



Stroke Risk Factors and Glasgow Outcome Scale-Based Clinical Outcomes at Royal Prima Hospital

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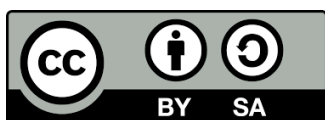
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Abstract

Stroke outcomes may vary according to demographic and vascular risk factors; however, their associations with clinical status at discharge require context-specific evaluation. This study aimed to examine the associations between selected stroke risk factors and clinical outcomes based on the Glasgow Outcome Scale (GOS) at Royal Prima Hospital Medan in 2026. An analytical observational study with a retrospective design was conducted using medical record data from April to August 2026. All 50 eligible patient records were included using total sampling. The evaluated risk factors included age, sex, hypertension, diabetes mellitus, heart disease, hyperlipidemia, and a history of previous stroke. Clinical outcomes at discharge were categorized as favorable or unfavorable based on the GOS. Bivariate associations were assessed using Pearson's chi-square test or Fisher's exact test when expected cell-count assumptions were not satisfied. Thirty-one patients (62.0%) had favorable outcomes, whereas 19 (38.0%) had unfavorable outcomes. Significant unadjusted associations were observed for age ($p = 0.031$), diabetes mellitus ($p = 0.023$), heart disease ($p = 0.043$), hyperlipidemia (Fisher's exact test, $p = 0.038$), and previous stroke history ($p = 0.001$). Hypertension ($p = 0.093$) and sex ($p = 0.991$) were not significantly associated with GOS category. These findings identify factors associated with discharge GOS in this sample; however, they do not establish independent effects or constitute a validated prognostic model because the analysis was retrospective and limited to bivariate testing.



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INTRODUCTION

Stroke is an acute neurological condition caused by disruption of cerebral blood flow, resulting either from vascular occlusion or intracranial hemorrhage. Acute stroke is broadly classified as ischemic or hemorrhagic. Ischemic stroke occurs when a cerebral blood vessel is occluded, reducing blood flow to brain tissue and potentially causing infarction, whereas hemorrhagic stroke results from rupture of a blood vessel and bleeding into the intracranial cavity (B. Utomo, 2020). Indonesian Health Profile reported a substantial burden of stroke, with approximately 1,789,261 individuals recorded as having experienced stroke (Rafiudin et al., 2024).

North Sumatra is among the Indonesian regions with a relatively high burden of stroke. Data from 25 hospitals in North Sumatra reported 562 patients with stroke (Rahayu, 2023). Stroke is associated with multiple modifiable and nonmodifiable risk factors. Hypertension, diabetes mellitus, and smoking can contribute to vascular injury and increase the risk of cerebral arterial occlusion or rupture. Unhealthy dietary patterns, including excessive consumption of sugar-sweetened foods and beverages, may also increase stroke risk through their contribution to metabolic and vascular disorders (Utama & Nainggolan, 2022).

Clinical outcomes after stroke can be evaluated using several standardized outcome measures. One instrument used in this study was the Glasgow Outcome Scale (GOS). The GOS was originally developed by Jennett and Bond to assess global outcomes after severe traumatic brain injury and classifies outcomes into categories ranging from death to good recovery. More recently, it has also been applied in studies of intracranial hemorrhage and other neurological conditions (Indradmojo et al., 2020; McMillan et al., 2016).

In international stroke research, functional outcomes are more commonly assessed using the modified Rankin Scale (mRS), whereas the severity of neurological deficits is frequently evaluated using the National Institutes of Health Stroke Scale (NIHSS) (Broderick et al., 2017; Rost et al., 2016). However, this study selected the GOS for methodological reasons. Because the study used a retrospective design, outcome assessment was limited to information documented in medical records. Determining an mRS score generally requires detailed information on functional independence and the level of assistance required in daily activities, which may not be consistently documented in routine records. The NIHSS, meanwhile, primarily measures neurological deficit severity rather than global functional outcome (Umarova et al., 2024; Utama & Nainggolan, 2022; T. Y. Utomo, n.d.; Valentina et al., 2015; Winkelmeier et al., 2024). The broader GOS categories—death, vegetative state, severe disability, moderate disability, and good recovery—could be determined more consistently from available documentation regarding consciousness, communication, functional dependence, and discharge status. In addition, because the study included both ischemic and hemorrhagic stroke cases, the previous use of GOS in intracranial hemorrhage supported its applicability in this setting (Indradmojo et al., 2020). Nevertheless, the GOS is less sensitive than the mRS for distinguishing milder degrees of disability, which should be acknowledged as a study limitation.

Previous studies cited in this manuscript have examined stroke characteristics and individual risk factors, whereas functional outcome research has more commonly relied on the mRS and NIHSS (Broderick et al., 2017; Rost et al., 2016). The GOS has also been applied to intracranial and neurological outcomes (Berlianty et al., 2022; Indradmojo et al., 2020); however, evidence examining multiple routinely documented vascular risk factors in relation to discharge GOS at Royal Prima Hospital Medan remains limited within the literature reviewed for this study. The contribution of the present study is therefore primarily contextual and methodological: it evaluates seven routinely recorded risk factors against a global discharge-outcome classification in a mixed stroke population using retrospective hospital data. The study was not designed to develop a prognostic prediction model. Rather, it aimed to describe patient characteristics, the distribution of stroke risk factors, GOS-based clinical outcomes, and the crude bivariate association between each risk factor and GOS category at Royal Prima Hospital Medan in 2026.

Stroke is a major neurological disorder caused by interruption of blood flow to the central nervous system (Rahayu, 2023). Clinically, stroke is characterized by the acute onset of neurological dysfunction due to a vascular cause and may involve the brain, spinal cord, or retina. Stroke is generally classified into ischemic and hemorrhagic subtypes according to whether the underlying event is vascular occlusion or bleeding. Accurate identification of

stroke subtype is important because management differs substantially between ischemic and hemorrhagic stroke (STR KE stroke, n.d.).

