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Correlation of plasma blood glucose levels at hospitality with clinical severity of Ischemic stroke patients at neurology department RSUD Dr. Soetomo surabaya during the period of January 2019 – December 2020

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Abstract

Stroke is one of the second most significant causes of death and the second highest cause of disability globally, 87% of which are ischemic strokes (IS). Blood glucose levels are known to have a relationship with the clinical outcome of IS patients as measured by the National Institutes of Health Stroke Scale (NIHSS). This study aims to determine the relationship between the patient's plasma blood glucose level upon hospital admission and the IS patient's severity. This research is a cross-sectional analytic study using medical records of IS patients hospitalized at the Neurology Department of RSUD Dr. Soetomo Surabaya between January 2019 and December 2020. Sampling was carried out using a total sampling technique, including patients with the diagnosis of an IS aged ≥18 years old. Patients with a diagnosis of ICH, SAH, TIA, and patients with a history of CHD were excluded from this study. We analyzed medical record data by Chi-Square statistical test on blood glucose and clinical outcomes of patients with NIHSS. In total, 53 out of 89 medical records met the inclusion criteria. Random; fasting; and 2 hours post-prandial blood glucose levels on IS patients in admission to the hospital showed a non-significant relationship with p=0.764; p=0.130; p=0.210 (p>0.05) with a weak correlation value to the clinical severity of patients as measured by NIHSS. Blood glucose levels at hospital admission cannot be the sole predictor in determining the clinical severity of IS patients using the NIHSS. Many other co-factors affect the clinical severity of the patient.

Keywords: Admission blood glucose; Ischemic stroke; Ischemic stroke outcome; National Institutes of Health Stroke Scale (NIHSS)

1. Introduction

Stroke is one of the second most significant causes of death after ischemic heart disease and the second highest cause of disability worldwide [1]. Stroke occurs due to blockage or rupture of brain blood vessels, resulting in cell/tissue death due to a lack of blood supply that carries oxygen to the brain [2]. Stroke is divided into two types based on pathology, ischemic stroke and hemorrhagic stroke. Ischemic stroke is an episode of neurological dysfunction in which there is damage to the brain and spinal cord due to a focal infarct in the brain, spinal cord, or retina [3]. 87% the most prevalence of stroke is ischemic stroke. In comparison, the majority of hemorrhagic strokes is 13%, further divided into 10% ICH and 3% SAH strokes [4].

One of the way to prevent and control stroke is to modify the risk factors for stroke itself. Risk factors for stroke include hypertension, diabetes mellitus, and high cholesterol levels [4]. Research conducted by [5] showed that an average high

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blood glucose level of >144 mg/dL (>8 mmol/L) during the initial 72 hours of acute stroke was associated with mortality or disability rates at three months. Especially in ischemic stroke patients, the duration of hyperglycemia throughout the day has a strong relationship with the risk of accelerating more severe brain damage in acute stroke patients. Meanwhile, another research concluded that hyperglycemia alone was not associated with poor outcomes with mortality in acute stroke patients admitted to the ICU due to glycemic variability and risk factors for post-stroke hyperglycemia [6].

This study aims to determine the plasma blood glucose levels of ischemic stroke patients on the first admission to the hospital, to determine the severity of ischemic stroke patients with the National Institute of Health Stroke Scale (NIHSS), to determine the relationship between glucose levels in patients admitted to the hospital and the degree of clinical severity ischemic stroke patients. The data obtained from this study are expected to minimize severity in ischemic stroke patients through control of patient clinical management.

2. Material and methods

This research is a type of cross-sectional analytic study using medical records of ischemic stroke patients hospitalized at SMF Neurology RSUD Dr. Soetomo Surabaya for January 2019 – December 2020. Sampling was carried out using a total sampling technique, including patients with a diagnosis of an ischemic stroke aged 18 years with complete supporting examinations. Patients with a diagnosis of intracerebral hemorrhage (ICH), subarachnoid hemorrhage (SAH), transient ischemic attack (TIA), and patients with a history of coronary heart disease (CHD) were excluded from this study. Medical record data were then analyzed by Chi-Square statistical test on blood glucose and clinical outcomes of patients with NIHSS scoring.

