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Relationship Between Results of The Gajah Mada Stroke Algorithm Assessment and Type of Stroke Based On Non Contrast Head CT-Scan Results at Wijayakusuma Purwokerto Hospital

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ABSTRACT

Background: Stroke is a neurological deficit condition that often results in serious consequences dan requires rapid dan accurate diagnosis. Objective: This study aims to determine the relationship between the results of the Gajah Mada Stroke Algorithm assessment dan the type of stroke detected through non-contrast head CT scans at RST Wijayakusuma Purwokerto. Methodology: The research employed an observational approach, collecting data from 32 patients presenting with acute stroke symptoms from June to July 2024. Data were gathered through patient anamnesis, physical examinations, dan non-contrast head CT-scan results. Results: The findings indicate that ischemic stroke is the most prevalent type, accounting for 84.4% of cases based on non-contrast head CT scans. The Gajah Mada Stroke Algorithm also identified the majority of cases as ischemic stroke, with 59.4% of cases. Bivariate analysis using Fisher's Exact Test revealed a p-value of 0.006, demonstrating a significant relationship between the Gajah Mada Stroke Algorithm assessment dan CT-scan results. Conclusion: The Gajah Mada Stroke Algorithm has proven effective in distinguishing between types of stroke. This study supports the use of the algorithm as a clinical diagnostic tool in stroke management.

1. INTRODUCTION

Stroke is a clinical symptom of local or systemic brain dysfunction that appears suddenly and lasts more than 24 hours so that it can be fatal caused by blood vessel disorders with complex and diverse clinical pictures (Jamilah et al., 2023). Stroke is a serious global health challenge. Globally, stroke ranks fifth among all causes of death after heart disease, cancer, Covid-19, and unintentional accidents (Tsao et al., 2023). Stroke can be classified as hemorrhagic or ischemic depending on the cause of the disruption of blood flow to the brain (Athar et al., 2023). According to data released by the American Heart Association (AHA) in 2023, an estimated 11.71 million cases of stroke cause 7 million deaths each year worldwide (Tsao et al., 2023). In Indonesia, based on the results of the 2018 National Basic Health Research, the prevalence of stroke increased to 10.9% from 7% in 2013. At the provincial level, the prevalence of stroke in Central Java based on a doctor's diagnosis was 11.8% or 96,794 cases (Riskesdas, 2018). According to the outpatient diagnosis report at the Banyumas Regency Health Center in 2023, there were around 10,149 cases of stroke reported (Dinas Kesehatan Banyumas, 2024). Based on the high number of stroke cases, a comprehensive approach is needed in establishing a stroke diagnosis, especially the identification between ischemic and hemorrhagic strokes, because there are differences in the initial management strategies for the two types of stroke (Athar et al., 2023). The majority of acute stroke cases are identified using Computed Tomography Scan or non-contrast head CT scan as the standard in establishing a stroke diagnosis, as well as helping to differentiate the type of stroke

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(Herring, 2016). There are several limitations to CT-scan examinations, generally related to availability factors because this tool is relatively expensive so that it cannot be reached by most hospitals that still have limited resources (Fakhruddin & Nurmalia, 2019). One example of this limitation can be found in Banyumas Regency, where only 8 out of a total of 25 hospitals are equipped with CT-scan facilities (Dinas Kesehatan Banyumas, 2024).

To overcome this, an efficient and inexpensive clinical strategy is needed to diagnose stroke and identify the type of stroke. One alternative that can be used is the Gajah Mada stroke algorithm (Saudin et al., 2020). The Gajah Mada stroke algorithm is a bedside diagnosis developed in Indonesia with the aim of distinguishing between hemorrhagic stroke and ischemic stroke. The variables used include decreased consciousness status, Babinski reflex, and headache (Rusdi, 1996). Based on research conducted by Fakhruddin & Nurmalia (2019), the accuracy level of the Gajah Mada stroke algorithm reached 88%. Although alternatives like this have lower accuracy than CT scans, the Gajah Mada stroke algorithm is still reliable because it is more efficient and economical, however, its accuracy still needs to be studied further (Sutarwi et al., 2020). Based on the explanation above, also because there are still few studies discussing the Gajah Mada stroke algorithm, the author is interested in studying the relationship between the results of the Gajah Mada stroke algorithm assessment and the type of stroke based on the results of a non-contrast head CT scan at RST Wijayakusuma Purwokerto.

