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Probability of Stroke Based on Clinical Decision Support System (CDSS) Using the Framingham Risk Score Method in dr Soebandi Hospital, Jember

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ABSTRAK

Stroke merupakan penyebab utama kematian di Indonesia. Identifikasi faktor risiko stroke dapat menggunakan Clinical Decision Support System (CDSS). Peneliti telah merancang dan mengembangkan CDSS dengan menggunakan metode Framingham Risk Score (FRS) untuk mengidentifikasi stroke pada pasien. Penelitian bertujuan untuk mengidentifikasi faktor risiko stroke menggunakan CDSS dengan metode Framingham Risk Score. Penelitian ini merupakan observasional analitik menggunakan data sekunder dari dokumen rekam medis pasien poli saraf. Populasi merupakan rekam medis pasien di poli saraf. Teknik sampling yang digunakan adalah insidental sampling yang memenuhi kriteria inklusi dan kriteria eksklusi. Kriteria inklusi yang digunakan dalam memilih rekam medis adalah rekam medis yang memiliki kelengkapan data mengenai jenis kelamin, usia, tekanan darah sistol, total kolesterol, HDL, perilaku merokok, riwayat diabetes mellitus, dan kejadian stroke pasien sehingga diperoleh 14 rekam medis pasien. Data dianalisis menggunakan metode FRS. Berdasarkan hasil penelitian dapat disimpulkan bahwa terdapat 8 pasien dengan risiko tinggi dan 6 pasien dengan risiko rendah. Namun, perlu dilakukan penelitian lebih lanjut untuk mengenai hubungan antar variabel sehingga dapat memberikan kontribusi lebih detail dalam upaya menurunkan prevalensi stroke yang ada di masyarakat.

Kata kunci: *CDSS, Framingham Risk Score, Hospital, Medical Record, Strokes*

ABSTRACT

Stroke is the main cause of death in Indonesia. Identification of stroke risk factors can use the Clinical Decision Support System (CDSS). Researchers have designed and developed a CDSS using the Framingham Risk Score (FRS) method to identify stroke in patients. The study aims to identify stroke risk factors using CDSS with the Framingham Risk Score method in dr Soebandi Hospital.This research was an analytic observational study using secondary data from medical record documents of neurology patients. . The sampling technique used was incidental sampling that met the inclusion criteria and exclusion criteria. The inclusion criteria used in selecting medical records were medical records that had complete data regarding gender, age, systolic blood pressure, total cholesterol, HDL, smoking behavior, history of diabetes mellitus, and the patient's stroke incidence thus obtaining 14 patient medical records.. Data were analyzed using the FRS method. Based on the research results, it can be concluded that there were 8 patients with high risk and 6 patients with low risk. However, further research needs to be carried out on the relationship between variables so that they can contribute in more detail to efforts to reduce the prevalence of stroke in society.

Keywords: *CDSS, Framingham Risk Score, Hospital, Medical Record, Strokes*

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I. INTRODUCTION

Stroke is the main cause of death in Indonesia.[1] The incidence of stroke in rural areas is 0.0017%, while in urban areas the prevalence of stroke is 0.022%.[2] The crude death rate due to stroke is 56/100,000, with a death rate based on age-gender of 99/100,000. Disability Adjusted Life Years (DALYs) lost due to stroke were 1311/100,000, while age-gender standard DALYs were 685/100,000. 2018 RISKESDAS data shows that East Java is one of the provinces with the highest incidence of stroke in residents aged ≥ 15 years.[3]

Stroke is a multicausal disease caused by many factors.[4] The research results of Ikhtiar et al (2023) stated that stroke was caused by smoking, hypertension and diabetes.[5] Stroke risk factors are divided into two, factors that can be controlled and factors that cannot be controlled. Risk factors that can be controlled consist of

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physical activity, smoking behavior, obesity and alcohol. Meanwhile, factors that cannot be controlled consist of a history of previous stroke, family history, and Transient Ischemic Attack (TIA).[6,7] Other studies state that strokes are caused by High Density Lipoprotein – Cholesterol.[8,9]

