the lower-than-expected mortality rate observed in infratentorial lesions in this study. Padwale et al. (2024) similarly noted that prompt and effective treatment is a

critical determinant of survival in both supratentorial and infratentorial strokes, potentially mitigating the traditionally higher risks associated with certain lesion locations. Additionally, differences in healthcare access, early diagnosis, and variations in treatment protocols could have influenced the outcomes observed in this study. Patients with access to comprehensive stroke centers are more likely to benefit from advanced care, which may reduce mortality differences across lesion locations.

This study has several limitations that should be carefully considered when interpreting the findings. One major limitation is the lack of comprehensive data on infarct size, which is a critical determinant of both stroke severity and mortality. Infarct size plays a pivotal role in influencing patient outcomes; larger infarcts, regardless of their specific location in the brain, are more likely to lead to severe complications. Such complications may include cerebral edema, herniation, or increased intracranial pressure, all of which can significantly worsen the patient's condition and ultimately affect survival rates. Without detailed information on infarct size, it becomes challenging to fully assess the relationship between lesion characteristics and clinical outcomes. Furthermore, the study's sample size is another important consideration. The inclusion of only 50 patients may limit the generalizability of the results to larger populations. A relatively small sample size can restrict the ability to detect subtle but clinically significant differences among subgroups within the study population. In addition, with a limited number of participants, the statistical power of the analyses may be compromised, making it difficult to draw robust conclusions from the data. A larger sample size would not only enhance statistical power but also facilitate more detailed subgroup analyses, allowing for a deeper understanding of how various factors interact and influence outcomes in ischemic stroke patients. Therefore, while this study provides valuable insights, caution should be exercised in extrapolating its findings to broader clinical contexts until further research with larger cohorts is conducted.

Conclusions

GCS scores are a strong predictor of mortality in ischemic stroke patients, underscoring their critical role in early risk assessment and management. Patients with severe GCS scores (3–8) had significantly higher mortality rates, indicating the severity of brain injury and its direct impact on vital functions. This emphasizes the importance of clinicians prioritizing GCS assessment during the initial evaluation in order to identify high-risk patients and implement appropriate interventions. In contrast, while lesion location showed some trends, with supratentorial lesions showing slightly higher mortality rates than infratentorial lesions, the correlation was not statistically significant. This implies that lesion location alone may not effectively predict mortality and underscores the need of examining other criteria such as infarct size, the involvement of important arterial areas, and the existence of sequelae like cerebral edema or herniation.

The findings of this study suggest that, while GCS scores provide significant prognostic information, lesion location should be interpreted cautiously, as its impact on mortality may be influenced by other clinical and pathological variables. These findings highlight the complexities of stroke outcomes and the need for a comprehensive approach that incorporates multiple factors, such as clinical assessments, imaging findings, and therapeutic interventions, to optimize patient care. Future research should explore these relationships in larger and more diverse populations, incorporating advanced diagnostic techniques and a broader range of clinical variables to further refine prognostic models and improve survival and recovery outcomes in ischemic stroke patients.

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