In 2021, stroke most commonly affected individuals aged 65–74 years globally, with a higher burden reported among men than women, while the highest mortality rates in both sexes occurred among those aged 80–84 years (Qian et al., 2025).

The risk factors evaluated in this study included age, sex, hypertension, diabetes mellitus, heart disease, hyperlipidemia, and previous stroke history. Stroke risk increases with age because aging is associated with vascular stiffening, endothelial dysfunction, and a greater likelihood of atherosclerotic plaque formation (Saifullah et al., 2024). Sex is a nonmodifiable risk factor. An ASNA (ASEAN Neurologic Association) survey of acute stroke patients from 28 hospitals in Indonesia reported a higher frequency of stroke among men than women, which may partly reflect a greater prevalence of behavioral risk factors such as smoking and alcohol consumption among men.

Hypertension is an important stroke risk factor because chronic elevation of blood pressure contributes to vascular remodeling, endothelial damage, and structural changes in small cerebral blood vessels (Saifullah et al., n.d.). Diabetes mellitus also increases stroke risk because chronic hyperglycemia promotes endothelial dysfunction, accelerates atherosclerosis, and contributes to vascular injury. Heart disease, particularly conditions associated with thromboembolism such as atrial fibrillation, is another major risk factor because intracardiac thrombi may embolize to the cerebral circulation and occlude cerebral arteries.

Hyperlipidemia contributes to atherosclerotic plaque formation through elevated circulating lipid levels, particularly low-density lipoprotein cholesterol. Progressive atherosclerosis can narrow or obstruct cerebral arteries and thereby increase the risk of ischemic stroke. A history of previous stroke is also associated with an increased risk of recurrence, particularly when modifiable risk factors such as hypertension, diabetes mellitus, and dyslipidemia remain inadequately controlled. Consequently, risk-factor management and secondary prevention are essential for reducing the likelihood of recurrent stroke.

Stroke is broadly classified as ischemic or hemorrhagic according to the underlying vascular event. Noncontrast computed tomography (CT) is routinely used in the acute assessment of suspected stroke because it can rapidly identify intracranial hemorrhage and assist in distinguishing hemorrhagic from ischemic stroke. Acute intracranial hemorrhage typically appears hyperdense on noncontrast CT, whereas ischemic changes may appear hypodense, although early ischemic stroke can initially show subtle or absent CT abnormalities (Dewi & Fitraneti, 2024). Stroke subtype is clinically important; however, it was not analyzed as an independent predictor in this study because of the limited sample size and the decision to analyze all stroke cases collectively.

Noncontrast CT supported the clinical differentiation of ischemic and hemorrhagic stroke before treatment. The representative CT images presented in Figures 1 and 2 provide clinical context; however, imaging findings were not included as variables in the statistical analysis of this study (Dewi & Fitraneti, 2024).

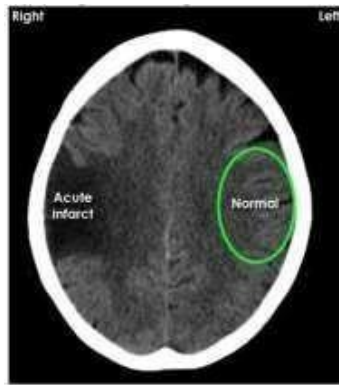


Figure 1. CT Scan of Ischemic Stroke
Source: Graham et al. (2019).

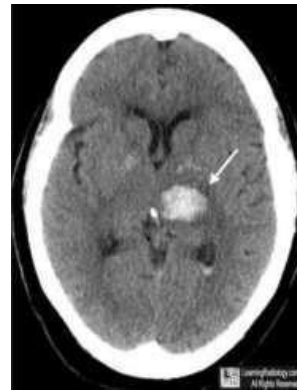


Figure 2. CT Scan of Hemorrhagic Stroke
Source: Graham et al. (2019).

The GOS category consists of five values, and the GOS value can be classified into VS–SD and MD–GR with the aim of creating a broader output category (Indradmojo et al., 2020), as presented in Table 1.

Table 1. Glasgow Outcome Scale (GOS) Categories

Value	Categories	External Groups
1	Death (<i>Death/D</i>)	<i>Unfavourable outcome</i>
2	Persistent Vegetative State (<i>VS</i>)	<i>Unfavourable outcome</i>
3	Severe Disability (<i>SD</i>)	<i>Unfavourable outcome</i>
4	Moderate Disability (<i>MD</i>)	<i>Favourable outcome</i>
5	Good Recovery (<i>GR</i>)	<i>Favourable outcome</i>

Source: Indradmojo et al. (2020); OpenMed (2022).

GOS provides a global outcome classification from death to good recovery and can be grouped into unfavorable (scores 1–3) and favorable (scores 4–5) outcomes (Indradmojo et al., 2020). In this study, GOS was used because discharge medical records contained information on consciousness, communication, motor function, and dependency that could support global classification. GOS is less sensitive than mRS for distinguishing milder disability, and this limitation is considered when interpreting the findings.

The theoretical framework positions vascular risk factors as exposures associated with the pathophysiological process of stroke and, ultimately, with clinical outcomes assessed by GOS. The pathophysiological process is included only as a conceptual basis and was not measured as an analytical variable in this study, as shown in Table 2.

Table 2. Research Theory Framework

Risk Factors for Stroke	Pathophysiological Process of Stroke	Clinical Outcomes (GOS)
Age		
Gender		<i>Death</i>
Hypertension	Blockage or bleeding of the blood vessels of the brain	<i>Vegetative State</i>
Diabetes mellitus		<i>Severe Disability</i>
Heart disease		<i>Moderate Disability</i>
Hyperlipidemia		<i>Good Recovery</i>
Previous stroke history		

Source: Authors' conceptualization based on the study variables, 2026.

The hypothesis of this study is that there is a relationship between stroke risk factors and patient clinical outcomes based on *the Glasgow Outcome Scale (GOS)*, assuming based on previous research that there is a relationship between risk factors for other diseases and clinical outcomes based on the GOS assessment.