One way to reduce the prevalence of stroke is by early detection. Early detection can be done by identifying risk factors using the Clinical Decision Support System (CDSS).[10–12] CDSS is an electronic system designed to assist medical personnel in making clinical decisions to improve health services and patient safety.[13–15] CDSS has been used since 1990 in hospitals which includes radiation therapy dosimetry systems, ECG interpretation, lung function interpretation, and other coverage. More specifically, in various clinical areas, CDSS is used to monitor drug use, drug prescribing, warning of abnormal laboratory results, quality of service comparison testing, and diagnostic and therapeutic consultation services.[16] Therefore, researchers have designed and developed a CDSS using the Framingham Risk Score (FRS) method to identify stroke in patients.[17]

The Framingham Risk Score (FRS) is a method used to predict stroke risk factors in patients.[18] FRS variables consist of age, gender, total cholesterol, HDL, smoking habits and systolic blood pressure. A high FRS score indicates the patient is at high risk of suffering a stroke.[19] Previous research on risk factors for stroke using the Framingham method was carried out by Sun et al (2023), but this study did not use CDSS.[20] Therefore, the aim of this study was to analyze the probability of stroke risk based on the Clinical Decision Support System (CDSS) using the Framingham Risk Score Method at RSD dr. Soebandi Jember.

II. METHODS

This research was carried out at RSD dr. Soebandi, Jember, Indonesia. The type of research carried out was analytical observational with a cross sectional research design. The method for determining stroke risk used in this study was Framingham Risk Score (FRS). FRS considers six stroke risk factors, including age, gender, total cholesterol, HDL, smoking habits, diabetes mellitus, and systolic blood pressure (table 1).

Research data used secondary data frompatient medical record documents. The population was the medical records of patients at the neurology clinic. The sampling technique used was incidental sampling that met the inclusion criteria and exclusion criteria. The inclusion criteria used in selecting medical records were medical records that had complete data regarding gender, age, systolic blood pressure, total cholesterol, HDL, smoking behavior, history of diabetes mellitus, and medical diagnosis of stroke. Meanwhile, the exclusion criteria are outpatient medical records and data in medical records that are illegible, thus, 14 samples of medical record documents were obtained. This research has received approval from the Jember State Polytechnic Health Research Ethics Commission with ethical approval letter number 1060/PL17.4/PG/2023. This research has also received approval from dr. Soebandi Hospital through research permit number 423.4/5492/610/2021.

The stages of this research are explained in the following flowchart:

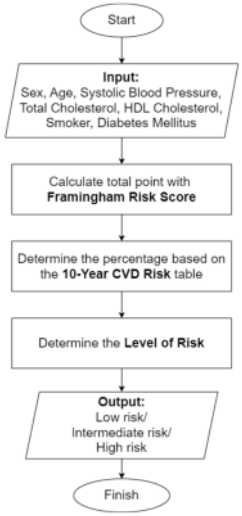

Figure 1. Framingham Risk Score flowchart

The research stages using the Framingham Risk Score (FRS) method:

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1. Starting from inputting data values for 7 variables, namely gender, age, systolic blood pressure, total cholesterol, HDL-cholesterol, smoker, and Diabetes Mellitus.
2. From the value of each variable the points will be calculated based on the Risk Points table from the FRS whose rules can be seen in table 1. Then the total points are calculated.
3. From the total points, the next step is to determine the percentage based on the 10-year CVD (Cardiovascular Disease) Risk table which can be seen in table 2.
4. Then determine the risk level using the following rules:
   1) Low Risk: if FRS < 10%
   2) Medium Risk: if FRS 10-19%
   3) High Risk: if FRS ≥ 20%

Table 1. Risk Points Framingham Risk Score

Risk Factor	Risk Points	
	Male	Female
Age		
30-34	0	0
35-39	2	2
40-44	5	4
45-49	7	5
50-54	8	7
55-59	10	8
60-64	11	9
65-69	12	10
70-74	14	11
75+	15	12
Total Cholesterol (mg/dl)		
<169	0	0
169-199	1	1
200-239	2	3
240-279	3	4
≥ 280	4	5