3. Results

The medical record data collection of ischemic stroke patients at SMF Neurology Dr. Soetomo Surabaya obtained 89 ischemic stroke patients from January 2019 - December 2020. Of this number, 36 patients did not have data on blood glucose levels when they first entered the hospital. So a total of 53 patients consisting of 33 ischemic stroke patients in the 2019 period and 20 ischemic stroke patients in the 2020 period, met the study inclusion criteria.

3.1. Patient Demographic Characteristics

Table 1 Patient Demographic Characteristics

Variable	**n (%)**
Gender	
Male	29 (54.72%)
Female	24 (45.28%)
Total	53 (100%)
Age	
18 – 32 years	1 (1.89%)
33 – 47 years	6 (11.32%)
48 – 62 years	29 (54.72%)
63 – 77 years	15 (28.30%)
≥78 years	2 (3.77%)
Total	53 (100%)
History of Disease	
History of Diabetes Mellitus	
Yes	16 (30.19%)
No	37 (69.81%)
Total	53 (100%)

Male patients (54.72%) suffered more from ischemic stroke than female patients (45.28%). The ischemic stroke patients were mainly found in patients aged 48-62 years, a total of 29 patients (54.72%). Ischemic stroke patients who do not have a history of diabetes mellitus (DM) (69.81%) are more numerous than ischemic stroke patients with a history of DM (30.19%).

3.2. Profile of Patient's Vital Signs and Metabolic Examination

Table 2 Patient's Vital Signs and Metabolic Examination

Variable	n (%)
Vital Sign Examination	
Blood Pressure	
Normal	1 (1.89%)
Pre-Hypertension	7 (13.21%)
Hypertension grade 1	17 (32.08%)
Hypertension grade 2	28 (52.83%)
Total	53 (100%)
Metabolic Examination	
Total Cholesterol	
Normal	25 (47.17%)
Borderline	17 (32.08%)
High	11 (20.75%)
Total	53 (100%)
LDL-C	
Normal	8 (15.09%)
Close to normal	14 (26.42%)
Borderline	14 (26.42%)
High	11 (20.75%)
Very high	6 (11.32%)
Total	53 (100%)
HDL-C	
Low	9 (16.98%)
Normal	39 (73.59%)
High	5 (9.43%)
Total	53 (100%)
Trigliseride	
Normal	27 (50.94%)
Borderline	16 (30.19%)
High	10 (18.87%)
Very high	-
Total	53 (100%)
Random Blood Glucose Test Results	
Normal	36 (67.92%)
Diabetes	17 (32.08%)
Total	53 (100%)

Fasting Blood Glucose Test Results	
Normal	23 (43.40%)
Pre-diabetes	8 (15.09%)
Diabetes	4 (7.55%)
Hyperglycemia	4 (7.55%)
Severe hyperglycemia	14 (26.42%)
Total	53 (100%)
2 Hours – Post Prandial Blood Glucose Test Results	
Normal	26 (49.06%)
Pre-diabetes	8 (15.09%)
Diabetes	19 (35.85%)
Total	53 (100%)

The blood pressure of ischemic stroke patients is dominated by patients with grade 2 hypertension (52.83%), grade 1 hypertension (32.08%), pre-hypertension (13.21%), and normal blood pressure (1.89%). Patients with normal total cholesterol levels (47.17%) occupied the most significant distribution, same number was also found in patients with borderline cholesterol levels (32.08%) and patients with high cholesterol levels (20.75%). Patients with borderline LDL-C levels (26.42%) occupied the most significant distribution, followed by patients with LDL-C levels near normal (26.42%), normal (15.09%), high (20.75%), and very high (11.32%). Patients with normal HDL-C levels (73.59%) occupied the most significant distribution, followed by patients with low HDL-C levels (16.98%) and high (9.43%). Patients with normal triglyceride levels (50.94%) occupied the most significant distribution, followed by patients with borderline triglyceride levels (30.19%) and high (18.87%). Patients with normal random blood glucose test results (67.92%) were more numerous than patients with diabetes (32.08%). Patients with regular fasting blood glucose (43.40%) occupied the largest distribution, followed by patients with severe hyperglycemia (26.42%), pre-diabetes (15.09%), hyperglycemia (7.55%), and diabetes (7.55%). Patients with regular blood glucose 2 hours post-prandial (49.06%) occupied the most significant distribution, followed by diabetes patients (35.85%) and pre-diabetes (15.09%).