METHOD

Research Type and Design

This study employed a quantitative analytical observational design with a retrospective approach to examine the association between stroke risk factors and clinical outcomes based on the Glasgow Outcome Scale (GOS) at Royal Prima Hospital Medan. Data were obtained from the medical records of patients diagnosed with stroke. The independent variables were age, sex, hypertension, diabetes mellitus, heart disease, hyperlipidemia, and previous stroke history, while the dependent variable was the clinical outcome based on GOS.

The study was conducted at Royal Prima Hospital Medan from April to August 2026. The study population comprised all patients diagnosed with stroke during this period. Eligible records were those of adult and older patients with complete information on the study variables and sufficient documentation to determine GOS-based clinical outcomes. Records with incomplete data or insufficient information for GOS classification were excluded. Patients older than 85 years were also excluded; however, the manuscript should provide a clear methodological or clinical justification for this criterion because age was one of the primary variables analyzed.

A total of 50 medical records met the eligibility criteria, and all were included using total sampling. Both ischemic and hemorrhagic stroke cases were included and analyzed as a single group. Separate analyses by stroke subtype were not performed because of the limited sample size ($N = 50$), which would have resulted in small cell counts for subgroup comparisons.

Medical records served as the primary data source for demographic characteristics, diagnoses, medical history, and other study variables. Clinical outcomes were assessed using the GOS at hospital discharge based on information documented in the medical summary and the most recent clinical progress notes. No outpatient follow-up data were included; therefore, the outcomes represented short-term clinical status at discharge rather than longer-term functional outcomes such as those assessed at 3 months (Broderick et al., 2017). The manuscript should also specify who performed the retrospective GOS classification, how GOS categories were assigned when scores were not explicitly documented, and how consistency of

classification was ensured. The rationale for using GOS rather than the modified Rankin Scale (mRS) was described in the Introduction (McMillan et al., 2016; Broderick et al., 2017; Indradmojo et al., 2020).

Data collection was conducted after ethical approval was obtained from the Faculty of Medicine, Dentistry, and Health Sciences, Universitas Prima Indonesia, along with research permission from Royal Prima Hospital Medan. Medical records from April to August 2026 were reviewed retrospectively, and data on age, sex, hypertension, diabetes mellitus, heart disease, hyperlipidemia, previous stroke history, and GOS-based clinical outcomes were extracted for analysis. The manuscript should include the ethics approval number or other identifying information for the approval document.

Univariate analysis was used to summarize each study variable using frequencies and percentages. Bivariate analysis was performed to examine associations between stroke risk factors and GOS-based clinical outcomes using Pearson's chi-square test. Fisher's exact test was applied when expected cell-count assumptions were not satisfied. The magnitude of association was expressed as an odds ratio (OR) with a 95% confidence interval (CI), while the strength of association was assessed using the phi coefficient or Cramér's V, as appropriate.

Table 3. Operational Definition

Variable	Operational Definition	Indicator	Data Collection Method	Measuring Instruments	Scale
<i>Glasgow Outcome Scale (GOS)</i>	An assessment scale that describes the patient's clinical outcomes or recovery rate after a stroke	Death <i>Vegetative state</i> <i>Severe disability</i> <i>Moderate disability</i> <i>Good recovery</i>	Assessment based on the patient's condition when discharged through medical records	Observation sheets and medical records	Ordinal
Risk factors for stroke	Conditions, characteristics, or habits that can increase a person's chances of having a stroke	Age Gender Hypertension Diabetes mellitus Heart disease Hyperlipidemia Previous stroke history	Data collection based on patient medical records	Observation sheets and medical records	Nominal

Source: Authors' operationalization based on the study variables, 2026.

RESULTS AND DISCUSSION

The study took place at Royal Prima Medan Hospital, one of the largest private hospitals and referral centers for the people of Medan City and North Sumatra, with data collected during April-August 2026 on 50 medical records of stroke patients. Clinical outcomes were determined by assessing GOS scores based on the patient's clinical condition when returning from hospitalization as recorded in medical records.

Univariate Analysis

The characteristics of stroke patients based on gender, age, and risk factors are presented in Table 4. The age of the respondents was grouped into adults (≤ 59 years) and the elderly (≥ 60 years), while other risk factor variables were categorized into yes and no.

Table 4. Frequency Distribution of Characteristics and Risk Factors of Stroke Patients at Royal Prima Hospital Medan in 2026

Variable	Categories	Frequency (f)	Percentage (%)
Gender	Male	21	42,0
	Women	29	58,0
Age	Adult (≤ 59 years)	14	28,0
	Senior (≥ 60 years old)	36	72,0
Diabetes mellitus	Yes	19	38,0
	No	31	62,0
Hypertension	Yes	24	48,0
	No	26	52,0
Heart disease	Yes	20	40,0
	No	30	60,0
Hyperlipidemia	Yes	12	24,0
	No	38	76,0
Previous stroke history	Yes	19	38,0
	No	31	62,0

Source: Medical record data processed by the researchers, 2026.

Description: N = 50 for each variable.

Based on Table 4, there were more female respondents, namely 29 respondents (58.0%), compared to 21 male respondents (42.0%). Most of the respondents were in the elderly age group (≥ 60 years), namely 36 respondents (72.0%), while the adult group (≤ 59 years) was 14 respondents (28.0%). A total of 31 respondents (62.0%) did not have diabetes mellitus, while 19 respondents (38.0%) had diabetes mellitus. Respondents who did not have hypertension were slightly more, namely 26 respondents (52.0%), compared to those who had hypertension as many as 24 respondents (48.0%).

A total of 30 respondents (60.0%) did not have heart disease, while 20 respondents (40.0%) had heart disease. A total of 38 respondents (76.0%) did not experience hyperlipidemia, while 12 respondents (24.0%) had hyperlipidemia. In addition, 31 respondents (62.0%) had no previous history of stroke, while 19 respondents (38.0%) had a history of previous stroke. Thus, the majority of stroke patients in this study were women and the elderly.