Risk Factor	Risk Points			
	Men		Women	
HDL-Cholesterol (mg/dl)				
≥ 60	-2		-2	
50-59	-1		-1	
45-49	0		0	
35-44	1		1	
≤35	2		2	
Systolic Blood Pressure (mmHg)	**Not Treated**	**Treated**	**Not Treated**	**Treated**
< 120	-2	0	-3	-1
120-129	0	2	0	2
130-139	1	3	1	3
140-149	2	4	2	5
150-159	2	4	4	6
160+	3	5	5	7
Smoker				
Yes	4		3	
No	0		0	
Diabetes Mellitus				
Yes	4		3	
No	0		0	

Table 2. 10-Year CVD Risk

Total Points	10-Year CVD Risk (%)	
	Male	Female
-3 or less	<1	<1
-2	1.1	<1
-1	1.4	1.0
0	1.6	1.2
1	1.9	1.5
2	2.3	1.7
3	2.8	2.0
4	3.3	2.4
5	3.9	2.8
6	4.7	3.3
7	5.6	3.9
8	6.7	4.5
9	7.9	5.3
10	9.4	6.3
11	11.2	7.3
12	13.3	8.6
13	15.6	10.0
14	18.4	11.7
15	21.6	13.7
16	25.3	15.9
17	29.4	18.51
18	>30	21.5
19	>30	24.8
20	>30	27.5
21+	>30	>30

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III. RESULT AND DISCUSSION

Testing was carried out on 45 patient medical record data from RSD dr. Soebandi Jember with 7 variables from the FRS, namely: gender, age, systolic blood pressure, total cholesterol, HDL cholesterol, smoker, and Diabetes Mellitus. The test dataset is outlined in the following table:

Table 3. Test Data

No.	Patient	Gender	Age	Systolic	Total Cholesterol	HDL Cholesterol	Smoker (Yes/No)	Diabetes Mellitus	Diagnosis
1.	Patient 1	Male	49	156	211	27.1	No	No	Stroke
2.	Patient 2	Female	52	148	231	38	No	No	Stroke
3.	Patient 3	Male	54	218	177	34	Yes	No	Stroke
4.	Patient 4	Male	60	180	200	27.2	No	No	Stroke
5.	Patient 5	Female	69	141	156	39	No	No	Stroke
6.	Patient 6	Male	56	140	103	36	No	No	Stroke
7.	Patient 7	Male	76	157	147	28.6	No	No	Stroke
8.	Patient 8	Male	60	157	120	14	No	Yes	Stroke
9.	Patient 9	Female	74	193	196	41.1	Yes	Yes	DM+CAD+HF*
10.	Patient 10	Male	62	150	135	23	No	Yes	Stroke
11.	Patient 11	Female	60	160	163	31	No	Yes	DM+HHD+CAD*
12.	Patient 12	Male	55	110	209	31	Yes	No	CAD + HF*
13.	Patient 13	Male	38	177	233	43	No	Yes	Stroke
14.	Patient 14	Female	54	149	120	32	No	Yes	Stroke

*CAD : Coronary Artery Disease (abnormalities in the coronary arteries in the heart)
*HF : Heart Failure
*HHD : Hypertensive Heart Disease
*DM : Diabetes Mellitus

From this data, detection is carried out in a system that has been created in accordance with the rules of FRS. The following is an example of testing carried out on the CDSS system:

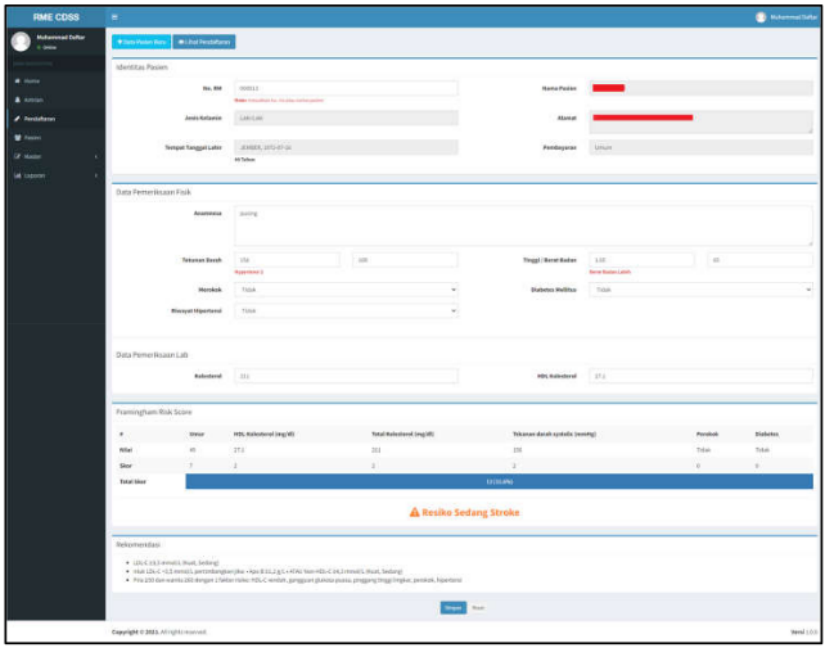

Figure 2. Testing for filling in patient 1 data on the Stroke Risk CDSS

In the picture above, the officer is completing an examination of the patient. Based on the entries in the FRS variable, the total score or points are calculated, so that the final results

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can determine the level of stroke risk experienced by the patient. In patient 1, the total FRS score was 13, which when converted to a 10-year CVD risk percentage, the percentage result was 15.6%, which means it was in the moderate risk level category. After testing 14 datasets, the scoring results carried out on the system are shown in the following table.

Table 4. Framingham Risk Score Calculation Results on Test Dataset

No.	Patient	Gender	Risk Points on the Framingham Risk Score: Age	Systolic	Total Cholesterol	HDL Cholesterol	Smoker (Yes/No)	Diabetes Mellitus	Total Risk Points
1.	Patient 1	Female	7	2	2	2	0	0	**13**
2.	Patient 2	Female	7	2	3	1	0	0	**13**
3.	Patient 3	Male	8	3	1	2	4	0	**18**
4.	Patient 4	Male	11	3	2	2	0	0	**18**
5.	Patient 5	Female	10	2	0	1	0	0	**13**
6.	Patient 6	Male	10	2	0	1	0	0	**13**
7.	Patient 7	Male	15	2	0	2	0	0	**19**
8.	Patient 8	Male	11	2	0	2	0	4	**19**
9.	Patient 9	Female	11	5	1	1	3	3	**24**
10.	Patient 10	Male	11	2	0	2	0	4	**19**
11.	Patient 11	Female	9	5	0	2	0	3	**19**
12.	Patient 12	Male	10	0	2	2	4	0	**18**
13.	Patient 13	Male	2	3	2	1	0	4	**12**
14.	Patient 14	Female	7	2	0	2	0	3	**14**

After knowing the total points from the calculation in table 4, then determine the value in the 10-Year CVD (Cardiovascular Disease) Risk table where the output is in the form of a percentage value as outlined in table 5 below

.

Table 5. Determination Of Patient Risk Level Categories

No.	Patient	Gender	Total Risk Points	Percentage of 10-Year CVD Risk (%)	Risk Level Category	Actual Disease Diagnosis
1.	Patient 1	Male	13	15.6	Medium Risk	Stroke
2.	Patient 2	Female	13	10.0	Medium Risk	Stroke
3.	Patient 3	Male	18	>30	High Risk	Stroke
4.	Patient 4	Male	18	>30	High Risk	Stroke
5.	Patient 5	Female	13	10.0	Medium Risk	Stroke
6.	Patient 6	Male	13	15.6	Medium Risk	Stroke
7.	Patient 7	Male	19	>30	High Risk	Stroke
8.	Patient 8	Male	19	>30	High Risk	Stroke
9.	Patient 9	Female	24	>30	High Risk	DM+CAD+HF*
10.	Patient 10	Male	19	>30	High Risk	Stroke
11.	Patient 11	Female	19	24.8	High Risk	DM+HHD+CAD*
12.	Patient 12	Male	18	>30	High Risk	CAD + HF*
13.	Patient 13	Male	12	13.3	Medium Risk	Stroke
14.	Patient 14	Female	14	11.7	Medium Risk	Stroke