3.3. Stroke Disease Profile Research Subjects

Table 3 Stroke Disease Profile Research Subjects

Variable	**n (%)**
Infarct Type	
Lacunar	25 (47.17%)
Teritorial	28 (52.83%)
Total	53 (100%)
NIHSS Scoring on First Hospital Admission	
Mild stroke	15 (28.30%)
Moderate stroke	34 (64.15%)
Moderate – severe stroke	2 (3.77%)
Severe stroke	2 (3.77%)
Total	53 (100%)

Abbreviation: NIHSS, National Institutes of Health Stroke Scale

Patients with territorial infarction (52.83%) were more numerous than patients with lacunar infarction (47.17%). Patients with moderate severity (64.15%) occupied the most significant distribution, followed by patients with mild severity (28.30%), moderate-severe (3.77%), and severe (3.77%).

3.4. Correlations of Plasma Blood Glucose Levels with Patients Clinical Severity

Table 4 Distribution of Plasma Blood Glucose Levels with Clinical Severity of Research Subjects (n=53) with Kolmogorov-Smirnov test

Plasma Blood Glucose Level	**Patients Clinical Severity (NIHSS Scoring) on First Admission to the Hospital**				***p-value***
	Mild stroke	**Moderate stroke**	**Moderate severe stroke**	**Severe stroke**	
Random Blood Glucose Test Results					
Normal	11	22	1	2	0.000
Diabetes	4	12	1	0	
Total	15	34	2	2	
Fasting Blood Glucose Test Results					
Normal	10	12	0	0	0.000
Pre – Diabetes	0	7	0	2	
Diabetes	0	3	1	0	
Hyperglycemia	1	3	0	0	
Severe hyperglycemia	4	9	1	2	
Total	15	34	2	2	
2 Hours – Post Prandial Blood Glucose Test Results					
Normal	9	14	1	2	0.000
Pre – Diabetes	1	7	0	0	
Diabetes	5	13	1	0	
Total	15	34	2	2	

Abbreviation: NIHSS, National Institutes of Health Stroke Scale

The total number of patients who had complete data regarding examination of plasma blood glucose levels and NIHSS was 53 out of 86 ischemic stroke patients. A normality test was performed using the Kolmogorov-Smirnov test to assess the distribution of the data analytically. The results of the normality test on random blood glucose, fasting blood glucose, blood glucose 2 hours postprandial, and NIHSS in 53 patients showed probability (p)=0.000 (p<0.05), so it can be concluded that the data distribution is not normal. Furthermore, the data transformation process is carried out to normalize the data distribution using the log function. Then the transformed data was carried out by the Kolmogorov-Smirnov test again to see the distribution of the data. The results of the Kolmogorov-Smirnov normality test on data that have been transformed into random blood glucose, fasting blood glucose, 2 hours postprandial blood glucose, and NIHSS data show p=0.000 (p<0.05), so it can be concluded that the distribution of variables abnormal transformation. Then the Spearman test was carried out to determine the correlation between plasma blood glucose levels upon hospital admission and stroke patients' clinical severity using the NIHSS scoring.

On random blood glucose examination, the significance value of p=0.764 (p>0.05) showed that the correlation between random blood glucose and the NIHSS score was not significant, while the correlation value of r = 0.042, which indicated the direction of the positive correlation with a low correlation strength. On examination of fasting blood glucose, it was found that the significance value of p= 0.130 (p>0.05), which indicates that the correlation between fasting blood glucose and NIHSS scores is not significant, while the correlation value of r = 0.210, which indicates the direction of the positive correlation with weak correlation strength. Whereas. In the 2-hour postprandial blood glucose examination, the significance value of p= 0.805 (p>0.05) showed that the correlation between the 2-hour postprandial blood glucose and the NIHSS score was not significant, while the correlation value of r = 0.035 which indicated the direction of the positive correlation with frail correlation strength.