Patients' clinical outcomes were assessed using GOS with a value range of 1 to 5, consisting of death, *vegetative state*, *severe disability*, *moderate disability*, and *good recovery*. The distribution of GOS values is presented in Table 5.

Table 5. Frequency Distribution of Glasgow Outcome Scale (GOS) Scores in Stroke Patients at Royal Prima Medan Hospital in 2026

GOS Value	Frequency (f)	Percentage (%)
Death	5	10,0
<i>Vegetative state</i>	2	4,0
<i>Severe disability</i>	12	24,0
<i>Moderate disability</i>	10	20,0
<i>Good recovery</i>	21	42,0
Total	50	100,0

Source: Medical record data processed by the researchers, 2026.

Based on Table 5, the most common GOS value found was *good recovery*, namely 21 respondents (42.0%). Furthermore, 12 respondents (24.0%) had a GOS value of *severe disability*, 10 respondents (20.0%) *moderate disability*, 5 respondents (10.0%) were in the death category, and 2 respondents (4.0%) were in the *vegetative state* category. The GOS value is further categorized as *unfavourable outcome* for GOS 1–3 and *favourable outcome* for GOS 4–5 as presented in Table 6.

Table 6. GOS Category Frequency Distribution in Stroke Patients at Royal Prima Medan Hospital in 2026

GOS Categories	Frequency (f)	Percentage (%)
<i>Unfavourable outcome</i> (GOS 1–3)	19	38,0
<i>Favorable outcome</i> (GOS 4–5)	31	62,0
Total	50	100,0

Source: Medical record data processed by the researchers, 2026.

Based on Table 6, as many as 31 respondents (62.0%) were in the *category of favorable outcome*, while 19 respondents (38.0%) were in the *category of unfavorable outcome*. Thus, *favorable outcomes* are more common clinical outcomes found in study respondents.

Bivariate Analysis

The relationship between each risk factor and the GOS category was analyzed bivariately using the Chi-Square test, or Fisher's Exact Test when expected-count assumptions were not met. Odds ratios (ORs) and 95% confidence intervals are therefore crude estimates and should not be interpreted as independent effects because age, comorbidities, stroke severity, stroke type, and other potential confounders were not adjusted simultaneously. Results are presented in Tables 7–13.

Age Relationship with GOS Category

Table 7. Age Relationship with GOS Category in Stroke Patients at Royal Prima Hospital Medan in 2026

Age	Unfavourable n (%)	Favourable n (%)	Total n (%)	p	OR (95% CI)
Adult (≤ 59 years)	2 (14,3)	12 (85,7)	14 (100,0)	0,031	0,186 (0,036–0,954)
Senior (≥ 60 years old)	17 (47,2)	19 (52,8)	36 (100,0)		
Total	19 (38,0)	31 (62,0)	50 (100,0)		

Source: Medical record data processed by the researchers, 2026.

Remarks: Pearson Chi-Square = 4.641; DF = 1; Cramer's V = 0.305 (Phi = -0.305). OR compares the adult group to the elderly.

The results of the Chi-Square test showed a value of $p=0.031$ ($p<0.05$), so there was a significant relationship between age and the GOS category. There were no cells with an *expected count* of less than 5, with a minimum *expected count* value of 5.32, so the assumption of the Pearson Chi-Square test was met. Cramer's V value of 0.305 indicated relatively low relationship strength, while a negative Phi value indicated the direction of the relationship based on the coding of variables in SPSS. Odds Ratio value of 0.186 indicated that the adult group had lower *unfavorable outcome odds* than the elderly group.

Relationship between Diabetes Mellitus and GOS Categories

Table 8. The Relationship between Diabetes Mellitus and GOS Category in Stroke Patients at Royal Prima Medan Hospital in 2026

Diabetes Mellitus	Unfavourable n (%)	Favourable n (%)	Total n (%)	p	OR (95% CI)
Yes	11 (57,9)	8 (42,1)	19 (100,0)	0,023	3,953 (1,173–13,325)
No	8 (25,8)	23 (74,2)	31 (100,0)		
Total	19 (38,0)	31 (62,0)	50 (100,0)		

Source: Medical record data processed by the researchers, 2026.

Description: Pearson's Chi-Square = 5.148; DF = 1; Cramer's V = 0.321.

The results of the Chi-Square test showed a value of $p=0.023$ ($p<0.05$), so there was a significant association between diabetes mellitus and the GOS category. There were no cells with an *expected count* of less than 5, with a minimum *expected count* value of 7.22. Cramer's V value of 0.321 indicates a relatively low strength of relationship. An Odds Ratio value of 3.953 indicates that respondents with diabetes mellitus had *unfavorable outcomes* odds of about 3.953 times compared to respondents without diabetes mellitus.

The Relationship of Hypertension with GOS Categories

Table 9. The Relationship of Hypertension with GOS Category in Stroke Patients at Royal Prima Medan Hospital in 2026

Hypertension	Unfavourable n (%)	Favourable n (%)	Total n (%)	p	OR (95% CI)
Yes	12 (50,0)	12 (50,0)	24 (100,0)	0,093	2,714 (0,834–8,829)
No	7 (26,9)	19 (73,1)	26 (100,0)		
Total	19 (38,0)	31 (62,0)	50 (100,0)		

Source: Medical record data processed by the researchers, 2026.

Description: Pearson's Chi-Square = 2.821; DF = 1; Cramer's V = 0.238.

The results of the Pearson Chi-Square test showed a value of $p=0.093$ ($p>0.05$), so there was no significant association between hypertension and the GOS category. There were no cells with an *expected count* of less than 5, with a minimum *expected count* value of 9.12, so the requirements of the Pearson Chi-Square test were met. The Cramer's V value of 0.238 with a significance of 0.093 showed a statistically insignificant relationship. The *Odds Ratio* value of 2.714 with a 95% CI of 0.834–8.829 included the number 1, so it was in line with the results of the Chi-Square test.