*CAD : Coronary Artery Disease (abnormalities in the coronary arteries in the heart)
*HF : Heart Failure
*HHD : Hypertensive Heart Disease
*DM : Diabetes Mellitus

Based on table 5, it can be concluded that there are 8 patients with high risk and 6 patients with medium risk. Research data shows that there were 9 male stroke patients (64.29%), and 5 female stroke patients (35.71%). In addition, 66.67% of male patients suffered from stroke with a high risk. This shows that the male gender is more at risk of suffering a stroke.

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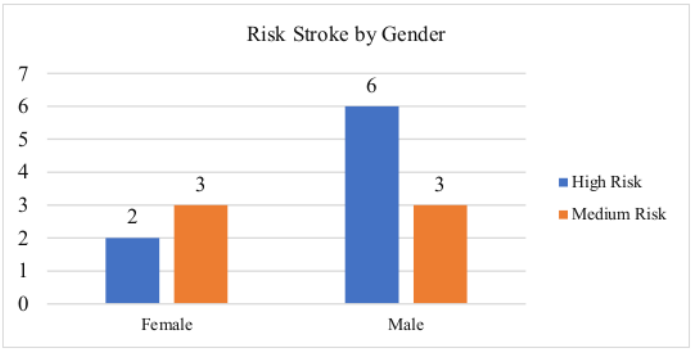

Figure 3. Risk Stroke by Gender

Stroke occurs more often in men.[21] This study support the Bushnull's research (2001), that stroke occurs in men because men possess the hormone testosterone that can enhance LDL.[22] If LDL levels are high, it can increase blood cholesterol levels as LDL is a risk factor for stroke [23]. This study concluded the same as the results of study by Thomas et al (2021) that the prevalence of stroke in women is lower instead of in men [24]. This is since the smoking habit is more dominant in men than in women. In addition, women tend to experience strokes in old age because women have the hormone estrogen that plays a role in maintaining the body's immunity until menopause and as protection against the atherosclerosis process.[22]

The level of stroke risk is influenced by age factors.[25] The age distribution of patients is shown in the following figure.

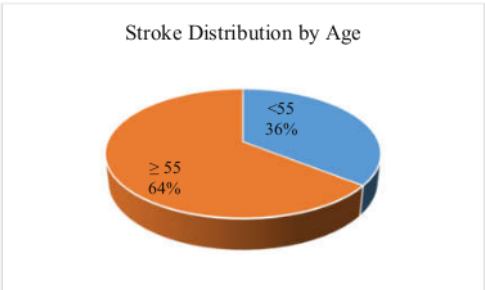

Figure 4. Stroke Distribution by Age

This study showed 64% of patients were aged ≥ 55 years. Suiraoka (2012) explains that the risk of stroke will increase after the age of 55 years.[26] The level of stroke risk is influenced by age factors. Age is related to aging of body organs, especially blood vessels. Increasing age causes a reduction in elasticity of blood vessels that can result in impaired blood flow to the brain.[27] However, this study found that there was a patient aged 38 years who suffered a stroke. This is because current lifestyles tend to be unhealthy which can increase the risk of stroke, including smoking, diabetes mellitus, consuming foods lots of fat, and lack of physical activity.

Obesity is a risk factor for stroke.[28,29] Patients suffering from obesity contain high levels of fat and cholesterol. The results showed that 36% of patients had high total cholesterol.