2. METHOD

This study used an observational method with a cross-sectional approach which was carried out by collecting and observing primary data in the form of the results of the Gajah Mada stroke algorithm assessment and the results of a non-contrast head CT scan as the gold standard in identifying the type of stroke at the beginning of the onset. The population of this study were patients with acute stroke symptoms who were being treated at the RST Wijayakusuma Purwokerto Emergency Room. The sample of this study was acute stroke patients treated at the RST Wijayakusuma Purwokerto Emergency Room who met the inclusion and exclusion criteria. The independent variable was the results of the Gajah Mada stroke algorithm assessment and the dependent variable was the type of stroke based on the results of a non-contrast head CT scan. The sampling technique used consecutive sampling with a sample size of 32.

Materials and Equipment

The data collection tools used are medical information of acute stroke patients, results of non-contrast head CT scans, Gajah Mada stroke algorithm, stationery, computers, DICOM viewer software.

Data Collection Process

The study was conducted from June 2024 to July 2024. The study began by conducting a direct examination of patients suspected of having acute stroke who were then asked for their willingness to become research subjects through a written consent form. Gajah Mada stroke algorithm data is based on the results of anamnesis and physical examination. Furthermore, data collection was carried out on the classification of stroke types based on the results of a non-contrast head CT scan and interpreted by a radiologist. After that, the inclusion and exclusion criteria were identified in the samples obtained. Data was collected until the sample size was met, the data was processed and analyzed to determine the relationship between variables.

Data Analysis

The collected data were analyzed univariately and bivariately. Univariate analysis shows the distribution of demographic data of research subjects and research variable data presented in the form of distribution tables and graphs. The distribution of demographic data of research subjects includes gender and age, while the distribution of research variable data includes the results of the Gajah Mada stroke algorithm assessment and the results of non-contrast head CT scan assessment. Bivariate analysis was conducted to test the relationship between the results of

the Gajah Mada stroke algorithm assessment and the type of stroke based on the results of non-contrast head CT scan at RST Wijayakusuma Purwokerto using the Fisher Exact Test.

3. RESULT AND DISCUSSION

Result

Analysis was conducted on 32 samples that met the inclusion and exclusion criteria and were willing to be research subjects.

Table 1. Distribution of Research Subjects by Gender and Age

Characteristic	Total	Percentage
Gender		
Male	16	50%
Female	16	50%
Age (Years)		
20-29 years	1	3,1%
30-39 years	1	3,1%
40-49 years	3	9,4%
50-59 years	4	12,5%
60-69 years	8	25,0%
70-79 years	5	15,6%
80-89 years	10	31,3%

A total of 32 patients with acute stroke symptoms participated in this study, with a balanced gender distribution, namely 50% male and 50% female. The majority of patients were in the elderly age group, with 31.3% aged 80-89 years and 25% aged 60-69 years. The 70-79 age group consisted of 15.6% of patients, while 50-59 years comprised 12.5% of patients. Only a small proportion were under 50 years of age, with 9.4% aged 40-49 years, and 3.1% each in the 20-29 and 30-39 age ranges.

Table 2. Distribution of Stroke Types Based on Gender

Gender	Ischemic Stroke	Hemorrhagic Stroke
Male	13	3
Female	14	2

From the total 32 patients studied, the distribution of stroke types between men and women showed that ischemic stroke was more common in both sexes. In men, 13 of 16 patients had ischemic stroke, while 3 others had hemorrhagic stroke. Among women, 14 of 16 patients had ischemic stroke, and 2 had hemorrhagic stroke. This shows that ischemic stroke is more dominant than hemorrhagic stroke in both male and female patients in this study.

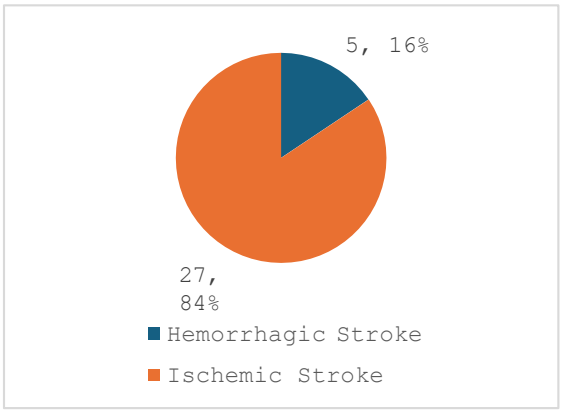

Figure 1. Results of a non-contrast head CT scan

Figure I shows that of the total 32 stroke cases, 27 cases (84%) were ischemic, while 5 cases (16%) were hemorrhagic. This shows that ischemic stroke is more prevalent than hemorrhagic stroke in the studied sample, with the percentage of infarction cases exceeding five times that of hemorrhagic cases.