The Relationship of Heart Disease with GOS Categories

Table 10. The Relationship between Heart Disease and GOS Category in Stroke Patients at Royal Prima Medan Hospital in 2026

Heart Disease	Unfavourable n (%)	Favourable n (%)	Total n (%)	p	OR (95% CI)
Yes	11 (55,0)	9 (45,0)	20 (100,0)	0,043	3,361 (1,016–11,117)
No	8 (26,7)	22 (73,3)	30 (100,0)		
Total	19 (38,0)	31 (62,0)	50 (100,0)		

Source: Medical record data processed by the researchers, 2026.

Description: Pearson's Chi-Square = 4.089; DF = 1; Cramer's V = 0.286.

The results of the Chi-Square test showed a value of $p=0.043$ ($p<0.05$), so there was a significant relationship between heart disease and the GOS category. There were no cells with an *expected count* of less than 5, with a minimum *expected count* value of 7.60. Cramer's V value of 0.286 indicates a relatively low strength of the relationship. An *Odds Ratio* value of 3.361 indicates that respondents with heart disease had *unfavorable outcomes* odds of about 3.361 times compared to respondents without heart disease.

Relationship of Hyperlipidemia with GOS Category

Table 11. The Relationship of Hyperlipidemia with GOS Category in Stroke Patients at Royal Prima Medan Hospital in 2026

Hyperlipidemia	Unfavourable n (%)	Favourable n (%)	Total n (%)	p	OR (95% CI)
Yes	8 (66,7)	4 (33,3)	12 (100,0)	0.038a	4,909 (1,223–19,709)
No	11 (28,9)	27 (71,1)	38 (100,0)		
Total	19 (38,0)	31 (62,0)	50 (100,0)		

Source: Medical record data processed by the researchers, 2026.

Description: Pearson Chi-Square = 5.507; df = 1; Cramer's V = 0.332. Fisher's Exact Test (two-sided) p = 0.038 was used for inference because 1 cell (25.0%) had an expected count <5.

Because one cell (25.0%) had an expected count below 5 (minimum expected count 4.56), Fisher's Exact Test was used as the inferential test. The two-sided Fisher p-value was 0.038 (p<0.05), indicating a significant crude association between hyperlipidemia and GOS category. Cramer's V was 0.332. The OR was 4.909 (95% CI 1.223–19.709), but the wide interval indicates limited precision and should be interpreted cautiously.

Relationship of Previous Stroke History with GOS Category

Table 12. The Relationship between Previous Stroke History and GOS Category in Stroke Patients at Royal Prima Medan Hospital in 2026

Previous Stroke History	Unfavourable n (%)	Favourable n (%)	Total n (%)	p	OR (95% CI)
Yes	13 (68,4)	6 (31,6)	19 (100,0)	0,001	9,028 (2,423–33,632)
No	6 (19,4)	25 (80,6)	31 (100,0)		
Total	19 (38,0)	31 (62,0)	50 (100,0)		

Source: Medical record data processed by the researchers, 2026.

Description: Pearson's Chi-Square = 12.037; DF = 1; Cramer's V = 0.491.

The results of the Chi-Square test showed a value of p=0.001 (p<0.05). There were no cells with an expected count of less than 5, with a minimum expected count value of 7.22, so there was a significant relationship between the previous stroke history and the GOS category. Cramer's V value of 0.491 indicates a moderate relationship strength. The Odds Ratio value of 9.028 showed that respondents with a previous stroke history had unfavorable outcome odds of about 9.028 times compared to respondents without a previous stroke history.

Gender Relationship with GOS Category

Table 13. Gender Relationship with GOS Category in Stroke Patients at Royal Prima Medan Hospital in 2026

Gender	Unfavourable n (%)	Favourable n (%)	Total n (%)	p	OR (95% CI)
Male	8 (38,1)	13 (61,9)	21 (100,0)	0,991	1,007 (0,317–3,202)
Women	11 (37,9)	18 (62,1)	29 (100,0)		
Total	19 (38,0)	31 (62,0)	50 (100,0)		

Source: Medical record data processed by the researchers, 2026.

Description: Pearson's Chi-Square = 0.000; DF = 1; Cramer's V = 0.002.

The results of the Chi-Square test showed a value of $p=0.991$ ($p>0.05$), so there was no significant relationship between sex and GOS category. There were no cells with an *expected count* of less than 5, with a minimum *expected count* value of 7.98. Cramer's V value of 0.002 indicated a very weak relationship. The *Odds Ratio* value of 1.007 with a 95% confidence interval of 0.317–3.202 included a value of 1, in line with the results of the Chi-Square test.

DISCUSSION

Characteristics of Research Respondents

This study involved 50 stroke patients who were treated at Royal Prima Hospital Medan in 2026. Based on gender characteristics, female respondents (58.0%) were more than male respondents (42.0%). These findings are different from several studies that found a more dominant proportion of men in reproductive age stroke cases, for example in a study of neurological clinical outcome characteristics of ischemic stroke patients who reported more men in thromboembolic stroke subtypes (Ischak et al., 2021). However, the dominance of women is in line with the age characteristics of the respondents in this study, which are mostly in the elderly group (72.0%), considering that women in old age lose the protective effect of the postmenopausal hormone estrogen on the walls of blood vessels, so the risk of cardio-cerebrovascular events increases with age.

The age distribution showed that the majority of respondents were in the elderly group (≥ 60 years) as much as 72.0%, in line with the epidemiological characteristics of stroke as a degenerative disease whose incidence increases with age due to the cumulative atherosclerosis process and decreased elasticity of blood vessels (Elavia et al., 2025). In addition, the comorbidity picture of respondents shows a fairly high burden of cardiovascular risk factors, namely diabetes mellitus (38.0%), hypertension (48.0%), heart disease (40.0%), hyperlipidemia (24.0%), and previous stroke history (38.0%). This high proportion of comorbidities illustrates the multifactorial nature of stroke, where the incidence and clinical outcomes of stroke are rarely determined by a single risk factor, but the interaction of several vascular risk factors at once (Hidayatullah & Ma'arif, 2022).