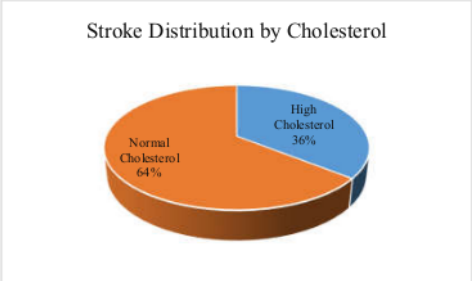

Figure 5. Stroke Distribution by Cholesterol

Increasing risk of ischemic stroke is associated with high total cholesterol [30]. High total cholesterol can generate atherosclerosis, the main pathology in the incident of ischemic stroke or non-hemorrhagic stroke [31]. High total cholesterol can be identified in 19% of ischemic stroke sufferers and has been found to be an independent predictor for ischemic stroke

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sufferers. An increase in total cholesterol in the blood will cause plaque in the blood vessels which can trigger stroke.[32] The research results of Listiana et al. (2018) states that total cholesterol has significant relationship with occurrence of stroke in patients.[33] International Geriatrics and Gerontology suggests that people with high total cholesterol over in the long term can worsen stroke recovery. In middle-aged and elderly people have greater ischemic stroke mortality associated with total cholesterol.[34,35]

Smoking is a risk factor for stroke. Compared to non-smokers, smokers have greater risk of stroke.[36,37] The substances contained in cigarette smoke can increase the depth of the intima and arterial media, resulting in stiffness or sclerosis that causes cardio vascular and cerebrovascular disease or stroke. The occurrence of stroke will get larger if smoking behavior is associated with another risk factors, especially hypertension. The results of our study show that smoking patients accompanied by hypertension have a high risk of stroke. Huangfu in his research also concluded that patients who smoke and who have hypertension are at high risk of stroke.[38]

Another factor that causes stroke is blood pressure. The greater blood pressure, so the higher the chance for stroke.[39] This is shown by the research results.

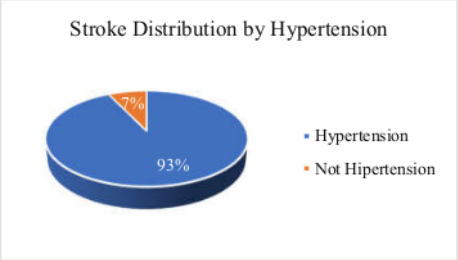

Figure 6. Stroke Distribution by Hypertension

The figure above illustrates that 93% of stroke patients have hypertension. Hypertension can trigger plaque deposits in blood vessels which can restrict the diameter of blood vessels. Unstable plaque will crack and fall off, increasing the risk of blockage of the brain's smaller blood vessels. If this happens, a stroke can occur.[40] Previous research results states there is significant relationship between hypertension and the occurrence of stroke [41–44].

Another risk factor is Diabetes Mellitus (DM). DM is the second largest risk factor for stroke after hypertension [45]. Our study resulted that there were 6 patients suffering from diabetes mellitus (42.86%). This is shown by the following results diagram.

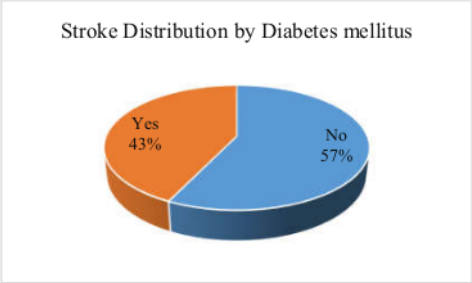

Figure 7. Risk Stroke by DM

DM causes changes in the vascular system, encouraging atherosclerosis and increasing the occurrence of hypertension. The combination of hypertension and DM has the potential to increase stroke complications.[46] In DM sufferers, increased blood glucose triggers several mechanisms that play a role in increasing the risk of stroke, namely vascular endothelial dysfunction, expanded arterial rigidity at an early age, systemic inflammation and thickening of the capillary basement membrane.[47] DM has been assured to be a risk factor for stroke with a relative risk increase of 1,6 to 8 times.[48] The results of other studies report a different risk of DM for stroke, namely 4,226. The large difference in the risk of DM and stroke between studies is caused by differences in the characteristics of the patients selected as research samples.[43]

IV. CONCLUSION

Research results concluded that there were 8 patients with high risk and 6 patients with medium risk. However, more research are required on the relationship between dietary habit and community behavior as risk factors for stroke so that they can contribute in more detail to efforts to reduce the prevalence of stroke in

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society. Hospital is advised to increase health promotion to the public to increase public awareness of having a healthy lifestyle so that the prevalence of stroke can decrease.

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