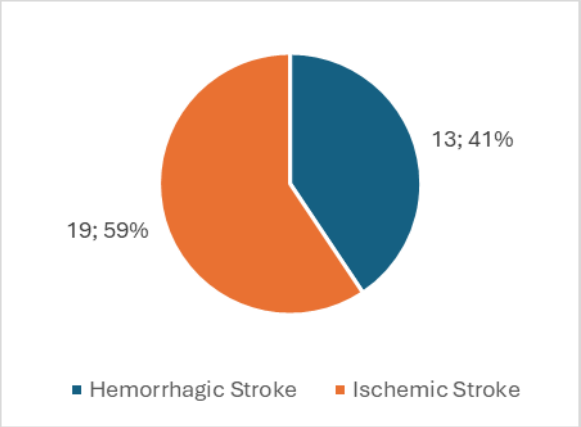

Figure 2. Result of Gajah Mada Stroke Algorithm Assesment

Figure II shows that out of a total of 32 stroke cases, 19 cases (59%) were ischemic strokes, while 13 cases (41%) were hemorrhagic strokes. This shows that ischemic strokes are more common than hemorrhagic strokes in the studied samples when assessed using the Gajah Mada stroke algorithm. With a percentage of more than half of the total number of cases, ischemic stroke is the most dominant type of stroke when assessed using the Gajah Mada stroke algorithm.

Table 3. Cross Tabulation Between Variables

		Non contrast head CT-scan		
		Hemorrhagic	Ischemic	**Total**
Gajah Mada Stroke Algorithm	Hemorrhagic	5	8	**13**
	Ischemic	0	19	**19**
	Total	**5**	**27**	**32**

Table 3 shows that out of a total of 32 study subjects, the Gajah Mada stroke algorithm identified 13 hemorrhagic strokes and 19 ischemic strokes. Among the cases identified as hemorrhagic strokes by the Gajah Mada stroke algorithm, 5 cases were confirmed hemorrhagic and 8 cases were confirmed ischemic by non-contrast head CT scan. Meanwhile, out of 19 cases identified as ischemic strokes by the Gajah Mada stroke algorithm, all were confirmed as ischemic strokes from non-contrast head CT scans. Overall, there were 5 hemorrhagic cases and 27 ischemic cases identified by non-contrast head CT scans.

Table 4. Relationship between variables with Fisher Exact Test

Test	***p-value***
Fisher exact test	0,006

Based on Table 4, the relationship between the results of the Gajah Mada stroke algorithm assessment and the type of stroke based on the results of a non-contrast head CT scan has a p value of 0.006. So if the p value is <0.05, which indicates a significant relationship between the results of the Gajah Mada stroke algorithm assessment and the type of stroke based on the results of a non-contrast head CT scan at RST Wijayakusuma Purwokerto.

Discussion

Stroke is a neurological disorder that causes sudden death of some brain cells due to blockage or rupture of arteries in the brain. Definitively, stroke is a neurological disorder that

appears suddenly due to blockage or rupture of blood vessels in the brain. Stroke gives different clinical symptoms according to the location or extent of damage to blood vessels in the brain. (Gunani et al., 2022). In this study, the distribution of research subjects between men and women was balanced, with a ratio of 1:1. This indicates that each gender contributes 50% of the total sample. Although this distribution is balanced, research conducted by Fakhruddin & Nurmalia (2019) shows that men have a higher risk of experiencing stroke than women, with a ratio of 3:1. This statement is also consistent with research conducted by Sakti et al (2021) namely Men have a three times greater risk of stroke, this difference in risk can be caused by unhealthy lifestyles such as smoking and alcohol consumption. In addition, hormones also play an important role in the occurrence of stroke. The testosterone hormone in men can increase LDL (Low Density Lipoprotein) levels, which, if high, can increase blood cholesterol and become a risk factor for stroke. In contrast, women have hormonal protection against stroke, namely the hormone estrogen. This hormone helps maintain the immune system until menopause and provides protection against the process of atherosclerosis. Although there is such a ratio, this comparison can be different in old age, where the incidence of stroke between men and women is almost equal (Laily, 2017). This incident is caused by the protection that women have from stroke until middle age thanks to the hormone estrogen. The risk of stroke in women becomes equal to that of men after menopause (Nurhidayat., 2019). Age is one of the main risk factors for stroke. As we age, the risk of stroke increases due to oxidative stress and the process of atherosclerosis. In old age, the elasticity of the arteries decreases, causing blood vessels to narrow and become stiff, which can be a predisposing factor for stroke (Sakti et al., 2021).