At discharge, 62.0% of respondents had favorable GOS outcomes and 38.0% had unfavorable outcomes, including 10.0% who died. This distribution describes the observed discharge status in the sample. It should not be attributed to treatment effectiveness because the study did not evaluate treatment type, treatment success, or a comparison group.

Age Relationship with GOS Category

Age was significantly related to the GOS category ($p=0.031$), with the proportion of *unfavorable outcomes* in the elderly group (47.2%) much higher than in the adult group (14.3%) and the strength of the relationship (Cramer's V 0.305) which was classified as moderate to low.

These findings are in line with the concept that age is a risk factor for stroke that cannot be modified but has a major influence on prognosis. In old age, there are various physiological changes such as a decrease in *neuronal reserve*, a decrease in the brain's neuroplasticity capacity to compensate after ischemic injury, as well as pharmacokinetic and pharmacodynamic changes in drugs that can affect the effectiveness of therapy (Elavia et al., 2025). In addition, the elderly tend to have a higher burden of cardiovascular comorbidities and a lower physiological reserve to recover from acute brain injury. However, not all studies reported a consistent relationship between age and clinical outcomes; some studies on more specific age subgroups (e.g. >75 years) did not find significant differences in outcomes, likely due to a relatively small proportion of samples in the very elderly age group (Unair news, 2021). Thus, the results of this study reinforce the importance of identifying at-risk age groups as part of the assessment of the initial prognosis of stroke patients.

Relationship between Diabetes Mellitus and GOS Categories

Diabetes mellitus was significantly associated with the GOS category ($p=0.023$), with an *unfavorable outcome odds* of about 3.9 times greater in respondents with diabetes mellitus (OR 3.953; 95% CI 1.173–13.325).

These findings are consistent with various studies that place diabetes mellitus, particularly through hyperglycemic conditions, as one of the dominant risk factors influencing the course and clinical outcome of stroke in Indonesia (Dewi, 2024). Pathophysiologically, chronic hyperglycemia in patients with diabetes mellitus accelerates the process of atherosclerosis through oxidative stress mechanisms, endothelial dysfunction, and increased prothrombotic status, thereby increasing the risk of brain vascular occlusion and expanding the infarction area. High blood glucose levels in the acute phase of stroke also worsen the condition of brain tissue in the ischemic penumbra region through increased free radical production and local lactic acidosis, resulting in a worse functional outcome. However, there are also studies with different populations that do not find diabetes mellitus to be an independent risk factor (Triyono et al., 2024), which suggests that the strength of the relationship between diabetes mellitus and stroke outcomes can be influenced by the degree of glycemic control, the duration of having diabetes, and the presence or absence of other vascular comorbidities.

The Relationship of Hypertension with GOS Categories

The results of the Chi-Square test showed that there was no significant relationship between hypertension and GOS category ($p=0.093$). The proportion of *unfavorable outcomes* in respondents with hypertension (50.0%) was higher than in respondents without hypertension (26.9%), with an *Odds Ratio* of 2.714; however, the 95% confidence interval (0.834–8.829) included a number of 1, so the difference was not statistically significant.

Hypertension has long been known to be the most dominant risk factor for stroke, both in terms of stroke incidence and clinical outcomes. Chronic high blood pressure leads to cerebral blood vessel remodeling, accelerates atherosclerosis in large arteries, and increases the

risk of rupture of small perforator blood vessels, thus contributing to ischemic and hemorrhagic strokes (Rahmawati et al., 2024). Several studies report that hypertension increases the risk of ischemic stroke by up to 3.45 times and hemorrhagic stroke by up to 3.66 times compared to individuals without hypertension (Rahmawati et al., 2024). Uncontrolled hypertension is also associated with a greater volume of infarctions and a higher stroke recurrence rate (Hasan et al., 2025). The tendency of higher *unfavorable outcomes* in respondents with hypertension in this study is in line with this concept, but does not achieve statistical significance, which may be related to the relatively small sample count as discussed in the limitations of the study. Thus, blood pressure control remains important as a secondary preventive measure in stroke patients.

The Relationship of Heart Disease with GOS Categories

Heart disease was significantly associated with the GOS category ($p=0.043$), with an *unfavorable outcome* proportion of 55.0% in respondents with heart disease compared to 26.7% in respondents without heart disease (OR 3.361; 95% CI 1.016–11.117).

Heart disease, especially those related to rhythm disorders such as atrial fibrillation, is the main source of cardioembolism stroke. Cardioembolic strokes generally originate from thrombus formed due to blood stasis in the left chamber of the heart; the thrombus tends to be large so that it can block large-diameter brain blood vessels such as the medial cerebral artery, resulting in a larger infarction area and heavier neurological deficits than other stroke subtypes (Sejawat, 2023). Atrial fibrillation is reported to increase the risk of ischemic stroke by 4–5 times (Lestari & Holisatul, 2025). Due to the mechanism of occlusion of large blood vessels, strokes originating from heart disease generally have a worse functional prognosis than atherombotic and laxinar strokes. These findings confirm the importance of cardiological evaluation, including heart rhythm examination, in each stroke patient to detect the source of cardioembolism as early as possible as a basis for secondary preventive management.

Relationship of Hyperlipidemia with GOS Category

Based on *Fisher's Exact Test*, hyperlipidemia was significantly associated with the GOS category ($p=0.038$), with an *unfavorable outcome* proportion of 66.7% in respondents with hyperlipidemia compared to 28.9% in respondents without hyperlipidemia (OR 4.909; 95% CI 1.223–19.709), which was the second highest OR value after a history of previous stroke.

Hyperlipidemia, especially increased LDL cholesterol and triglyceride levels accompanied by a decrease in HDL cholesterol, plays an important role in the process of atherogenesis through the formation of atheroma plaques on the walls of cerebral and extracranial blood vessels (Journal of Pioneer Health, 2025). Lipid ratios such as the ratio of triglycerides to HDL cholesterol are even reported to correlate with the clinical severity of acute ischemic stroke patients and are a significant predictor of stroke outcomes (Andaryani et al., 2017). In terms of governance, the use of statin group drugs to control lipid profiles is reported to provide better functional status outcomes in ischemic stroke patients, including in cases of recurrent stroke (Alexxander et al., 2017). Thus, the results of this study provide empirical support for the importance of screening and management of dyslipidemia as part of efforts to improve the clinical outcomes of stroke patients, although the presence of cells with *low expected* counts on cross-tabulation indicates the need for careful interpretation and larger sample sizes in future studies.