Table 5 Correlations of plasma blood glucose levels with clinical severity of research subjects (n=53) with Spearman's test

Plasma Blood Glucose Level	**Patients Clinical Severity (NIHSS Scoring) on First Admission to the Hospital**		
	r	***p*-value**	**n**
Random Blood Glucose Test Results	0.042	0.764	53
Fasting Blood Glucose Test Results	0.210	0.130	53
2 Hours – Post Prandial Blood Glucose Test Results	0.035	0.805	53

Abbreviation: NIHSS, National Institutes of Health Stroke Scale

4. Discussion

The results of random blood glucose, fasting blood glucose, and 2 hours post-prandial blood glucose cannot be the sole predictor or the primary reference in determining the clinical severity of patients using the NIHSS. *Ischemic stroke* is a multifactorial disease caused by many risk factors, both modifiable and non-modifiable. The main modifiable risk factors such as hypertension, diabetes mellitus, and hyperglycemia play a significant role in the progression of ischemic stroke when first admitted to the clinic. In this study, data were obtained that 1.89% of ischemic stroke patients had a single modifiable risk factor (hypertension, diabetes, and cholesterol). This means that only 1 out of 53 patients has a single risk factor for ischemic stroke.

A cross-sectional study conducted by [7] on 953 ischemic stroke patients showed that there was no specific relationship p=0.08 (p>0.05) related to the length of hospital stay with stroke patients. Ischemic patients with diabetes mellitus. A similar study [8] on 48,733 ischemic stroke patients with diabetes mellitus did not find significantly higher mortality rates at 60 days and one year after being diagnosed with ischemic stroke. Another study by [9], using a meta-analysis of 11 of 1565 articles that met the inclusion criteria, did not find a significant relationship in control group patients or groups of patients who were given pharmacological intervention on the clinical outcome of patients in terms of mortality rates. as well as the number of dependence in DM patients. In DM patients, the odds ratio (OR) is 0.66 (95% CI 0.35-1.24), while in non-DM patients, the OR of 1.02 (95% CI 0.81-1.30) means that the probability of mortality in non-DM ischemic stroke patients is twice more than patients with DM.

In contrast, the remaining 52 patients have > 1 risk factor that worsens the clinical condition of ischemic stroke patients—worsening of the initial symptoms of ischemic stroke influenced by other factors such as the volume of infarct on the flow of the collateral circulation to the circle of Willis. The size of the tissue infarction will cause reperfusion failure to spread to the penumbra area. This reduces oxygen supply to the underlying tissue since the first stroke onset. In addition, the incidence of recurrent stroke also plays a role in the clinical deterioration of ischemic stroke patients [10].

This study has several limitations, such as the patient data used in this study consisting of ischemic stroke patients who came at the time of the first onset and repeated onset, which has implications for the clinical severity status of ischemic stroke patients. Second, this study did not discuss the stroke phase, namely the hyperacute, acute, sub-acute, and chronic phases, which also affect the clinical severity of ischemic stroke patients. Third, it is complicated to find ischemic stroke patients who come to the clinic with a single risk factor related to the patient's blood glucose. This study found only 1 of 53 patients who presented with regular random blood glucose without any other risk factors, 2 of 53cpatients who presented with fasting blood glucose without any other risk factors, and 1 of 53 patients who presented with 2 hours of blood glucose. Post-prandial comes in the absence of other risk factors. Fourth, the data parameters used in this study are also secondary parameter data that are not directly related to the clinical severity of ischemic stroke patients. The addition of primary parameter data can come from radiological imaging and data on infarct volume so that it can detect the clinical severity of ischemic stroke patients specifically.

5. Conclusion

The results of random blood glucose, fasting blood glucose, and 2 hours post-prandial blood glucose cannot be the sole predictor or the primary reference in determining the clinical severity of patients using the NIHSS. *Ischemic stroke* is a multifactorial disease caused by many risk factors, both modifiable and non-modifiable. The main modifiable risk

factors such as hypertension, diabetes mellitus, and hyperglycemia play a significant role in the progression of ischemic stroke when first admitted to the clinic. In this study, data were obtained that 1.89% of ischemic stroke patients had a single modifiable risk factor (hypertension, diabetes, and cholesterol). This means that only 1 out of 52 patients has a single risk factor for ischemic stroke.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare that there is no conflict of interest that would affect the findings of this study.

Statement of ethical approval

This research was started after obtaining permission and approval from the Health Research Ethics Committee of RSUD Dr. Soetomo. This study uses data from medical records from Installation of Communication and Information Technology (ITKI) center RSUD Dr. Soetomo Surabaya.

Statement of informed consent

Informed consent was obtained from all participants included in the study.

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