Based on the results of the non-contrast head CT scan reading, the dominance of ischemic stroke is clearly visible, with the number of ischemic stroke cases as many as 27 out of a total of 32 stroke cases. These results show that ischemic stroke cases are five times higher compared to hemorrhagic strokes, which only amount to 5 cases. This finding is in line with the global prevalence of stroke, which shows that 88% of all stroke cases are ischemic strokes (Nurhidayat et al., 2019). In the assessment using the Gajah Mada stroke algorithm, the dominance of ischemic stroke was found, namely 19 out of a total of 32 cases. These results show that ischemic stroke is also more prevalent when compared to hemorrhagic stroke when assessed using the Gajah Mada stroke algorithm.

The Gajah Mada stroke algorithm has 3 assessment components, namely decreased consciousness, headache and Babinski reflex. These three components have previously been calculated for their significance in relation to each stroke classification. Decreased consciousness occurs when the center of consciousness is disturbed. Consciousness is regulated by the ascending reticular activating system (ARAS) and the two hemispheres of the brain. Therefore, extensive damage to the ARAS after a stroke will contribute to a decreased level of consciousness (Aprilia & Wreksoatmodjo, 2015; Kwak & Chang, 2020). The entire brain parenchyma and cerebellum as well as intraparenchymal vessels are insensitive to stimuli. However, severe bleeding or edema caused by hemorrhagic stroke and ischemic stroke can cause headaches by shifting and stretching pain-sensitive intracranial structures. The presence of ischemic and hemorrhagic strokes can result in distension, deformation, and stretching of pain-sensitive structures in the central nervous system (Ahmadi et al., 2015). Both ischemic and hemorrhagic strokes can cause the Babinski reflex to appear. Stroke can cause damage to the corticospinal tract which causes sensory input to spread to other nerve roots, causing contraction of the toe extensor muscles via the deep peroneal nerve and causing extension of the great toe (hallux) and sometimes splaying of the other toes (Acharya et al., 2023).

In the assessment using the Gajah Mada stroke algorithm, hemorrhagic stroke occurred more frequently, namely 13 cases, compared to the assessment using non-contrast head CT scans which only recorded 5 cases. Differences in results like this can be caused by factors from the Gajah Mada stroke algorithm, including the clinical picture of ischemic and hemorrhagic stroke patients who have similarities. According to research by Li et al (2020), headaches often occur in ischemic stroke patients, with a percentage reaching 35%, meanwhile, the Gajah Mada Stroke algorithm immediately classifies patients as hemorrhagic stroke if complaints of headache are found, factors like this can cause a high percentage of hemorrhagic strokes if assessed using the

Gajah Mada stroke algorithm. Regarding this problem, the Gajah Mada stroke algorithm system can be further refined to increase its accuracy in distinguishing types of stroke. The steps that can be taken are to add other components that can increase accuracy in distinguishing types of stroke.

Improvement of the Gajah Mada stroke algorithm can be done by adding components from the Siriraj score, which is known to have high accuracy in detecting stroke classification. One important component of the Siriraj score that is relevant to be included in the Gajah Mada stroke algorithm is vomiting, because in the initial development of the algorithm, vomiting was already one of the variables tested and it turned out to show quite high accuracy in distinguishing the type of stroke. By including this component, it is hoped that the accuracy of the Gajah Mada stroke algorithm can be increased in distinguishing between ischemic and hemorrhagic strokes (Rusdi, 1996). Other risk factors such as marital status, type of residence, glucose levels, occupation, age, gender, hypertension, heart disease, BMI, and smoking habits, as studied by Hassan et al (2024), can also be included to improve the accuracy of the algorithm. The addition of these variables allows the algorithm to be more effective in identifying high-risk individuals, especially those who work in the private sector or are self-employed. Salvadori et al (2021) research also shows that factors such as diabetes, dyslipidemia, and atrial fibrillation are important in distinguishing ischemic and hemorrhagic strokes, so adding them to the algorithm can improve the accuracy of stroke diagnosis. By adding more comprehensive risk factors, the Gajah Mada stroke algorithm, which previously only used three components, is expected to be more accurate in diagnosing stroke. This improvement aims to increase the effectiveness of the algorithm as a clinical diagnostic tool, help medical personnel determine the type of stroke more precisely, and ultimately, provide more optimal treatment for stroke patients.