Relationship of Previous Stroke History with GOS Category

Previous stroke history showed the strongest crude association with GOS category ($p=0.001$; Cramer's V 0.491), with unfavorable outcomes in 68.4% of respondents with a previous stroke compared with 19.4% among those without a previous stroke (OR 9.028; 95% CI 2.423–33.632). Although statistically significant, the confidence interval is very wide, indicating substantial uncertainty in the magnitude of the OR because of the small sample and event count.

Previous stroke history reflects previous brain tissue damage, so that the brain *reserve* to compensate for subsequent ischemic injury becomes increasingly limited. Each recurrent stroke episode has the potential to increase the cumulative burden of neurological damage, so the resulting functional deficit tends to be heavier than the first stroke. This condition also often reflects the control of vascular risk factors that have not been optimal in previous stroke episodes. Research on risk factors for recurrent ischemic stroke incidence report that hypertension and diabetes mellitus, both stand-alone and concomitant, are the dominant risk factors that contribute to the occurrence of recurrent strokes, and non-adherence to therapy also accelerates the recurrence time (Panggabean et al., 2017). In addition, lipid profiles in patients with recurrent ischemic stroke tend to exhibit low HDL cholesterol levels and high atherogenic lipid ratios (Fitriani, 2018), which strengthens the association between mutually aggravated vascular risk factors. Thus, the strong association between previous stroke history and clinical outcomes confirms the importance of comprehensive secondary prevention, including continuous control of blood pressure, blood sugar levels, and lipid profiles.

Gender Relationship with GOS Category

The results of the Chi-Square test showed that there was no significant relationship between sex and GOS category ($p=0.991$). The proportion of *unfavourable outcomes* in male patients was 38.1% and in female patients was 37.9%, while the proportion of *favourable outcomes* in men was 61.9% and in women was 62.1%. Odds *Ratio* value of 1.007 indicates that the *odds* of *unfavourable outcomes* in male patients are almost the same as in female patients, and Cramer's V value of 0.002 indicates a very weak relationship. Thus, the two groups have relatively similar output distributions.

The findings regarding the distribution of sex can be compared with the research of Sinurat et al. (2022) which showed that the majority of stroke patients were men, namely 63 people (63.64%) out of a total of 99 patients. However, the findings better describe the distribution of the patient's sex and do not directly show the relationship between sex and clinical outcomes based on GOS, so the difference in sex proportions between studies cannot be used as a basis to conclude that there is a difference in clinical outcomes. Meanwhile, the research of Mahendra et al. (2025) shows that the age group of >60 years is the group with the largest proportion (37.5%), while the age group of 31–40 years is 4.2%; the study is more relevant for the discussion of age characteristics than the relationship between sex and clinical outcomes. The absence of a significant association between sex and GOS categories suggests that the clinical outcomes of stroke patients are likely to be more influenced by a variety of other clinical factors, so the interpretation of the relationship between sex and stroke outcomes needs to consider patient characteristics and other risk factors.

Research Limitations

This study has several limitations. First, the analysis is limited to bivariate analysis using the Chi-Square test and *Fisher's Exact Test*. The vascular risk factors studied are interrelated and can act as *confounding* factors; for example, hypertension and diabetes mellitus are more commonly found in the elderly group, and both conditions are also major risk factors for recurrent stroke. Therefore, the association found cannot be interpreted as an independent influence of each variable on clinical outcomes. Multivariate analyses such as multiple logistic regression were not performed because the number of *unfavorable outcome* events was only 19 out of 50 patients, so models with six to seven independent variables were at risk of being unstable and *overfitting*. Adequate sample sizes for multivariable models need to be calculated formally based on the number of events and the number of predictor variables (Riley et al., 2020).

Second, all cases of ischemic and hemorrhagic stroke were analyzed as a single group without analysis by subtype, even though the two subtypes had different pathophysiological mechanisms, management, and prognosis, with hemorrhagic strokes generally accompanied by higher acute phase mortality rates. Third, GOS was initially developed to assess the outcomes of traumatic brain injury patients (McMillan et al., 2016); compared to mRS which is more commonly used as a functional outcome standard in stroke studies (Broderick et al., 2017), GOS is less sensitive in distinguishing degrees of mild to moderate disability. In addition, the severity of stroke upon hospitalization, for example based on NIHSS, is not analyzed, even though initial severity is a strong predictor of outcomes (Rost et al., 2016).

Fourth, the GOS assessment was conducted when the patient was discharged from hospitalization and did not include *a follow-up evaluation*, for example at the 3rd month after onset (Broderick et al., 2017), so the outcomes assessed were short-term outcomes. Fifth, the retrospective design caused the completeness of the data to be highly dependent on the quality of medical record recording. The relatively small number of samples (N = 50) and coming from one hospital also limited the statistical strength and generalization of the results. The wide confidence interval of the *Odds Ratio* on several variables, such as hyperlipidemia (95% CI 1.223–19.709) and previous stroke history (95% CI 2.423–33.632), suggests that the large estimates of the relationship are still imprecise.

CONCLUSION

Among 50 patients with stroke treated at Royal Prima Hospital Medan in 2026, 31 (62.0%) had favorable discharge outcomes and 19 (38.0%) had unfavorable discharge outcomes based on the Glasgow Outcome Scale (GOS). Significant unadjusted bivariate associations were observed for age ($p = 0.031$), diabetes mellitus ($p = 0.023$), heart disease ($p = 0.043$), hyperlipidemia (Fisher's exact test, $p = 0.038$), and previous stroke history ($p = 0.001$), whereas hypertension ($p = 0.093$) and sex ($p = 0.991$) were not significantly associated with discharge GOS category. These findings support the clinical relevance of vascular risk-factor assessment but should not be interpreted as a validated basis for prognostic prediction because no multivariable prognostic model was developed or validated. Risk-factor assessment and secondary prevention remain clinically important, while future studies should include larger prospective cohorts, multivariable analyses, standardized stroke-severity measures such

as the National Institutes of Health Stroke Scale (NIHSS), longitudinal follow-up outcomes, and stratification by stroke subtype.

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CONFLICT OF INTEREST

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AUTHOR'S CONTRIBUTION

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GENERATIVE ARTIFICIAL INTELLIGENCE USAGE STATEMENT

The author states that no generative artificial intelligence was used in the preparation of this article.

REFERENCES

- Berlianty, B., Dian, S., & Ganiem, A. R. (2022). Glasgow Outcome Scale assessment in patients with cerebral toxoplasmosis. *Althea Medical Journal*, 9(1), 30–36. <https://doi.org/10.15850/amj.v9n1.2290>
- Broderick, J. P., Adeoye, O., & Elm, J. (2017). Evolution of the modified Rankin Scale and its use in future stroke trials. *Stroke*, 48(7), 2007–2012. <https://doi.org/10.1161/STROKEAHA.117.017866>
- Dewi, L., & Fitraneti, E. (2024). Ischemic stroke. *Sciena*. <http://journal.scientic.id/index.php/sciena/issue/view/22>
- Hasan, H., Bora, M. A., Afriani, D., Artiani, L. E., Puspitasari, R., Susilawati, A., Dewi, P. M., Asroni, A., Yunesman, Merjani, A., & Hakim, A. R. (2025). *Metode penelitian kualitatif*. Yayasan Tri Edukasi Ilmiah.
- Hidayatullah, A. F., & Ma'arif, M. R. (2022). Indonesian Sentiment Analysis Using Machine Learning and Natural Language Processing Approaches. *International Journal of Advanced Computer Science and Applications*.
- Indradmojo, C., Zaiyanah, M., Setijowati, N., & Eddy, M. I. (2020). *Factors influencing the value of the Glasgow Outcome Scale in head trauma patients (study at the emergency room of Dr. Iskak Tulungagung Hospital)*.
- McMillan, T., Wilson, L., Ponsford, J., Levin, H., Teasdale, G., & Bond, M. (2016). The Glasgow Outcome Scale—40 years of application and refinement. *Nature Reviews Neurology*, 12(8), 477–485. <https://doi.org/10.1038/nrneurol.2016.89>
- Qian, N., Lu, C., Wei, T., Yang, W., Wang, H., Chen, H., Li, J., Zhu, S., Wang, W., & Shao, N. (2025). Epidemiological trends and forecasts in stroke at global, regional and national levels. *Journal of Stroke and Cerebrovascular Diseases*, 34(8), 108347. <https://doi.org/10.1016/j.jstrokecerebrovasdis.2025.108347>

- Rafiudin, M. A., Utami, I. T., & Fitri, N. L. (2024). Application of range of motion (ROM) active cylindrical grip to muscle strength in non-hemorrhagic stroke patients. *Journal of Young Scholars*, 4(3).
- Rahayu, T. G. (2023). Analysis of risk factors for stroke and stroke type. *Faletahan Health Journal*, 10(1), 48–95. <https://www.journal.lppm-stikesfa.ac.id/ojs/index.php/FHJ>
- Rost, N. S., Bottle, A., Lee, J.-M., Randall, M., Middleton, S., Shaw, L., Thijs, V., Rinkel, G. J. E., Hemmen, T. M., & Collaborators, G. C. S. G. (2016). Stroke severity is a crucial predictor of outcome: An international prospective validation study. *Journal of the American Heart Association*, 5(1), e002433. <https://doi.org/10.1161/JAHA.115.002433>
- Saifullah, Y. Y., Rachman, M. E., Ramlian, Limoa, L. T., & Hamado, N. (2024). Literature review: Hubungan hipertensi dengan kejadian stroke iskemik dan stroke hemoragik. *Fakumi Medical Journal: Jurnal Mahasiswa Kedokteran*, 4(10), 695–708.
- Triyono, T., Al Qudsi, M. F. F., Rahmawati, N., Rozaki, Z., & Kamarudin, M. F. (2024). The role of organic rice farm income on farmer household welfare: Evidence from Yogyakarta, Indonesia. *Open Agriculture*, 9(1), 20220273. <https://doi.org/10.1515/opag-2022-0273>
- Umarova, R. M., Gallucci, L., Hakim, A., Wiest, R., Fischer, U., & Arnold, M. (2024). Adaptation of the concept of brain reserve for the prediction of stroke outcome: Proxies, neural mechanisms, and significance for research. *Brain Sciences*, 14(1), 77. <https://doi.org/10.3390/brainsci14010077>
- Utama, Y. A., & Nainggolan, S. S. (2022). Risk factors influencing stroke incidence: A systematic review. *Jurnal Ilmiah Universitas Batanghari Jambi*, 22(1), 549. <https://doi.org/10.33087/jiubj.v22i1.1950>
- Utomo, B. (2020). *Manajemen sarana dan prasarana fisik di rumah sakit*.
- Utomo, T. Y. (n.d.). *Buku ajar stroke*. Eureka Media Aksara.
- Valentina, B., Lumbantobing, M., & Anna, A. (2015). *Effect of sensory stimulation on the Glasgow Coma Scale value in head injury patients in the Neurosurgical Critical Care Unit of Dr. Hasan Sadikin Hospital Bandung*.
- Winkelmeier, L., Knip, H., Faizy, T., Heitkamp, C., Holtz, L., Meyer, L., Flottmann, F., Heitkamp, A., Schell, M., Thomalla, G., Fiehler, J., & Broocks, G. (2024). Age and functional outcomes in patients with large ischemic stroke receiving endovascular thrombectomy. *JAMA Network Open*, 7(8), e2426007. <https://doi.org/10.1001/jamanetworkopen.2024.26007>