The relationship between diagnostic findings through non-contrast head CT scans and the Gajah Mada stroke algorithm shows a significant relationship between the Gajah Mada stroke algorithm assessment and non-contrast head CT scans (Sutarwi et al., 2020). Hemorrhagic and ischemic strokes are difficult to distinguish when viewed only from signs and symptoms (Nurhidayat et al., 2019). To overcome this, the bedside diagnosis method was developed to overcome challenges and improve clinical diagnosis. The scoring system functions as a tool that allows health workers to identify strokes based on existing signs and symptoms (Sutarwi et al., 2020). One of the available systems is the Gajah Mada stroke algorithm developed in Indonesia. This algorithm is designed to overcome the weaknesses of the scoring system which requires relatively long calculations and time (Fakhruddin & Nurmalia, 2019). Based on the findings of the research that has been conducted, the Gajah Mada stroke algorithm is still suitable for use as a bedside diagnosis to help differentiate ischemic stroke and hemorrhagic stroke.

4. CONCLUSION

The dominance of stroke cases occurs at the age of 60 years and above, with the majority of stroke cases being ischemic strokes based on the results of non-contrast head CT scans and there is a significant relationship between the results of the Gajah Mada stroke algorithm assessment and the type of stroke based on the results of non-contrast head CT scans at RST Wijayakusuma Purwokerto.

5. REFERENCES

Acharya, A.B., Jamil, R.T. and Dewey, J. (2023), Babinski Reflex, Statpearls, Statpearls Publishing.

Ahmadi Aghangar, A., Bazoyar, B., Mortazavi, R. and Jalali, M. (2015), "Prevalence of Headache at the Initial Stage of Stroke and its Relation with Site of Vascular Involvement: A Clinical Study", Caspian J Intern Med, Vol. 6 No. 3, pp. 156–160.

Aprilia, M. and Wreksoatmodjo, B.R. (2015), "Pemeriksaan Neurologis pada Kesadaran Menurun", CDK Bagian Neurologi Fakultas Kedokteran Universitas Atmajaya, Vol. 42 No. 10, pp. 780–786.

Athar, I., Malik, A.M., Khattak, N.N., Anis, A., Iqbal, M., Majid, H. and Badshah, M. (2023), "Reliability of Siriraj stroke score to distinguish between hemorrhagic and ischemic stroke", Brain Hemorrhages, KeAi Communications Co., Vol. 4 No. 1, pp. 13–16, doi: 10.1016/j.hest.2022.07.002.

Fakhruddin, H. and Nurmalia, L. (2019), "Perbandingan Uji Diagnostik Siriraj Stroke Score dan Algoritma Stroke Gadjah Mada Sebagai Prediktor Jenis Stroke di RS Sentra Medika Bekasi", Jk Unila, Vol. 3 No. 2, pp. 251–257.

Herring, W. (2016), Learning Radiology Recognizing The Basics, third edition, Elsevier, Philadelphia.

Hassan, A., Gulzar Ahmad, S., Ullah Munir, E., Ali Khan, I. and Ramzan, N. (2024), "Predictive modelling and identification of key risk factors for stroke using machine learning", Scientific Reports, Nature Research, Vol. 14 No. 1, doi: 10.1038/s41598-024-61665-4.

Inggas, Made Agus M., et al. Biokimia, Biologi Molekuler dan Aplikasinya Dalam Bidang Kesehatan. Mafy Media Literasi Indonesia Publisher, 2024, doi:10.1112/kakinaan1132.

Jamilah, S., Sobirin Mohtar, M., Eka Fayuning Tjomiadi, C. and Rahmat Santoso, B. (2023), "Perbedaan Siriraj Stroke Score (3S) & Dave And Djoenaidi Stroke Score System (3S2D) Terhadap Durasi Penentuan Diagnosa Keperawatan Pasien Stroke Di IGD", Indo-MathEdu Intellectuals Journal, Vol. 4 No. 3, pp. 2830–2842, doi: 10.54373/imeij.v4i3.598.

Dinas Kesehatan Banyumas. (2024), "Laporan Diagnosa Penyakit Stroke Seluruh Puskesmas Tahun 2023 hingga 2023".

Dinas Kesehatan Banyumas. (2024), "Data Ketersediaan CT-scan di RS Sekabupaten Banyumas", Dinas Kesehatan Banyumas.

Kwak, S. and Chang, M.C. (2020), "Impaired Consciousness due to Injury of the Ascending Reticular Activating System in a Patient with Bilateral Pontine Infarction: A Case Report", Translational Neuroscience, De Gruyter Open Ltd, Vol. 11, pp. 264–268, doi: 10.1515/tnsci-2020-0138.

Laily, S.R. (2017), "Hubungan Karakteristik Penderita dan Hipertensi dengan Kejadian Stroke Iskemik", FKM Unair, Vol. 5 No. 1, pp. 48–59, doi: 10.20473/jbe.v5i1.

Li, J., Zhang, P., Wu, S., Yuan, R., Liu, J., Tao, W., Wang, D., et al. (2020), "Impaired consciousness at stroke onset in large hemisphere infarction: incidence, risk factors and outcome", Scientific Reports, Nature Research, Vol. 10 No. 1, doi: 10.1038/s41598-020-70172-1.

Nurhidayat, S., Andarmoyo, S., Widiyati, W. and Kusumaningsih, D. (2019), "Hubungan Antara Hasil Penilaian Siriraj Score Dengan Jenis Stroke Di Rsud Dr. Harjono S Ponorogo", Arah Kebijakan Dan Optimalisasi Tenaga Kesehatan Menghadapi Revolusi Industri 4.0, pp. 7–13.

Riskesdas. (2018), Riset Kesehatan Dasar, Badan Penelitian Dan Pengembangan Kesehatan Departemen Kesehatan Republik Indonesia, Jakarta.

Rusdi, L. (1996), "Algoritma Stroke Gajah Mada", Berkala Ilmu Kedokteran, Vol. 28 No. 4, pp. 181–187.

Saudin, D., Rajin, M. and Yadi Rriswanto, Moch. (2020), "Perbandingan Siriraj Skor (SS) Dan Algoritma Gajah Mada (AGM) Kasus Stroke Di IGD RSUD Dr. Soedono Madiun", JURNAL EDUNursing, Vol. 4 No. 1, pp. 29–33.

Salvadori, E., Papi, G., Insalata, G., Rinnoci, V., Donnini, I., Martini, M., Falsini, C., et al. (2021), "Comparison Between Ischemic and Hemorrhagic Strokes in Functional Outcome at Discharge From an Intensive Rehabilitation Hospital", Diagnostics, Multidisciplinary Digital Publishing Institute (MDPI), Vol. 11 No. 1, doi: 10.3390/diagnostics11010038.

Sakti, P., Wulandari, I.S. and Kanita, M.W. (2021), Perbandingan Tingkat Akurasi Allen Stroke Score Dan Ct-Scan Dalam Membedakan Jenis Stroke Di Rumah Sakit Pku Muhammadiyah Karanganyar, Universitas Kusuma Husada Surakarta.

Sutarwi, S., Bakhtiar, Y. and Rochana, N. (2020), "Sensitivitas dan Spesifitas Skor Stroke Literature Review", Gaster, Universitas Aisyiyah Surakarta, Vol. 18 No. 2, pp. 186–193, doi: 10.30787/gaster.v18i2.521.

Tsao, C.W., Aday, A.W., Almarzooq, Z.I., Anderson, C.A.M., Arora, P., Avery, C.L., Baker-Smith, C.M., et al. (2023), "Heart Disease and Stroke Statistics - 2023 Update: A Report from the American Heart Association", Circulation, Lippincott Williams and Wilkins, 21 February, doi: 10.1161/CIR.0000000000001123.

Yunani, olang, J. and Winarto, E. (2022), "Siriraj Stroke Score To Detected Cerebrovascular Disease Hemorrhagic-Non Hemorrhagic", Vol. 7 No. 3